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MACHINERY

SEPTEMBER, 1914

A MODERN HEAT-TREATMENT PLANT

NEW FEATURES IN DODGE BROS. HEAT-TREATMENT SHOP—CYANIDE HARDENING

BY E. F. LAKE[*]

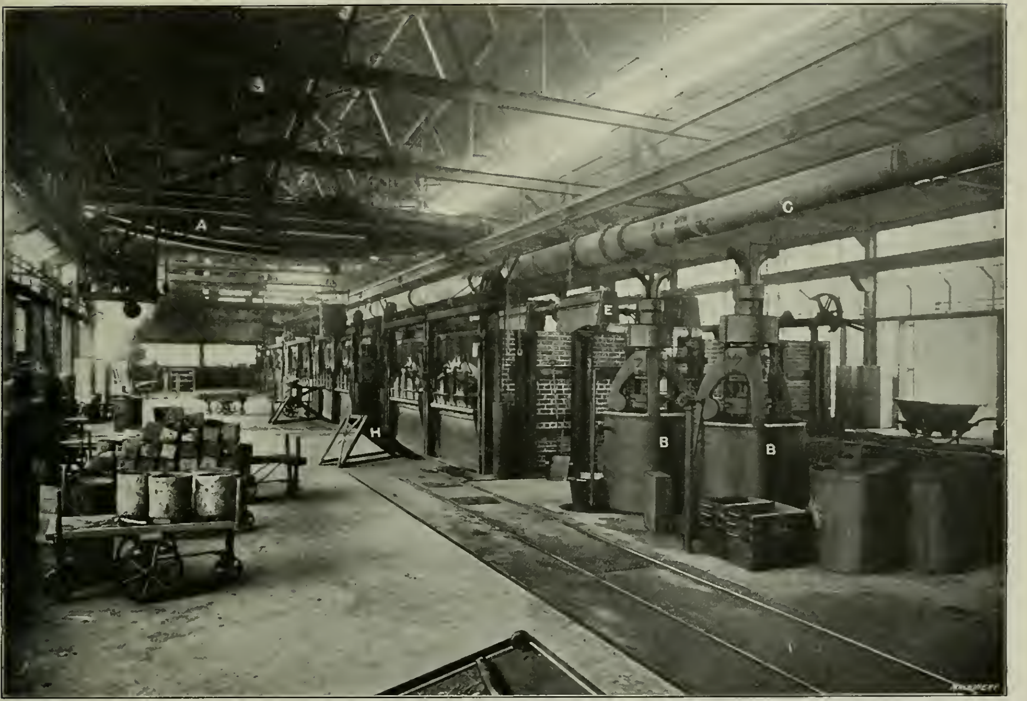

Fig. 1. North Half of Heat-treatment Building recently added to Dodge Bros. Plant, Detroit, Mich.

THE increase in strength, wearing qualities and resistance to fatigue that can be given steel by a proper heat-treatment is fast being recognized by those that manufacture products out of this metal or alloy. Therefore, many improvements are being made in hardening rooms and new apparatus is continually being devised and installed to insure certainty of results.

The ordinary machine steels, which do not contain enough carbon to be made hard enough to resist filing, will show an increase of from 10 to 30 per cent in their tensile strength, compressive strength and elastic limit when heated to a temperature a little above their highest transformation point and then cooled suddenly. In the higher carbon steels this increase is raised to 50 and 60 per cent, while many of the special alloys are given two and three times the strength they have when they leave the rolls or when in the annealed state. The resistance to fatigue can be increased in greater proportions by a correct heat-treatment. Other physical properties can also be made better able to resist the strains or stresses to which a given part may be subjected.

Thus, machine parts can be designed considerably lighter when they are to be heat-treated, and the saving in material will often more than pay for the cost of heat-treating. These conditions have even started an agitation in favor of heat-treating structural steel, while heat-treating all of the steel that goes into bridges has been advocated for some time. In the moving parts of machinery, the saving in the cost of power to move them should be added to the saving in the pounds of steel used, to show the real economy of heat-treatment. Other things should also be considered; for instance, less material in such parts as carry or support these heat-treated parts; a reduction in the size of surfaces to be machined; smaller foundations; lower freight bills; smaller, and thus cheaper, hoisting and conveying apparatus to handle such parts when machining, erecting or shipping them; less power to drive these, etc. In order to give the maximum physical properties to their steel parts and take advantage of those factors which would effect a saving in the cost of production, Dodge Bros., Detroit, Mich., recently completed a building, 70 feet wide and 400 feet long that will be devoted exclusively to the heat-treatment of steel. They have just discontinued manufacturing parts for the Ford automobile in order to build a car of their own design.

In Fig. 1 is shown the interior of about one-half of this building. The side walls are composed of structural steel and "Fenestra" sash; this makes them nearly all glass and admits the maximum amount of light. The roof is of steel framework and fire-proof roofing. Throughout the entire length of the building, the central part of the roof is raised some six feet to provide for windows that will let out the smoke, steam, gases, etc., and admit more light. The apparatus and methods that have been devised during the past few years for the accurate heat-treatment of steel have done away with the necessity of darkening hardening rooms, so the color of heated steels could be properly judged. Thus

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[*] Address: 1453 Waterloo St., Detroit, Mich.

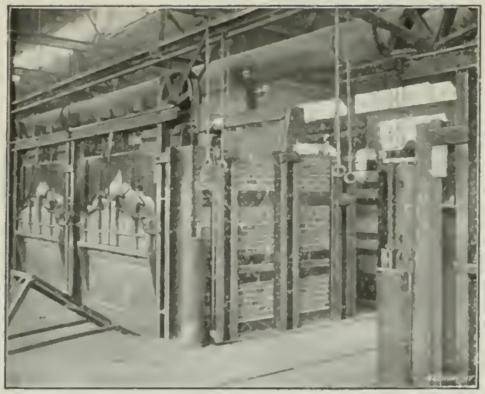

Fig. 2. Pair of Rockwell Furnaces, which pre-heat the Air before mixing it with the Fuel Oil for Combustion

the modern heat-treating rooms are made as light as possible.

The furnaces and other heat-treating apparatus are located through the center of the shop, lengthwise. (See the plan view, Fig. 5.) The battery of furnaces shown in Fig. 1 is oil-fired and is used for hardening, annealing and carbonizing. These twenty furnaces are of the under-fire oven type and were built in pairs and placed back to back by the W. S. Rockwell Co., New York. They pre-heat the air just before it enters the burners, to economize on the amount of fuel oil used. In the concrete floor in front of the furnaces, on both sides of the shop, a standard gage track runs the entire length of the building. Its special cars will be described later. Two 2-ton, electric traveling cranes, like that shown at *A*, Fig. 1, are operated on both sides of the shop in front of the furnaces. These were built by Pawling & Harnischfeger, Milwaukee, Wis. The Gleason Works, Rochester, N. Y., furnished the two special gear-quenching machines shown at *B*.

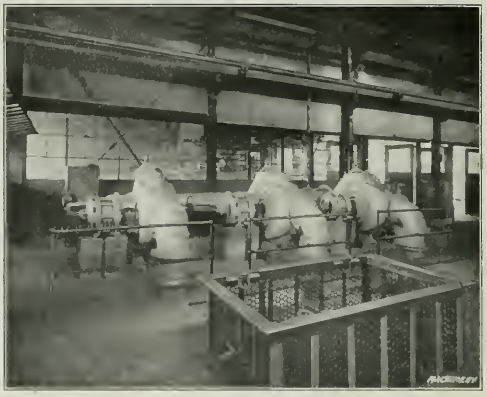

Fig. 3. Blowers for forcing Compressed Air to the Furnace Burners

In Fig. 2 will be seen a single pair of this battery of twenty furnaces. The piping, burners, etc., are all located at the back of the furnaces and this leaves the front clear for the work of the furnace operators. Three motor-driven blowers (made by the B. F. Sturtevant Co., Boston, Mass.,) shown in Fig. 3 are used to furnish all the air required in the shop. The air is forced through pipe *C*, Figs. 1 and 2, which runs the full length of the center of the shop. (Symbols signify the same thing in all views.)

The alley-way between the backs of these furnaces is shown in Fig. 4. The sole duty of one man consists of keeping the furnaces operating at the correct temperatures and this will keep him in this alley-way most of the time. The temperature there is not uncomfortable, however, as the furnaces have been designed and built so as to retain the heat inside. The shop can be heated in a much cheaper way. To preheat the air before it goes to the burners, it is drawn from main pipe *C* through pipe *D* and into a pipe coil inside of box *E*, Figs. 2 and 4. The exhaust or spent gases from the furnace are sent through box *E* and around the pipe coil. This heats the compressed air while it is passing through the coil and it then goes through pipe *F* and into the burners at *G*. There it is mixed with the fuel oil in the proper proportions to perfect combustion.

One of the hardening jobs which is done in this battery of furnaces is shown in Fig. 6. Automobile driving shafts have been charged into the furnace. This is done by inserting into the oven the lower end of an inclined plane like those shown at *H* in Figs. 1 and 2. The supporting legs rest on the outer edge of quenching tank *I*. Then the traveling crane brings a load of the shafts to the furnace in a special rack and dumps them on the inclined plane so they will roll back into the furnace. When heated to the hardening temperature, the shafts are pulled out with long rods that have a hooked end. Fig. 6 shows some as they are rolling down the sheet-steel hearth *J* to drop onto a jointed rack in the oil in tank *I* and thus become quenched. Fig. 7 shows how the traveling crane lifts one side of this jointed rack to raise the drive shafts out of the oil and dump them onto the trucks by which they are taken away.

The quenching tank cars are one of the decided novelties of this department. Several are used on both sides of the shop and they are wheeled to any furnace desired. Standing oil would soon get too hot to quench the steel enough to give the required hardness; therefore, the valve in pipe *K* is turned on when the work is being quenched and a two-inch stream of cold oil is kept flowing into the tank. The oil, which is heated by the red-hot steel, passes out of overflow pipe *L*, through the hole in the floor and into a pipe that conducts it to an underground tank. This underground pipe is made very large so there will be no danger of its clogging, which would necessitate tearing up the floor. Each furnace throughout the 400-foot length of the shop is provided with a similar inlet pipe and floor hole connection to the pipe that carries away the overflow.

From the underground tank the oil is pumped to upright tanks close to the outside of the building. One of these can be seen through the crack of the door at *N* in Fig. 8. From these tanks the oil flows by gravity to the tank cars. One of the motor-driven pumps shown at *M* is used for pumping the oil, and the other is used for pumping the water that is used for quenching steels. They are located next to the side wall, near the center of the heat-treating building and give a good circulation to all of the quenching fluids. At the extreme left of this same view a man is at work testing hardened pieces with the scleroscope.

The equipment for hardening and tempering forging dies is another decided novelty. This is shown by Figs. 9 and 10. Four runways, filled with three-inch malleable iron balls, ex-

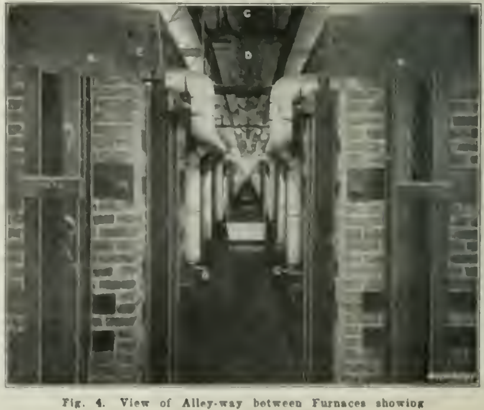

Fig. 4. View of Alley-way between Furnaces showing Piping and Pre-heaters

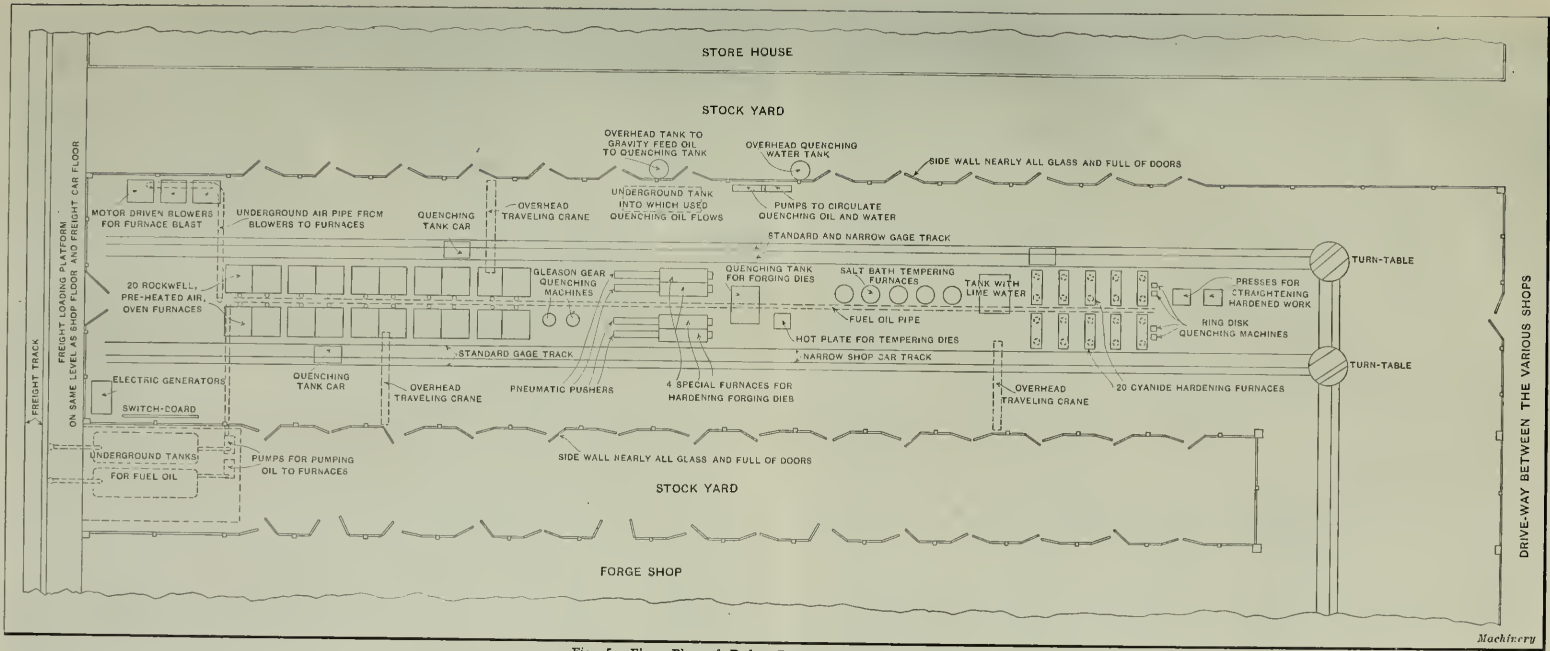
STORE HOUSE
STOCK YARD
OVERHEAD TANK TO GRAVITY FEED OIL TO QUENCHING TANK
OVERHEAD QUENCHING WATER TANK
SIDE WALL NEARLY ALL GLASS AND FULL OF DOORS
MOTOR DRIVEN BLOWERS FOR FURNACE BLAST
UNDERGROUND AIR PIPE FROM BLOWERS TO FURNACES
QUENCHING TANK CAR
OVERHEAD TRAVELING CRANE
UNDERGROUND TANK INTO WHICH USED QUENCHING OIL FLOWS
PUMPS TO CIRCULATE QUENCHING OIL AND WATER
STANDARD AND NARROW GAGE TRACK
FREIGHT TRACK
FREIGHT LOADING PLATFORM
ON SAME LEVEL AS SHOP FLOOR AND FREIGHT CAR FLOOR
20 ROCKWELL, PRE-HEATED AIR, OVEN FURNACES
GLEASON GEAR QUENCHING MACHINES
QUENCHING TANK FOR FORGING DIES
SALT BATH TEMPERING FURNACES
TANK WITH LIME WATER
PRESSES FOR STRAIGHTENING HARDENED WORK
TURN-TABLE
FUEL OIL PIPE
RING DISK QUENCHING MACHINES
HOT PLATE FOR TEMPERING DIES
STANDARD GAGE TRACK
NARROW SHOP CAR TRACK
TURN-TABLE
ELECTRIC GENERATORS
SWITCH-BOARD
QUENCHING TANK CAR
OVERHEAD TRAVELING CRANE
PNEUMATIC PUSHERS
4 SPECIAL FURNACES FOR HARDENING FORGING DIES
OVERHEAD TRAVELING CRANE
20 CYANIDE HARDENING FURNACES
DRIVE-WAY BETWEEN THE VARIOUS SHOPS
UNDERGROUND TANKS FOR FUEL OIL
PUMPS FOR PUMPING OIL TO FURNACES
SIDE WALL NEARLY ALL GLASS AND FULL OF DOORS
STOCK YARD
FORGE SHOP
Machinery

Fig. 5. Floor Plan of Dodge Bros. Heat-treatment Building

tend throughout the length of the oven floor of the heating furnaces. Castings, that fit over the balls in two of these runways and that are the correct size to carry one of the forging dies, are placed in position in the end of the furnace shown in Fig. 9. When the cold die is placed on this casting, as shown at *O*, one of the pneumatic pushers *P* is brought into play and the castings act as a cart to carry the die into the furnace. When the furnace is full, the ram has to move a whole row of dies to get the last one in, but with the casting cart rolling over balls this is easily done. It then pushes the first die out of the other end ready to quench. Each furnace is double tracked and heats two rows of dies at once.

At the end of the furnace shown in Fig. 10 the hot dies come out on the extension of the runway marked *Q*. Their faces are turned downward so a traveling crane, with tongs similar to ice tongs, can pick them up and lower them into the quenching tank, as shown at *R*. If a die was quenched like this, in standing water, the steam would be liable to form pockets in the impression cut for the forging and thus leave soft spots; therefore, each die is held a few inches above the water level and a two-inch stream of cold water is squirted upward to cover the face of the die and quench it uniformly all over. This stream continually forces away the water that has been heated and keeps the cold water flowing over the face of the die. The heated water passes through an overflow pipe to an underground pipe, the same as the oil does in the quenching tanks shown in Figs. 6 and 7.

The hot plate shown at *T* is used for drawing the temper. This is an iron casting, about two inches thick, that has been planed smooth on the top surface. It is kept red hot by burning fuel oil underneath the plate. The dies are moved around on this hot plate until they show the color that indicates the correct drawing temperature. Then they are cooled and sent to the forge shop.

A battery of twenty cyanide furnaces is shown in Figs. 11 and 12. These are located in the opposite end of the building from that illustrated by Fig. 1. In front of the first pair of cyanide furnaces in Fig. 11, two special machines are shown, which suddenly cool or quench the work as fast as it can be heated and removed from the furnace. They are used for hardening the steel ring disks shown at *U*. These alternate with brass disks in a multiple disk clutch on the engine of the automobile. They resist wear for a much longer time when they are correctly hardened.

Each of these machines consists of three iron castings that are located one above another and have flat machined surfaces. These castings are about 2½ inches thick and are hollow in the center so water can be forced through to cool them. The upper and lower castings are kept about 3½ inches apart by bolts and are held stationary. Compressed air moves the middle casting up and down against the others.

One man keeps all of the twenty furnaces operating at the correct temperature, with the aid of pyrometers and the burner valves. Then the man at the furnace only puts the

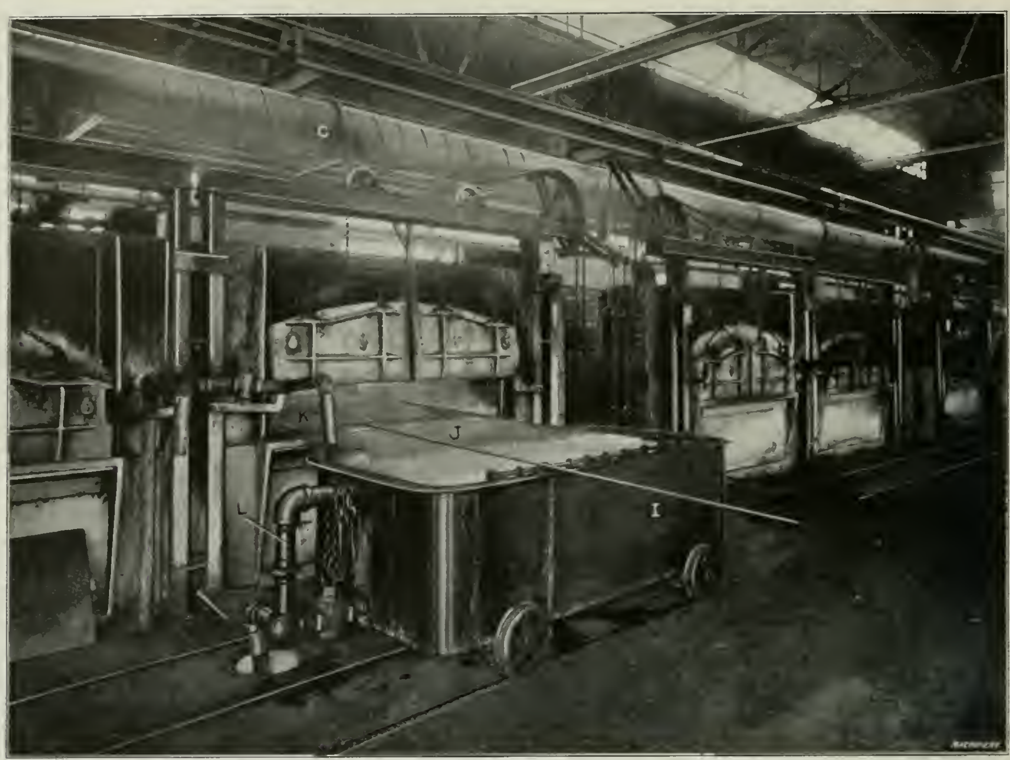

Fig. 6. Oil Quenching Tank ready for receiving Automobile Drive Shafts from the Furnace

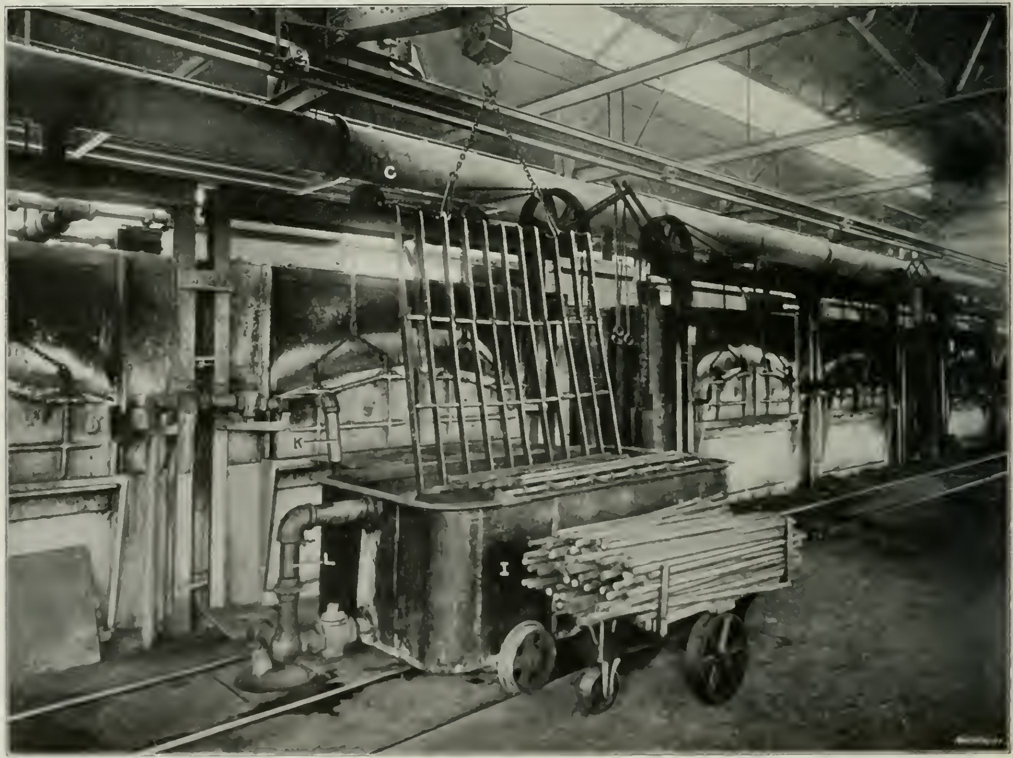

Fig. 7. Dumping the Drive Shafts from an Oil Quenching Tank into Truck

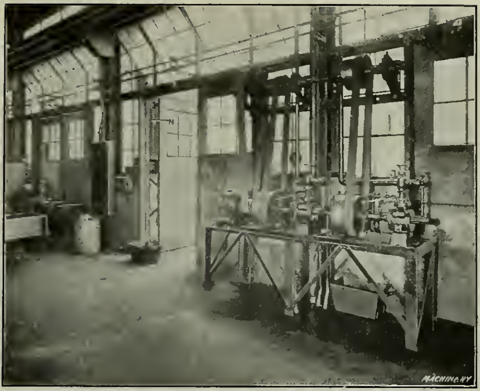

Fig. 8. Motor-driven Pumps for circulating Quenching Oil and Water

disks into the molten cyanide and removes them when they have reached the hardening temperature. He removes them one at a time and passes them to a man stationed at the machine. The machine man puts this red-hot disk *U* between the upper and middle castings at *W* and in so doing, knocks out the disk that was formerly cooled. He then steps on pedal lever *X* and causes the air to press the middle and upper castings together with the disk between them. The water flowing through the center of these iron castings keeps them cool enough to quench the red-hot ring disks quickly, as they are only $\frac{1}{8}$ inch thick. Thus they are hardened and at the same time kept from warping. The next disk is inserted between the lower and middle castings at *Y* and foot lever *Z* is stepped on to press these together and squeeze the disk; at the same time, this releases the disk at *W* so it can be pushed out.

By thus alternating the pressure on the middle casting, so it will first press against the upper and next against the lower casting, the disks can be quenched as fast as they come from the furnace and the furnace heats them as fast as the machine man inserts them between the castings and depresses the pedal levers. This work is done much faster than it takes to describe it and no skilled labor is used. With such apparatus unskilled labor is today doing hardening and tempering at more accurate temperatures and with greater uniformity than was obtained by skilled labor only ten years ago. Other ways of saving on the cost of production have also been perfected and we are now enabled to heat-treat parts with economy that formerly would add much to the cost of the finished product.

The potassium cyanide used in these furnaces is a salt that will keep molten when heated to any of the temperatures that are used for hardening steel. As the name implies, it is composed of equal parts of potassium, carbon and nitrogen; its chemical symbol being KCN. The carbon in this composition has a tendency to carbonize the steel being heated in the bath and this overcomes any tendency toward a decarbonization. If machine steel is immersed in a bath of cyanide and kept at a hardening temperature for a certain length of time, it can be given a carbon content of from 0.60 to 0.80 per cent for the depth of a few thousandths inch. For various reasons, however, it is not as good as other materials for the real carbonizing process.

In oven and muffle furnaces every effort is made to keep the atmosphere either neutral or reducing; that is, to allow no more oxygen to enter than will be used for combustion. When the furnace doors are continually opened, to insert and remove the work, this is a very difficult thing to do, as air is likely to rush in and carry with it an excess of oxygen. This excess oxygen makes the atmosphere oxidizing and it unites with the iron and raises a scale on the steel being heated. This sets four times as much nitrogen free to combine with the carbon in the steel and form the gas methane, which escapes when the metal undergoes changes in its grain structure as its temperature rises. Thus, when steel is heated to the hardening temperatures in such furnaces, a slight decarbonization of all the exposed surfaces often takes place. Frequently this action is not uniform and decarbonized spots are produced. The higher the temperature, the more easily can carbon be drawn out or made to flow into the steel. To overcome such chemical changes, steels have been heated for hardening in a molten cyanide bath, as then the air is kept away from the steel and a slight carbonizing effect is produced instead of a decarbonizing one.

As cyanide of potassium is very poisonous and also the fumes which arise from it when molten, the furnaces must be covered and other precautions taken. Each pair of furnaces, shown in Figs. 11 and 12, is covered with a hood to gather the poisonous fumes and convey them to the outer atmosphere, through pipes extending through the roof. In addition to this, sheet metal shields are located in front of the furnace openings shown at *V* to carry away from the workmen any fumes that might come through these openings. (These shields were removed for photographing). The workmen wear gloves while using the furnaces, and, in some cases, face masks to protect any exposed parts of the body.

As to the poisonous nature of cyanide of potassium, two grains might be enough to kill a man and in other cases it might require fifty grains. A solution of one ounce of cyanide to four ounces of water is one of the best things for cleaning rust from polished steel surfaces or the oxide from other metals. In one case a jeweler had a barrel filled with this solution and standing in the basement for cleaning silverware and other metals. A scrub woman, thinking it was potable water, drank a glassful and dropped dead beside the barrel. It almost instantly paralyzes the flesh tissues of the body and thus stops their action

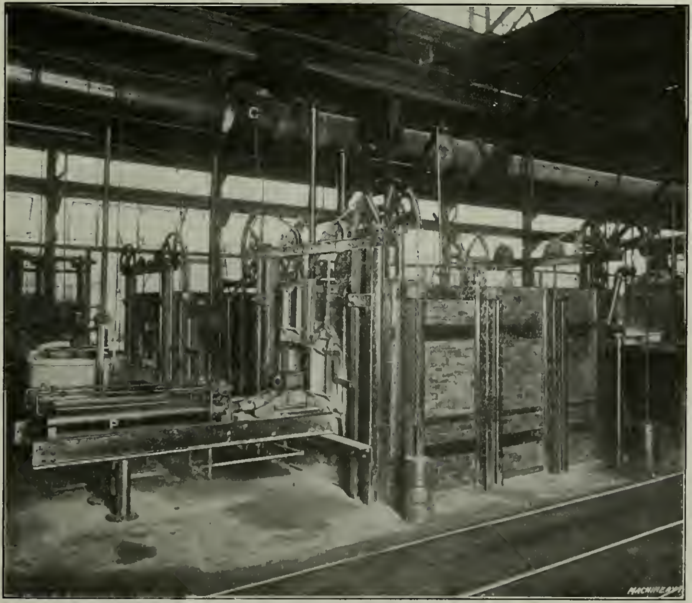

Fig. 9. Intake End of Special Furnace for hardening Forging Dies

and causes death. It will not penetrate the skin unless submitted to its action for quite a time but it is liable to penetrate raw sores. It dissolves very readily in water and if one were perspiring, the dry salt would dissolve in the perspiration and more quickly pass through the skin. The fumes arising from the molten cyanide are a cyanogen gas, which is extremely poisonous, and this paralyzes the lungs in the same manner that drinking a solution, or swallowing the dry salt, would paralyze the tongue, throat and stomach.

After rust and scale have been cut loose and removed by a cyanide solution, steel surfaces can be polished by a hard rubbing with cyanide soap. To make this, stir potassium cyanide in water until no more will dissolve; then add enough precipitate chalk to make a creamy paste. To this paste, add Castile soap shavings until it is quite stiff. These should be thoroughly mixed, which is best done with a mortar.

The poisonous nature of cyanide has caused searches to be made for materials that will give as good results and not have any poisonous effect. Other salts and combinations of salts are being used with the claim that the results are the same. None of them contain as much carbon as cyanide of potassium and hence could not have as great a carbonizing effect on the steel. Steels that were high enough in carbon could be used, however, and if they prevented a decarbonization the same results would be attained. When steel is immersed in a salt bath and then heated, oxygen cannot get to it and this cause of decarbonization would be overcome. Some of the chlorides are combined in a way to give them melting temperatures which make them useful for heating steels to any of the hardening temperatures. The nitrate, carbonate and fluoride salts might also be made into combinations that would keep molten at the desired temperatures and not be poisonous or have injurious effects on the steel.

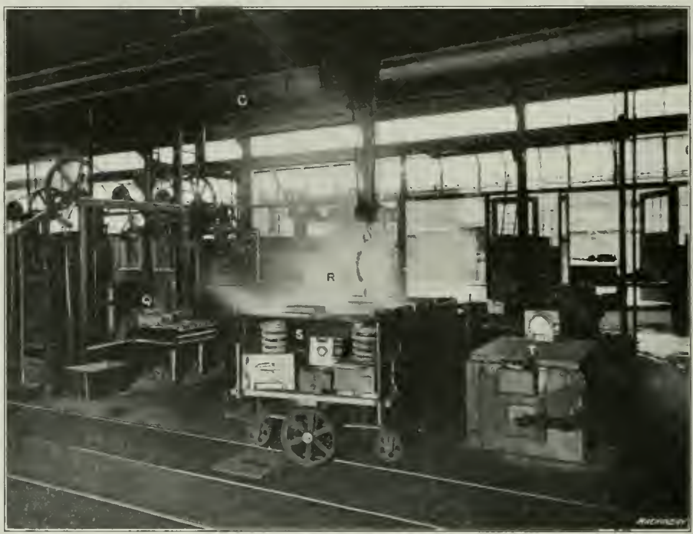

Fig. 10. View showing End where Dies are removed from Furnace; also Quenching Tank and Tempering Plate

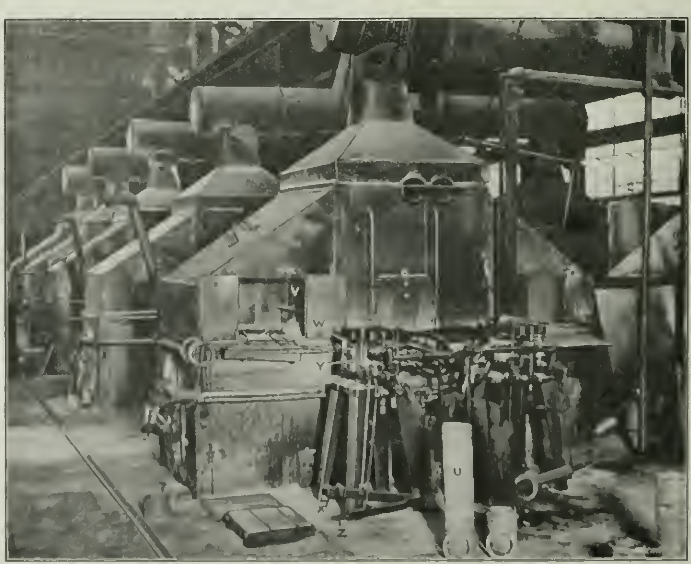

Fig. 11. Battery of Cyanide Furnaces—Special Quenching Machines for Clutch Rings in Foreground

The nitrogen content of the cyanide of potassium is liable to have a bad effect on the steel and thus be a detriment to its use. If any nitrogen were absorbed by the steel, the elongation and contraction would rapidly diminish with each increase in the percentage of nitrogen and the ductility would be reduced. When the pores of the steel are opened, as its temperature reaches the transformation point at which it is hardened, the carbon will enter the steel and is liable to carry some nitrogen with it. The best carbonizing compounds are free from nitrogen. Investigations have shown that nitrogen causes brittleness in the same manner as does phosphorus but more intensely. On steel specification reads "The sum of the percentage of phosphorus, plus 5 times the percentage of nitrogen, should not exceed 0.060 per cent."

To illustrate this, some watch springs were heated for hardening in cyanide of potassium. When used, it was found that the main springs wore well but the hair springs broke quickly. The main spring is subjected to a steady tension but the hair spring is subjected to alternating vibrations by the oscillations of the balance wheel. Thus any brittleness would soon cause the hair spring to rupture but might have but little effect on the main spring. When the same hair springs were heated to the hardening temperature in molten glass, they did not break and this might indicate that it was the nitrogen in the cyanide which caused the brittleness.

Steel is sometimes immersed in molten cyanide and then dipped in water to produce certain colors. Other processes are now used, however, which produce richer colors in a greater variety of shades and at less cost. To keep the steel pieces from hardening, when being colored, it is necessary to melt the cyanide in pots made from low-carbon steel, as cast-iron pots increase their hardness. The cyanide acts as a conductor for carbon in much the same manner as a copper wire does for electricity; thus the carbon flows from the iron pot into the steel being heated. Sometimes the work is made harder if it is heated in the cyanide the first time it is melted down in a new steel pot; therefore, the cyanide should be melted down once before it is used for coloring.

At the end of the cyanide furnaces shown in Fig. 12 is a stationary tank of lime water in which some of the work is quenched. At the side of the first furnace is located another of the quenching tank cars. On the floor is shown a tray loaded with bevel differential gears and having a long rod for a handle. This is lowered into the cyanide bath to heat the gears, then lifted out and lowered in the quenching tank, and when cool the gears are dumped into boxes to take to the tempering furnaces. Other parts that were being hardened are shown in the metal boxes beside the tray of gears.

Fig. 13 shows four salt bath furnaces that are used for tempering the smaller pieces. The salt is held in iron pots that are heated with fuel oil the same as the bigger furnaces. As the drawing temperatures seldom run above 1000 degrees F., sodium nitrate and potassium nitrate can be used. These do not corrode the pots as easily as the chloride salts and hence the pots last a long time. There is nothing poisonous about them and there is nothing in them that is injurious to steel. The work sinks in the bath and it is easier to handle it than when a lead bath is used. If one should hold one's head directly over the pot it would cause a feeling of sickness in the stomach, but this position is not necessary when a rod handle is put on the tray that holds the work. This is the only disagreeable feature of this bath.

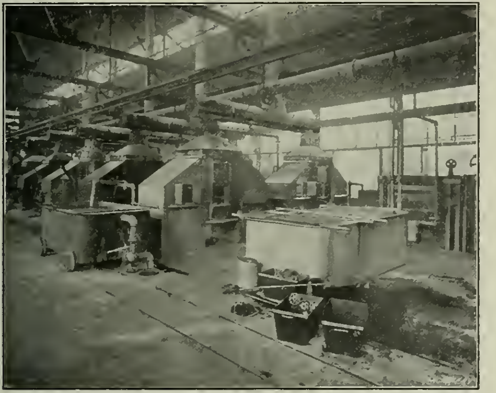

Fig. 12. Cyanide Furnace, Quenching Tank and Car Tank with Flowing Oil

An electric generator with a very complete switchboard is located in one corner of the building. This makes the heat-treatment shop a complete unit in itself, as it is not dependent on any other part of the plant for power, light, heat, or anything else. Thus, work can be done there when all the rest of the plant is shut down and no power, heat, etc., would be wasted if it were shut down and all the rest of the plant were working.

* * *

CARRYING OUT THE ORDERS OF THE BOSS

BY CON WISE

There is a widely prevalent idea that as soon as a man goes into business for himself he becomes independent. That this is not so was brought to our attention a few days ago by a neighboring machine tool builder. He was complaining that he was unable to get drawings made to suit him. It was some matter of center lines or style of lettering or some minor thing like that, but one which was a constant source of error in the shop. Come to think of it, the special bone of contention was about using 5ft. 6" or 5' 6", but that is not the point. Here is a case of an intelligent, able-bodied, responsible, profitable concern that pays its bills (including payroll) on time, but that cannot issue an order to its own drafting-room with any confidence that it will be obeyed.

A similar state occurs in many shops, not alone in the drafting-room but in the tool-room. Why is it endured? Simply because the owner knows that if he enforces his regulations his men will quit before very long and go where they can do as they please, and that he cannot get any better conditions by hiring new men, unless he begins all over with entirely green ones and trains them his way. The matter comes about through the assumption of professional privileges by these two classes of men. If we hire a physician we do so under conditions to which they stick as a class. We do not give them orders; on the contrary they order us around in what seems like a pretty arbitrary fashion. We do not pick out our own particular penance for our infractions of the law of nature but we take what they give us and are duly thankful. On the other hand we do not patronize their profession except in case of dire necessity and we dispense with their services as soon as possible. They have us at their mercy when we are sick but we assert our independence in short order when we recover. The fact is that some of us get well solely for the sake of getting even.

Is a draftsman a professional man? Is a tool-maker? It all depends on circumstances. If a retired physician should decide to go into the machine tool business with no other training than what he had gotten in the course of his professional relations with machine tool builders, we should presume that his draftsmen and his tool-makers and his office boy would be able to maintain professional relations with him, but if a man with years of work at the machinist trade and at drafting should go into the same business, it would seem that he could readily hire men who would expect to do as they were told and do it in a spirit of cooperation or go elsewhere, just as would a machinist or carpenter.

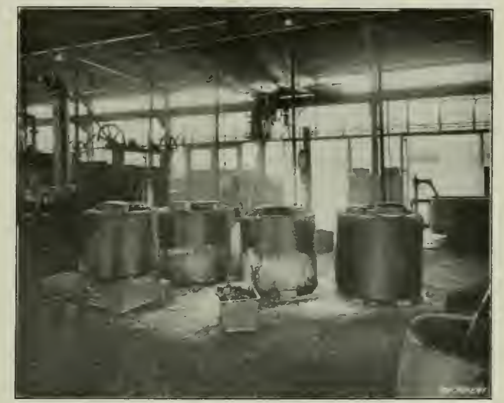

Fig. 13. Salt Bath Oil-fired Furnaces for tempering the Smaller Automobile Parts

A very considerable degree of professional pride is desirable in all workmen, but when that pride goes beyond the desire and purpose of doing the most creditable job possible under the circumstances which surround it, we wonder if there is not something wrong. Certainly among professional men there must be cooperation. Two surgeons who stopped to wrangle during an operation might find nothing more than a corpse as a result. So too, if a man in charge of a machine shop has demonstrated his fitness to hold the place he must really be a professional man among his employes, and should be so recognized by them.

* * *

A new method of obtaining very high temperatures from the electric arc has been developed. An ordinary electric arc is combined with a jet of oxy-acetylene or oxy-hydrogen to reinforce and increase its temperature. The simplest form of the apparatus has a high carbon electrode through which a blast of oxygen or air can be blown. The metal plate to be heated forms the positive pole and the carbon electrode the negative pole. The effect of the oxygen burning inside the arc is to produce a temperature much higher than that of the electric arc alone.

FIXTURES AND MACHINES FOR WIRE FORMING[*]

SUGGESTIONS FOR LAY-OUTS USED IN MAKING VARIOUS WIRE SHAPES

BY FRANK H. MAYOH[†]

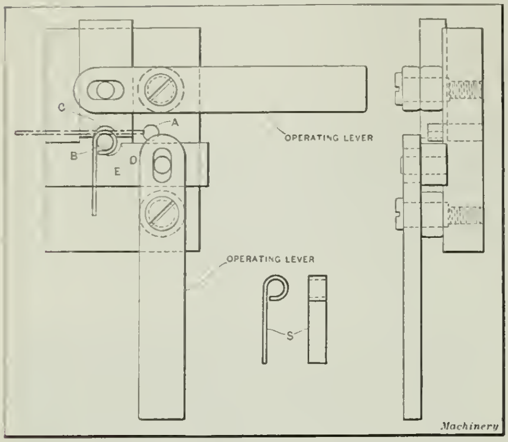

Fig. 1. Hand Operated Bending Fixture for producing the Piece S

Wire forming from flat, round or irregular shaped stock is sometimes accomplished by crude methods and sometimes by very complex automatic machines. The choice of equipment is largely governed by the amount of work and the experience of the man who handles it. Inventors who have occasion to produce a large number of different wire shapes often depend upon some crude hand-operated device which results in a high-priced product, while manufacturers of wire products usually employ automatic machines which are capable of forming wire up to about ½ inch in diameter. The high output of such machines results in producing work that can be sold at surprisingly low prices. It is not the purpose of this article to go very deeply into the details of the mechanism which performs the different operations on the wire, as this varies considerably in different types of machines. The idea is to describe the operations around which the machines are built and to illustrate the principles involved by simple illustrations.

First, let us consider a piece of the form shown at *S* in Fig. 1. As only five hundred of these pieces are required, we cannot afford to rig up an elaborate machine and so a hand bending fixture is produced. This consists of a stop *A*, against which the end of the stock—which has previously been cut off to the required length—is held in the position shown by the dot and dash lines. It will also be seen that there is an arbor *B* around which the stock is formed, a jaw *C* which makes the first bend and a jaw *D* which forms the bend *E*. The jaws *C* and *D* are operated by levers which cause them to slide in and out as required. This fixture is held in a vise in such a position that the levers are free to move without interference.

The punch and die shown in Fig. 2 was designed for the purpose of producing the piece *T*, although an equipment of this type could be used for producing work of the form shown in Fig. 1 and a variety of other shapes. This punch and die are used in a power press, the method of operation being as follows: The blank shown by the dot and dash lines is put into the die and when the press is tripped, the punch is forced down against the work at *A*, bending both ends around the punch until the latter reaches the position shown. While the punch is descending, the beveled plunger *B* comes into contact with the plunger *C*, forcing it against the work by means of the pressure exerted on its beveled end. This plunger forms the small bend at the end of the work, thereby bringing it to the required form shown at *T*. When the punch rises, the spring *D* forces the plunger *C* out to the starting point, the movement being limited by the fetter screw *E*. Although these two methods do very well for bending small lots of work, pieces that are to be produced in large numbers can be manufactured far more economically in automatic machines where the wire is fed to the machine from a reel, cut off and bent to the required form, the machine running for days without requiring any particular attention from the operator.

As an example of the method followed in laying out an automatic machine, let us consider the operations and the method of reasoning followed in setting up for producing work of the form shown at *U* in Fig. 3. The first step is to feed the wire up to a stop and cut off a piece of the right length. The next step is to form the bends, while the small loops at the ends of the piece are twisted around two mandrels which are made to revolve by means of a rack. Fig. 3 shows a preliminary lay-out of the tools required for this purpose. The wire is fed up to the stop *A* by means of the feed-slide *B*, after first passing through straightening rolls similar to those shown in Fig. 8. The cam *C* pushes the form *D* forward against the wire and holds it in place until it has been cut off by the blade *E*. After the cutting operation has been completed, another rise on the cam pushes the form *D* forward again, thus bending the wire to the shape shown at *V*. The arbors *F*, which up to this time were held below the wire by means of a spring, are now released and forced up into place through the action of the cam *G* and lever *H*. The arbors are caused to revolve by means of a rack *J* and the pinions on the arbors, thereby forming the loops on the ends of the piece and finishing it to the shape shown at *U*. The wire is twisted around the arbors by the pins *I*.

After this sequence of operations has been completed, the machine is returned to the starting position by means of springs or return cams. At the same time, the work is picked out of the machine and thrown to one side by means of the hook *K* which is caused to move by the mechanism shown in Fig. 4. The lift *A* on the cam which controls this ejecting mechanism operates the spring hook *B* by swinging the arm about the pivot *C*. In this way the bevel *D* on the spring hook

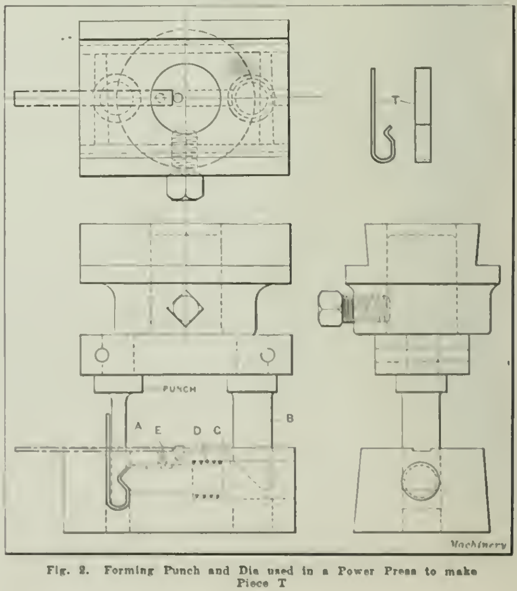

Fig. 2. Forming Punch and Die used in a Power Press to make Piece T

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[*] For other articles on the subject of wire forming see "Tools for Four-slide Automatic Wire Forming Machine" published in MACHINERY, February, 1912, "Wire Bending in the Foot Press" March, 1913, and "Four-slide Tools for a Wire Forming Job" June 1913.

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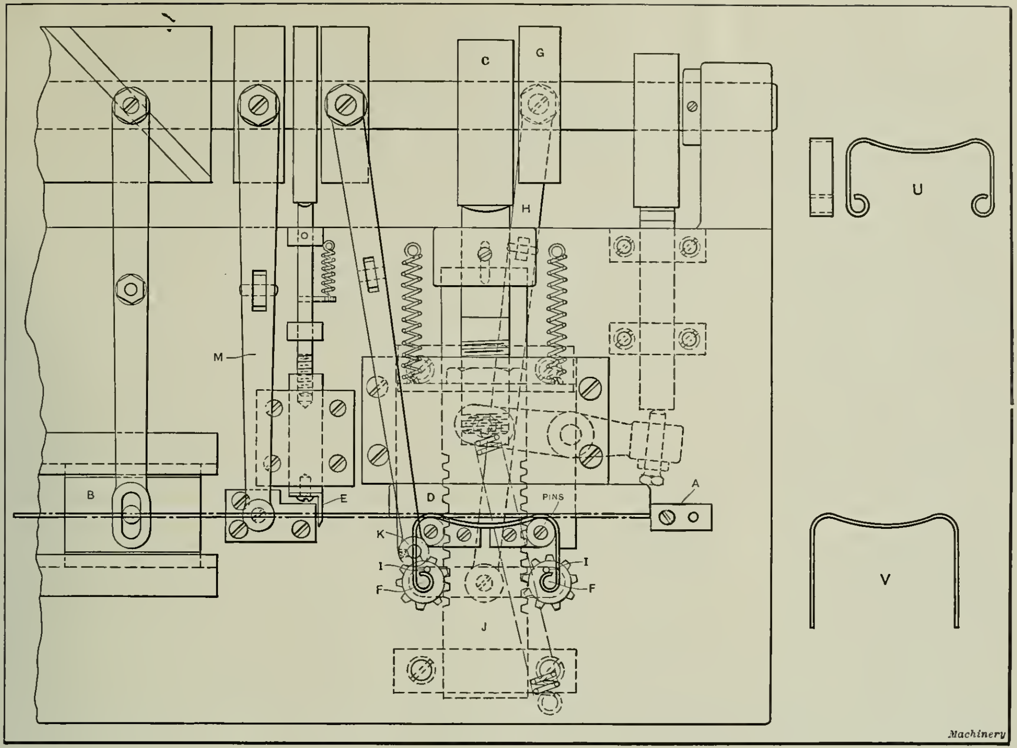

Fig. 3. Automatic Machine Lay-out for forming Piece shown in Detail at U

is sprung out by coming in contact with the work; the hook catches under the work in the position shown in the illustration, and when the hook is pulled back by the spring *E* it carries the work with it. When the curled ends clear the arbors about which they were wound, the work drops off the hook and falls down through a hole in the bed of the machine into a box placed ready to receive it.

This cycle of operations is repeated over and over again. The operations may be briefly outlined as follows: First, the wire is fed forward against a stop; second, the form is moved forward to hold the wire against a stationary form; third, the wire is cut off and the loose end is also held to prevent it from running back on the reel; fourth, the central part of the wire blank is bent over the form; fifth, the arbors engage the wire and are then revolved to form the curled ends; sixth, the arbors drop down, leaving the curled ends free; seventh, the finished piece is picked out while the machine is returning to the starting position. After these operations have been completed, the machine is ready to commence a second cycle.

Another point to be considered on most automatic wire forming machines is holding the end left loose after the blank has been cut off, in order to prevent the wire from running back onto the reel. This is step number three of the cycle of operations referred to in the preceding paragraph, and it must be so timed that when the feed-slide loosens its grip to move back and reengage the wire ready to feed the next piece forward, it will hold the wire and then release it before the feed-slide is ready to make its next forward movement. This is conveniently accomplished by the device shown in detail in Fig. 5 which is designated as *M* in Fig. 3. The operation of this mechanism is as follows: Just before the feed-slide lets go, the lift *A* on the cam causes the screw *B* carried by the rocker arm *C* to push the sliding pin *D* forward against the wire. In this way the wire is prevented from sliding back. As soon as the feed-slide has re-gripped the wire, the end of the lift on the cam is reached, thus releasing the pressure on the rocker arm and pin to permit the wire to be fed forward at the proper time.

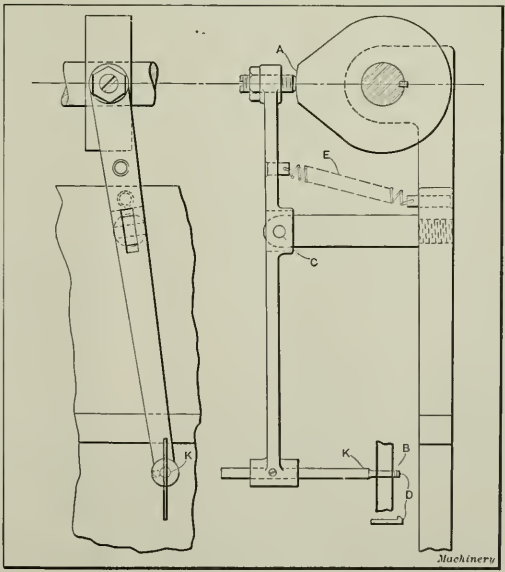

Fig. 4. Mechanism for operating Ejector K in Fig. 3

Small spring *W* in Fig. 7 is another good example of wire forming. The mechanism used for coiling this spring is also shown in this illustration, the operation being as follows: First, the wire is fed forward by means of a slide *A*, of similar design to the one previously described, and caught by the twisting spindle *B;* second, this spindle is caused to revolve through the required number of revolutions by means of the bevel gears *C* and *D* which are driven by the arm *E* connected to the end of the shaft *F*. This mechanism is actuated by the cam *G* which pushes the connecting-rod *H* forward; after completing the operation, the return of the mechanism to the starting point is effected by means of the spring *I*; third, while coiling the spring, the feed-slide goes back and secures a fresh grip on the wire ready for feeding it forward for the next spring; fourth, the spring is cut off from the wire on the reel by means of the blade *J* which is operated by the cam *K* through the push-rod *L* and rocker arm *M*; fifth, the spring in its finished form drops through a hole in the bed of the machine into a box. These operations are repeated until the required number of springs has been formed and cut off. The work turned out by automatic wire forming machines is usually counted by special "counting scales."

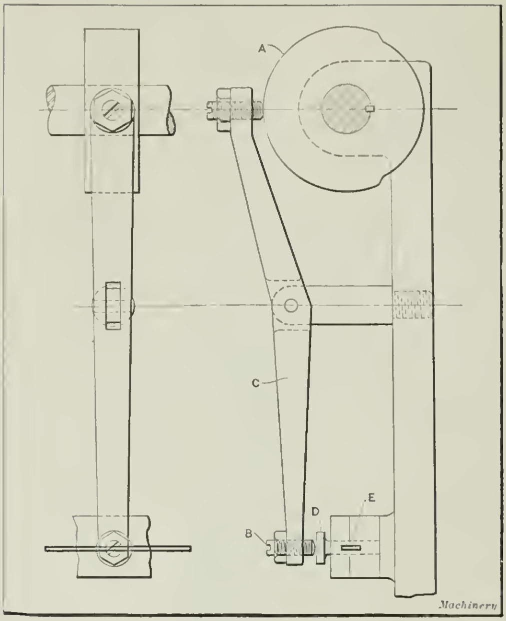

Fig. 5. Device for holding Wire to prevent it running back on the Reel

A more complicated wire forming operation and one which calls for very good work—both in design and set-up—is met with in automatic chain making machines. Such machines are used in the manufacture of watch chains and similar products, and produce chain of an indefinite length, which is afterward soldered where the ends of the links join. The chain is sometimes rolled to produce fancy links which give a more elaborate appearance. An automatic knock-off is provided on such wire forming machines to stop the operation in the event of the chain snarling up or any other unusual condition which would otherwise result in the waste of expensive wire. Fig. 6 shows the motions necessary in making chain of the form shown in detail at *X* in this illustration. Wire up to 3/32 inch in diameter may be used and links as great as ½ inch in length can be formed. The operations are as follows: First, the wire is drawn from the reel and fed up to the stop *A* by means of the feed-slide *B*. This slide is operated by the rocker arm *C* and cam *D*, as previously described. The cam has two movements, one for lifting the arm *C* up and down to bind or loosen the wire, and the other for feeding the wire. Second, the spindle *E* is caused to move forward until the jaws *F* hold the wire against the arbor *G*. Third, while the spindle is moving forward, the cam *H* lifts the rocker arm *I* which binds the wire *J*, thus preventing it from slipping back out of the wire guide *K* when the slide releases its grip for the purpose of obtaining a fresh hold. Fourth, the wire is cut off by the blade *L* which is operated by an arm *M* and cam *N*. After cutting off the wire, the blade is returned to its starting point. Fifth, the spindle *E* comes forward and bends the wire around the arbor *G*, partly forming the link in the jaws *F*. Sixth, the arbor *G* is moved slightly forward to set the partly formed link. Seventh, with

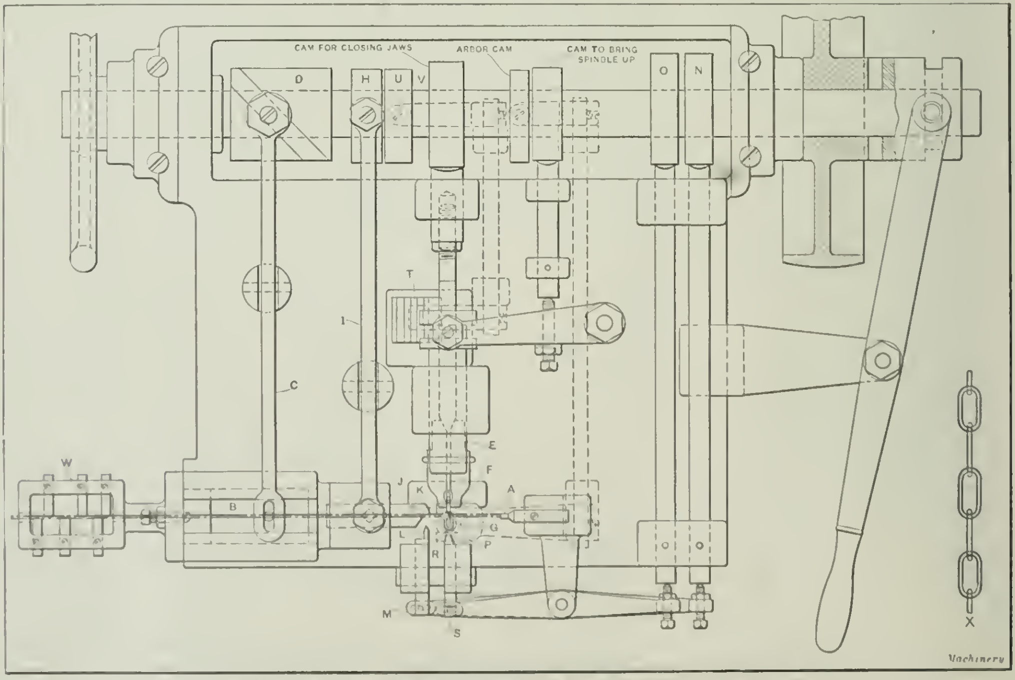

Fig. 6. Lay-out showing Motions of Machine which makes Jewelry Chain shown at X

all the parts of the machine held in this position, a cam *O* drives the header *P* against the link *R* in order to seal the link, the movement being obtained through the arm *S*. Eighth, another lift on the cam forces the arbor *G* down out of the link which is still held in the jaws. Ninth, by means of a segment *T* operated by the cam *U* and plunger *V*, the spindle *E* is caused to revolve through a quarter turn, holding the link in position to have the wire fed through it. The wire is fed up against the stop and the same sequence of operations repeated.

One of the vital points in the manufacture of wire articles is the straightening of the wire, which must be free from kinks or bends. For this purpose the wire is passed through a straightener shown at *W* in Fig. 6. A detailed illustration of another form of wire straightener is shown in Fig. 8. This consists of a series of rolls, between which the wire is passed to take the kinks out of it before being converted into any finished product. The efficiency of wire forming machines of the kind described in this article can be seen when it is understood that one man can easily operate a dozen machines and still have time to make up any special tools—such as arbors and jaws—required on subsequent work that these machines are to be operated on.

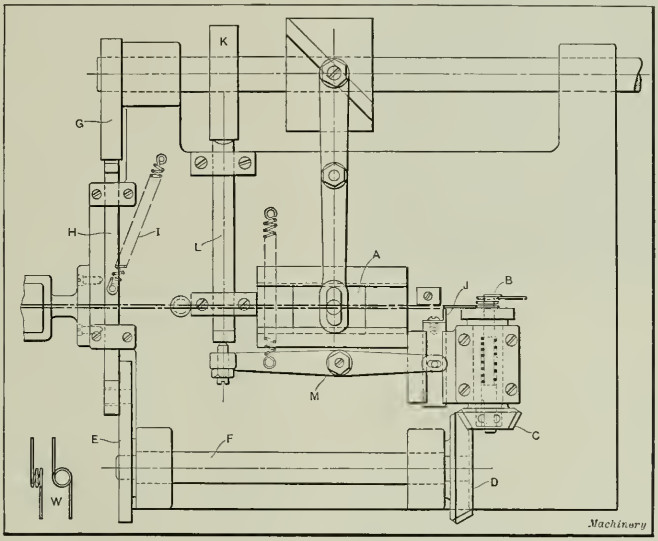

Fig. 7. Automatic Machine for coiling Springs of the Form shown at W

* * *

Some years ago a cylindrical grinding machine maker developed a design in which power was transmitted through a long shaft having two splines or keyways cut in opposite sides. The shaft was supported at the ends and by the driving pulley which traversed the space between the end bearings. It was found that the long shaft could not be successfully run if only two keyways were cut in opposite sides because of the tendency to whip and run out of balance. The trouble was overcome by cutting four keyways at points 90 degrees apart. The question is, why should four keyways cut at points 90 degrees apart stop the trouble that developed when only two were cut 180 degrees apart?

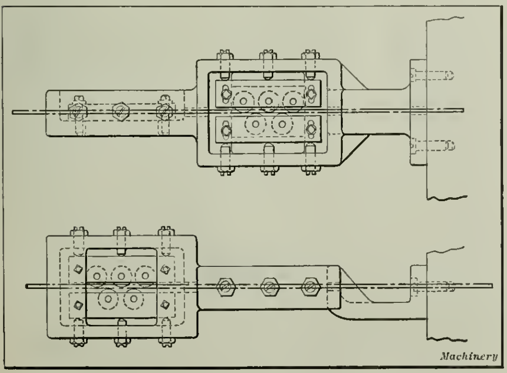

Fig. 8. Wire Straightener for preparing Wire to be formed

CAST-IRON AND BRASS BUSHINGS

BY CHARLES C. ANTHONY*

I have often wondered why the manufacturers of machine tools that are first-class in other respects do not put bushings in wherever possible so that when it becomes necessary to repair the machine the old bushings can be driven out and new ones put in place, thus doing away with a lot of extra work. The lack of bushings often means considerable expense, time and material to rig up something suitable to rebore holes. We have frequently had to do this with large punching and drawing presses, whereas if they had been designed and built with the repair end in view, many dollars could have been saved. I am sure that if prospective purchasers insisted on bushed bearings in the machines, the builder would be compelled to recognize the importance of doing it. I am also sure that is one of the first things I should consider in the purchase of machine tools. Too many machines are built at present in such a way that when the time comes to repair them, it can only be done at great cost, and sometimes at the expense of the strength of the machine, as provision has not been made for re-boring.

In this day of high-speed machines the question often arises as to the relative merits of cast iron and bronze for bushings. A great many manufacturers of machinery, in advertising their tools, place great stress on the fact of their having phosphor-bronze bushings. My experience has been that while bronze makes a good bushing for machines running at a very high speed and not being called upon to withstand any great pressure, cast iron will far surpass brass or bronze for bushings as regards wearing qualities. We have tried bronze bushings in certain machines and found them to last only about six months, while cast iron, with the same lubrication, would last several years. We have also used brass bushings in a number of twenty-spindle drilling machines, only to find them worn out in six months. They were replaced with cast iron and have been in service for several years. While it is true that cast iron, if poor in quality and rough in finish and not properly lubricated, will grind to powder, it is also true that poor brass or bronze roughly finished and not properly lubricated will do so likewise; but good cast iron, if smooth in finish and properly oiled, will far outwear brass or bronze. Then again, if the bearings warm up, bronze will expand more rapidly than cast iron, making bad conditions worse. We have, at present, a modern high-speed engine with a four-inch cast-iron wrist-pin which is showing excellent wearing qualities. Wherever we have tried cast iron in place of bronze or brass, we have always found the bushing to wear about 200 per cent better.

* * *

One of the large dealers in metals and alloys stated recently that since the beginning of the European war, tin has more than doubled in price and antimony has more than trebled. During the early part of August, there was a daily, not to say hourly, rise in the price of many metals.

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MAKING ALOXITE GRINDING WHEELS

PRODUCTION OF ALOXITE IN THE ELECTRIC FURNACE—MAKING VITRIFIED WHEELS AT PLANT OF CARBORUNDUM CO.

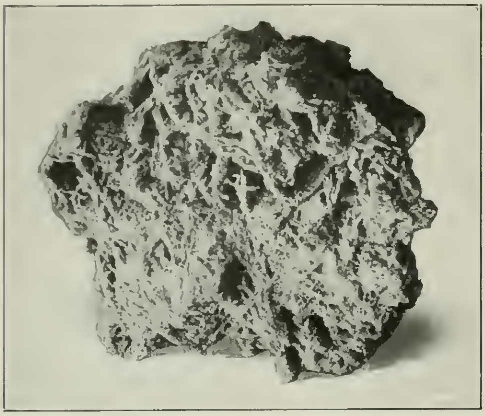
Fig. 1. Sample of Aloxite showing its Crystalline Formation

THE fast-cutting, artificial abrasives which are now produced, and the improved methods of bonding them together to form a wheel, are undoubtedly the two chief factors in the development of the modern process of grinding. At the present it is possible to grind successfully almost any kind of material, owing to the different characteristics of the abrasives now produced and the bonding processes that have been developed to meet various manufacturing requirements. As the characteristics of wheels necessary for grinding different materials efficiently have been determined as the result of experiments and experience, wheel manufacturers have endeavored by means of artificial processes to meet these requirements. That they have been successful is evident to anyone familiar with the quality and variety of work now produced by grinding, not only in machine shops but in many other lines of manufacture.

One of the more recent artificial abrasives placed on the market is known as aloxite and is the product of the Carborundum Co. of Niagara Falls, N. Y. Aloxite, like other artificial abrasives, is produced in the electric furnace and its manufacture and subsequent formation into grinding wheels involves many interesting processes. Aloxite is especially adapted for grinding steel or other materials of high tensile strength, as it possesses the necessary qualities of hardness, sharpness and toughness. A small piece of aloxite is shown in Fig. 1. As this illustration indicates, it is of crystalline formation so that when broken or fractured, sharp cutting edges are left which cause the wheel to cut rather than to work with an abrading action.

The raw material from which aloxite is made is the mineral bauxite which, when taken from the mines, is a clay-like substance that is an impure aluminum oxide. In the process of manufacture, the bauxite, which in the natural state is in granular masses and earthy form, is crushed and then calcined by feeding it through an inclined rotary kiln to eliminate all moisture prior to smelting. The calcined material is then elevated mechanically to a mixing machine (similar to a cement mixer) where anthracite coal is added to it. The coal is so proportioned as to reduce the oxides of silicon and iron in the bauxite during the smelting process, but leave the alumina unreduced.

Charging the Electric Furnace

The electric furnaces used in the French plant where most of the aloxite for the Carborundum Co. is produced, are circular in shape and equipped with two vertical electrodes suspended over the furnace opening. When a furnace is being charged, the bottom is first covered with a thick layer of the bauxite and coal mixture. The electrodes are then lowered until the ends rest upon this bottom layer. At first, it is necessary to form a path for the current by placing graphite between the electrodes, but as soon as arcs are formed between the ends of the electrodes and the charge becomes molten, it is no longer a non-conductor and the current passes directly through it. When the first layer is in a molten state, additional material is added and the electrodes are gradually raised and carefully regulated so as to maintain the proper resistance to the flow of the current and a constant amount of power for the furnace. This process of adding more mixture and raising the electrodes is continued until the furnace is completely filled.

Charging the furnace requires a period of from twenty-four to thirty-six hours. During the smelting process the reduced oxides of iron and silicon unite to form ferro-silicon, and the alumina is freed of practically all its impurities. As the ferro-silicon is heavier than the alumina, it sinks to the bottom of the furnace, where it is easily separated from the aloxite. After the smelting operation is completed, the furnace is allowed to cool, and then the ingot or "pig" is removed and crushed, as will be described later.

Fig. 2, which is a view in the French plant, shows several of these electric furnaces to the left and two of the large ingots, one being held by the crane. The shell of the furnace is of steel and the shape circular, the sides tapering inward slightly toward the top so that the shell can be lifted off the ingot. This steel shell is water cooled on the outside but does not have a refractory lining, the charge forming its own lining as the smelting process proceeds. The bottom is lined with a mixture of carbon and tar. Each furnace is mounted on wheels and has a suitable track so that it can be removed from under the electrodes. The alternating current used is

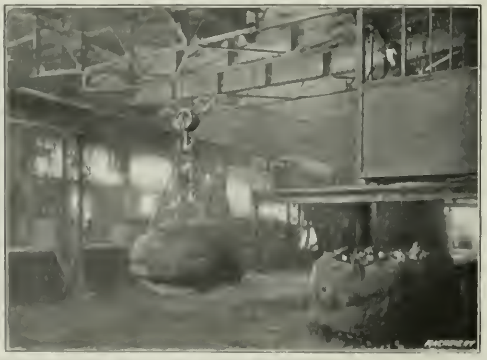
Fig. 2. Electric Furnaces (at Left) used in Production of Aloxite—Large "Pigs" or Ingots of Aloxite

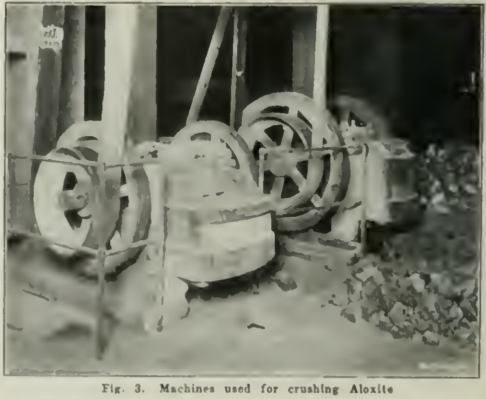
Fig. 3. Machines used for crushing Aloxite

stepped down by a transformer from 5000 volts to about 100 volts and is conducted to the electrodes by bus bars. These electrodes are of carbon. The practice is to operate several furnaces at the same time, the charging of the different furnaces being so regulated that the current consumption will be approximately uniform.

Crushing Aloxite Ingots or "Pigs"

A large "pig" or ingot obtained from the electric furnace, as just described, is first broken up into smaller pieces by the use of a drop weight or "skull cracker." These pieces are then crushed in ordinary rock crushers. Two crushers similar to those illustrated in Fig. 3 are used, the second one through which the material passes having the jaws set closer in order to break the particles finer. This preliminary crushing is followed by a magnetic separator treatment to remove any lumps of ferro-silicon which were not separated from the ingot. The aloxite is then re-crushed by passing it between plain rapidly revolving rolls. There are two sets of these crushing rolls. The first set of coarse crushing rolls receives the larger pieces which vary considerably in size, while the second set crushes the aloxite more uniformly and about as fine as ordinary gravel.

Screening Machines

This crushed material is next screened or graded by passing it over reciprocating wire screens through which the small pieces fall. A number of these screening machines are shown in Fig. 4. The screens not only have a reciprocating motion but are inclined slightly so that the abrasive grains feed along down the incline. The screen is composed of sections of different mesh, varying from fine to coarse from the feeding end, so that the grains are graded as they feed along and fall through openings at the side of the machine into the cans shown. The coarser screens are made of wire and those for very fine numbers are made of silk cloth. The oversize stock which is too coarse to pass through the coarsest screen falls off at the extreme end and is re-crushed in the second set of crushing rolls previously referred to.

Uniform grading is secured by close regulation of feed, by keeping the screens in perfect condition and by regular testing of the graded material. This testing is done at frequent intervals during the day by means of small testing machines carrying master screens. These show the exact amount of over size and "fines," and the slightest variation from the standard causes the material to be rejected. Complete chemical analyses are also made, as a standard chemical composition is essential in the production of high-class grinding wheels. Various other treatments are employed, such as chemical treatment, hydraulic classification or magnetic concentration to produce aloxite grain for special classes of wheels.

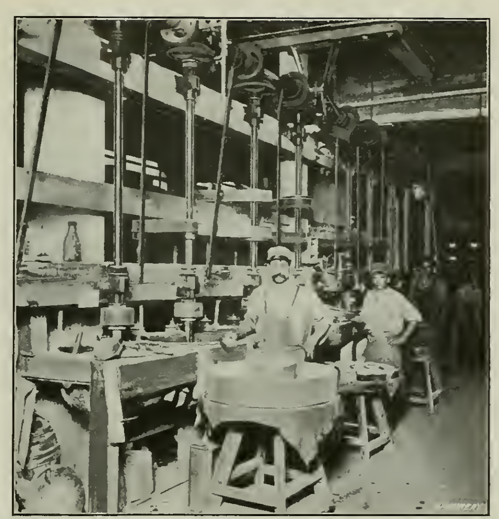

Fig. 5. Power-driven Mixing Kettle used when bonding by Vitrified Process

Bonding and Puddling or Mixing

One of the most important processes connected with grinding wheel manufacture is that of bonding the abrasive grains together in the form of a wheel. The three principal bonding processes are the vitrified, silicate, and elastic. As vitrified wheels are the most common, especially in connection with machine shop practice, this process will be described somewhat in detail in this article. The bond of a vitrified wheel is composed of suitable clays and fluxes which are mixed with the proper abrasive. By varying the amount and composition of the bond, wheels of different grade are obtained. The base of all bonds for vitrified wheels is feldspar or a fusible clay to which is added a refractory clay to decrease the fusibility of the bond. As the possible combinations of clays that may be used for bonding are almost endless, this is a branch of wheel manufacture that requires a great deal of experience and, at the plant of the Carborundum Co., it is in charge of an expert on ceramics.

The clays to be used are first dried to eliminate all moisture so that they can be proportioned by weight without the necessity of considering the weight of the moisture. Obviously, if there were an unknown amount of moisture in the different clays it would be impossible to determine the relative weights with accuracy. The bond, after being pulverized and

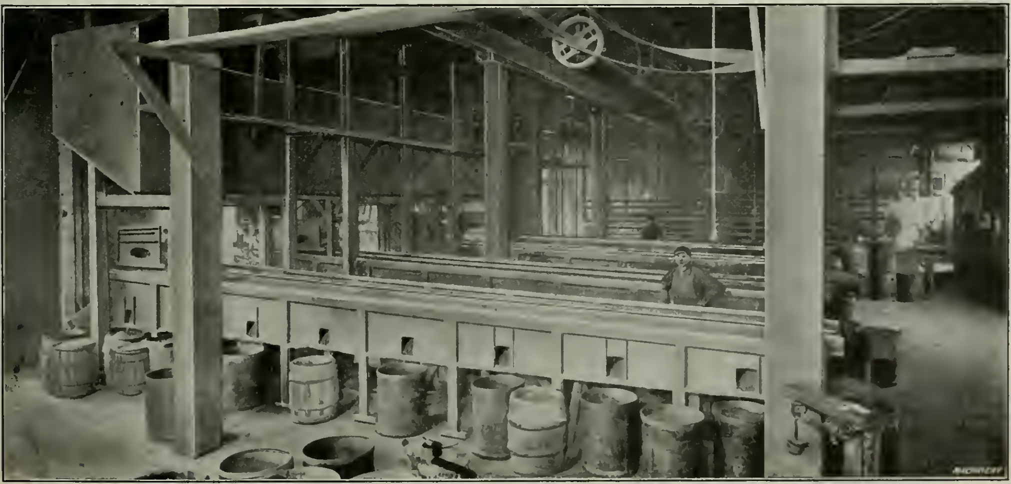

Fig. 4. Screening Machines used for grading Abrasive Grains

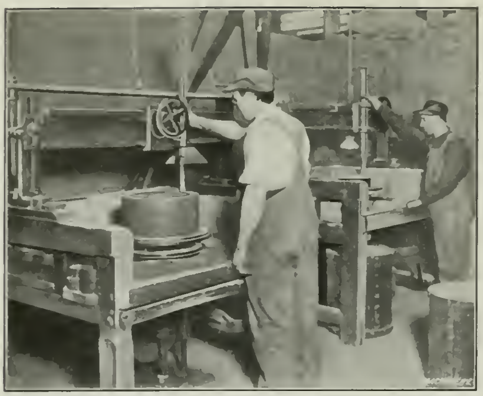
Fig. 6. Potter's Wheel used for truing Grinding Wheels prior to burning

screened to remove lumps, is mixed with the abrasive grains in power mixing kettles similar to those illustrated in Fig. 5. These kettles have rotating paddles attached to the vertical shafts shown. After the mixture of bond and abrasive is placed in the kettle, water is added and the mixing process begins. It is very important that the correct amount of water be added, the amount depending upon the coarseness of the abrasive and the composition of the bond. The coarser the grain, the less water is used. If there is too much water in the mixture, the grains and bond separate and the former, being heavier, sink to the bottom. An excessive amount of water also makes the wheels too compact, whereas if the mixture is too dry, they will be too coarse. The mixing requires several hours and depends upon the coarseness of the abrasive and the kind of wheel for which the mixture is intended.

Molding Vitrified Wheels

When vitrified wheels are mixed by the wet process in power driven kettles as described in the foregoing, they are molded as illustrated in Fig. 5. The mixture, which has the consistency of thick paint, is transferred from the mixing kettle to the mold, and when the mold is full the mixture is carefully worked to remove all air bubbles and insure a solid wheel. This operation requires considerable time when molding wheels which must be absolutely free from air bubbles such as those used for grinding glass, etc. The molds are then partially air dried in an open room to prevent formation of cracks. This preliminary drying is followed by a more complete drying in a heated room. When the molded wheels are hard enough to be handled they are ready to be turned to shape preparatory to burning in the kiln. The wheels are, of course, molded large to allow for turning and also to compensate for shrinkage in drying.

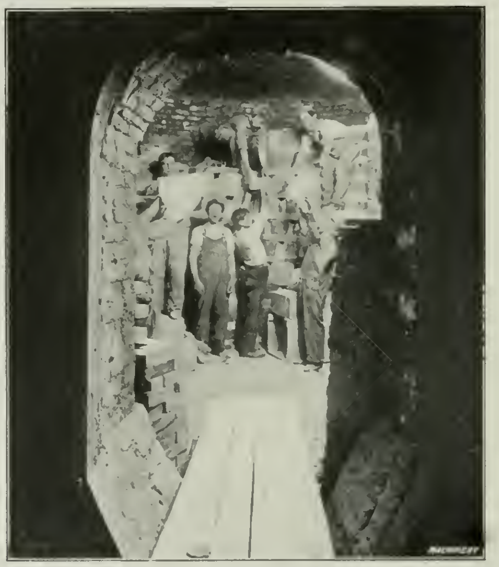
Fig. 7. Loading a Kiln with Grinding Wheels preparatory to burning

When very hard, close vitrified wheels are required, they are molded under the hydraulic press. Very strong molds must be used, as the pressures are enormous. For example, a 36-inch wheel would require a pressure of about 1000 tons. The bond and grain for pressed wheels are first mixed dry in a tumbling barrel, after which water is added until the proper consistency is obtained; the mixture is then spread evenly in the steel molds and pressed. The wheels are at once removed from the molds, dried, and "fired" in the same manner as other vitrified wheels.

Truing Grinding Wheels on Potter's Wheel

The rough molded wheel is trued and turned to the required form on a potter's wheel, as indicated in Fig. 6. This is a very simple device which consists principally of a revolving table and a horizontal cross-rail along which the tool-slide is fed by hand. The wheel to be trued is not held in any way but is simply placed on the center of the table, which is made of plaster-of-paris. The tool used for turning plain surfaces is a piece of flat, unhardened steel. This tool can be fed either vertically or horizontally, and scales on the machine enable the operator to turn to the required dimension without taking any measurements.

The wheel is not reduced to the size finally required but an allowance is made for shrinkage in the kiln and also to provide material for a final truing operation after burning. This allowance depends upon the size and grain of the wheel. A coarse wheel requires a greater allowance than a fine one, other conditions being equal. In the operation of the potter's wheel, hand tools are used to a certain extent, particularly in the formation of special shapes.

Burning Vitrified Grinding Wheels

Another important process in connection with vitrified grinding wheel manufacture is the burning of the wheels in order to partially melt the bond and form a solid but porous wheel. Much skill and care is required to burn wheels suc-

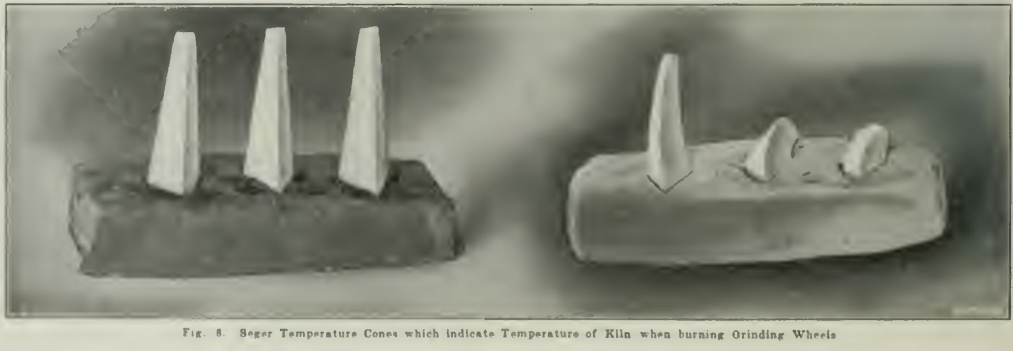
Fig. 8. Seger Temperature Cones which indicate Temperature of Kiln when burning Grinding Wheels

cessfully, as the temperature must be very accurately controlled for long periods. The wheels to be burned are stacked in a large brick kiln as illustrated in Fig. 7, which shows an interior view of a kiln as it is being loaded. The wheels are protected against the direct action of the flames and gases, by packing them in fire-clay saggers. When the kiln is full, the door is closed and luted with fire-clay and the burning begins. This continues without interruption for a period of from three to five days; the furnace is then allowed to cool slowly for a week.

The heat is derived from a coal fire beneath the floor of the kiln, and the temperature is regulated by the adjustment of dampers in the main and auxiliary draft tunnels. The draft through that part of the kiln containing the wheels is downward, and the heat is uniformly distributed by having draft openings in various parts of the kiln floor. The temperature in the kiln is gaged by Seger temperature cones. These cones, which are distributed throughout the kiln and are observed through small openings or "peep-holes," are in the form of triangular pyramids about two inches high which are held in a base as shown in Fig. 8. They are made in series or numbers which fuse at different temperatures and for this particular work, each "bat" or base contains three or four cones. When the first cone of the series fuses or becomes plastic enough to fall over, the temperature of the kiln is known and it is held at this temperature for a number of hours to insure uniform heating of all the wheels. The temperature is then increased until the next cone in the series falls over and it is maintained at this point, but is not allowed to rise high enough to fuse the last cone of the series. When two of the cones in a bat have fallen over, as shown to the right in Fig. 8, the man in charge of the kiln knows that the temperature at that point is somewhat less than that represented by the last cone of the series or the one still standing. In this way, the temperature is gaged and by having the cones distributed around the kiln, above and below and in the center, they also indicate whether or not the temperature is uniform. After the wheels are taken from the kiln they receive a preliminary inspection for flaws or cracks and then go to the truing department, as illustrated in Fig. 9.

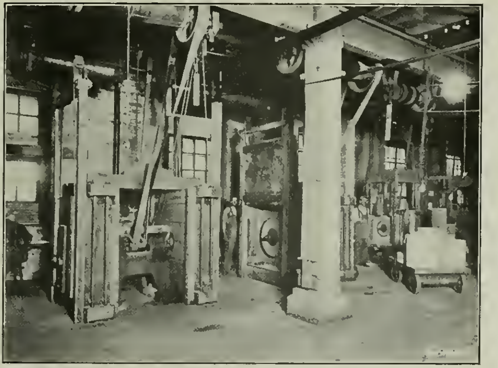
Fig. 10. Department where Grinding Wheels are given Speed Test

Truing the Grinding Wheels

The sides of the wheels are first trued in machines similar to the one shown in Fig. 9. The wheel is held in an ordinary chuck and a revolving disk type of truing tool is used. This is held in a tool-post and is fed in against the wheel by the large handwheel shown, and in a lateral direction by an automatic feed. After the hole has been bushed with babbitt, the wheel is mounted on a true running spindle and the periphery is trued. The disk wheel type of dresser is also used for the periphery on large wheels, and diamond tools for small wheels.

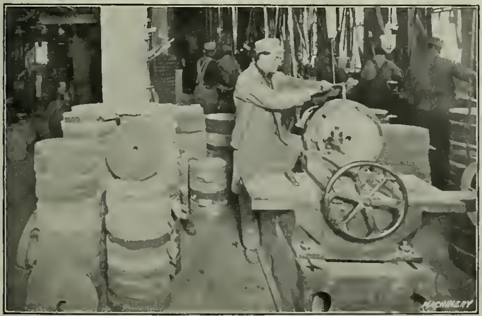
Fig. 9. One Corner of Grinding Wheel Truing Department

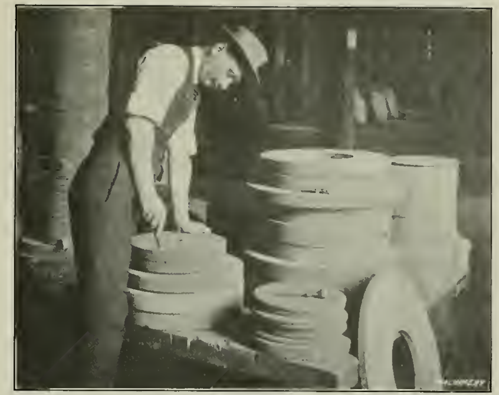
Fig. 11. Method of determining Grade of Grinding Wheel

Balancing and Speed Test of Grinding Wheels

The trued wheels are next tested for balance by mounting them on an arbor and placing the latter on horizontal parallel ways. If the wheel is out of balance slightly, very light weights of standard size are temporarily attached to the periphery and if the standard weight for a given wheel does not counteract the unbalanced side, the wheel is rejected.

The department in which the wheels are given the speed test is shown in Fig. 10. This department is considered one of the most important in wheel making and every precaution is taken to insure that the wheels, as they leave the works, are perfect and safe to operate. The wheel to be tested is mounted on the spindle of the machine and then the sliding door at the side is lowered, thus enclosing the wheel in a heavy wooden box so that in case of breakage, no one will be injured. The speed for this test is about 70 per cent faster than the normal speed, and it is indicated by a direct-reading tachometer connected with the spindle of the machine. During this test, an internal stress is developed which is at least three times greater than the stress to which the wheel is subjected when running at the correct working speed. After a wheel is tested, the operator makes a duplicate written record of the test, one copy being attached to the wheel and the other filed in the records of the company. At the end of the day all records are sworn to before a notary.

Determining Grade of Wheels

The grade of a grinding wheel or the tenacity with which the bond holds the abrasive grains in place is determined by a hand test and requires considerable experience and skill. The tool used has a ball-shaped handle and a blade which is beveled on the end like a cold chisel. When making the test this beveled end is simply pressed into the side of the wheel as shown in Fig. 11, and is then turned or twisted. The resistance to this twisting movement indicates to the experienced man the grade. The delicate sense of touch is soon lost even by an expert who discontinues the work.

Many attempts have been made to supplant the hand grade test by a mechanical one, but up to the present time the simple tool in the hands fo an expert has proved to be the most reliable and practicable. After the grading test, the wheels are again carefully inspected and tested for soundness and then they are ready for the shipping department.

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AMERICAN INDUSTRIAL CONDITIONS AND THE OUTLOOK*

Step by step during the past three weeks we have been making our way toward a resumption of our foreign trade, following the paralysis of exchange and shipping facilities which came with the outbreak of war, and the progress made is now plainly evident. Our business men have met the situation calmly, their faith in the future strengthened by the effect on our domestic trade of the unprecedented harvest, the change in public sentiment toward legitimate business enterprises, our absolutely sound financial condition resulting from seven years of liquidation, and the settlement of our currency question so that we have an abundant supply of money for all legitimate purposes. Every one has noticed that there has been no approach to panic here.

Some exaggerated statements have been published regarding the benefits of the war to the United States, and this article is intended to be a conservative review of the situation as it affects our machinery industry, based on more than twenty-five years' personal acquaintance with European and American conditions.

Germany was ready for the war, and her vast army was mobilized almost by pressing a button; but neither England, France nor Russia was prepared. England's army is her weak point. The French army is still equipped with rifles of the 1886 pattern, although efforts have been made to substitute modern ones. Russia, during the past two years, has been spending vast sums for armament, in the construction of which many American machine tools have been employed. When the writer was in Russia last month, it was expected that the government expenditures would continue for at least two years, and machinery dealers there were looking for a continuation of active business during that period, although the recurring strikes of industrial workers imparted a sinister aspect to the future. The Russian army, on a peace footing, numbered 1,284,000 men, which sounds formidable to us, but most of these are required for garrison duty; 40,000 are needed for St. Petersburg alone, where there were 140,000 strikers last July. Germany needs no such garrisons in time of war for interior points.

Before the war Great Britain and Germany were close competitors in the manufacture of machinery and supplies. France was a small producer but increasing. Russia and Austria were buyers of machinery but not manufacturers. This war will probably cause great industrial as well as political changes. Unknown millions of producers have been suddenly withdrawn from the manufacturing industries and farms of Europe and turned into consumers and destroyers of life and property, so that virtually all producing is stopped in some of the countries at war, except where it can be carried on by old men, women and girls. Not only the countries involved, but also those that received their product, must continue as consumers to a large extent, and the United States is the only nation left to supply their demands freely; but time is necessary to build up an organization to do this.

The fearful load of debt which war entails means heavier burdens for the already overtaxed European peoples. Heavier taxes mean increased cost of living, of labor and of material—which will inevitably bring all European costs nearer those of our own manufacturers. Whatever happens to the three emperors who are responsible for the war, one result will surely be the transfer of some of their power to the people of Germany, Russia and Austria. This tendency is world wide, and in those countries needs only such an impetus as the war will give to become irresistible. Greater power for the people means higher wages, better living—and also higher costs for all kinds of manufactured products, and probably for farm products as well. All of these influences must work to our advantage by equalizing the cost of labor, which is the only advantage Europe now has over us.

No one who knows the German people can withhold his admiration for the wonderful capacity for organization, the matchless perseverance and far-sighted methods of handling public and private works which have developed in one generation the most powerful nation on earth. But the strength and military training of the Germans have made them overconfident, and begotten a war madness which will check their commercial progress for a generation. This was very noticeable when the writer was in Germany last summer during the break with England. The war fever possessed nearly every one, and only a spark was then needed to start the conflagration. This year the spark was applied, and like a flash of gunpowder all the powerful nations of Europe but one, were united against Germany.

Every one familiar with European industrial conditions has long seen that Germany would become our strongest competitor, and although she is hated and feared by all of Europe except Austria, her export trade everywhere has been increasing by leaps and bounds—in machinery and supplies more than one thousand per cent in ten years. She was reaching for the trade of the world and getting it. German makers of machinery and tools of all kinds have not only glutted their own markets, but those of England, France, Russia, Austria, Italy, the Asiatic countries, the Colonies and South America. No market was too small or too remote for profitable German cultivation. The only country where her mechanical products have not yet gained a foothold is the United States, and that is accounted for by our depression and the length of time necessary to perfect selling organizations covering such a large territory.

It will be years before the trade of Germany can recross the bloody barriers which will separate her at the close of the war from the countries she is seeking to destroy. Those countries will inevitably prefer tools and other products made by America—a nation always friendly; and our foreign machinery trade should reach the figures of our most prosperous years, so that whether we will or not, we stand to profit by the misfortunes of other nations.

Increased activity has already appeared in many domestic industries, such as the manufacture of prints, gloves, hosiery, carpets and woolens, pottery, toys, chemicals and nearly every business which has come into sharp competition with foreign products. A manufacturer of women's garments who uses two thousand gross of buttons weekly now buys them in America instead of Germany. Our powder mills have just started running double time on foreign orders. These are only straws, but they show the direction of the wind and indicate a tendency which will be followed in many other lines—*to buy here*, because we are almost the only source of supply for manufactured products. Every manufacturing business that is benefited helps the machinery industry.

We cannot expect business to revive over night; the situation is too complex. Some industries will be helped by the war, others will be injured; and while the immediate effect has been injurious, it is largely sentimental. Most American manufacturers, particularly those who make staple commodities, when they review the situation calmly, will find other markets opened by the war to replace those closed; and meanwhile our domestic markets under the influence of world-wide buying will expand gradually. Conditions here are such that the revival of business is largely dependent on sentiment. When a common sense view of the future prevails, the business pendulum will begin to swing the other way, and the swing will be a long one.

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* By Alexander Luchars, publisher of MACHINERY, who spent three months in Russia, Germany and other parts of Europe, just before the outbreak of the war.

GAS PRODUCERS AND CHEAP HEAT AND POWER

The developments in gas producers and the improvements in the gas engine made in recent years have placed within the reach of the consumer small plants in which power can be produced as economically as in the very largest steam engine power stations. With the best types of gas producers it is possible to generate power with a fuel consumption of only one pound of coal per horsepower hour, and the coal used may be the very cheapest grade of bituminous, that is, "run-of-mine." The small producer power plant has a number of other advantages besides small fuel consumption and cheapness of fuel. It needs very little attention, and that attention for small-sized units may be given by a man regularly employed with other duties. The plant can be quickly shut down at night and started in fifteen or twenty minutes in the morning. There is no danger of disastrous explosion and the installation is compact and cheaply housed.

The lower operating cost of a gas producer plant compared with that of a steam engine plant is most pronounced in the case of small power installations wherein a boiler and steam engine of low efficiency often require five times as much fuel per horsepower hour as the gas producer plant of the same power capacity. In these smaller units the producer plant is somewhat more costly to install than the steam engine plant, but as the saving in fuel is so marked, the actual economy of the producer plant is beyond question. In the larger power installations, however, the comparative costs of highly efficient steam boilers and engines and producer cost equipment are about the same, and the saving of fuel effected by the latter is less. The gas producer, nevertheless, compares very favorably with the steam plant both in the matter of first cost and efficient power production.

The superiority of the gas producer plant over Diesel engines operating on fuel oil can also be demonstrated, probably without difficulty, as the oil used by the latter has of late years been increasing in price. The very high temperatures generated in the Diesel engine cylinders result in greater operating difficulties and higher costs of maintenance than in gas engines running on producer gas.

The gas producer undoubtedly has a great future, not only for stationary power plants, but also for marine propulsion. It requires less space than the steam engine power plant, and this, with the smaller amount of fuel needed for the same power, makes available larger cargo space. No smokestacks are required, and the fuel, unlike that for the Diesel engine, is available in practically every port of call.

It is not, however, for power purposes only that producer gas gives the greatest promise to manufacturers. It has been found to be a very cheap and valuable fuel for metal heat-treating furnaces. Installations of this type which have been in operation for some time have shown that at least one-half of the fuel cost, as compared with oil fuel, may be saved, and more uniform heats obtained in the furnaces. The great advantage of uniformity of heat is due to the fact that with producer gas the burners may be arranged along a pipe extending the full length of the inside of the furnace, whereas with oil fuel it is necessary to have the burners at the point where the oil and air mixture enter the furnace to force the flames against baffle plates. Inasmuch as it is also possible with producer gas to raise the temperature of the furnace to a required degree more quickly than with oil, there is an increase in the quantity of product as well as in the quality. The rapid growth of heat-treating plants and the probable great increase of such installations in all metal manufacturing plants making high-grade products make this advantage of producer gas of great importance.

* * *

MODERN MACHINE TOOL DESIGN

The designer of heavy machine tools which will satisfactorily meet present-day requirements has to provide better materials of construction than ordinary machinery steel and cast iron; he has to take care of heavier bearing pressures than were formerly the rule; and, lastly, he must safeguard gears, pulleys and other moving parts wherever practicable in order to prevent injuries to workmen.

It is not difficult to obtain better materials of construction for the smaller types of machines, but it is indeed a serious problem for heavy tools. In fact, at the present stage of machinery building, cast iron must be generally used for frames, slides, gears, faceplates, etc. To use steel castings is out of the question in some competitive lines. Machinery steel must be used for most shafts, large screws, etc. With these limitations what can be done? In the first place, the quality of cast iron must be made more uniform and dependable, and of higher tensile strength. Better design which tends to eliminate shrinkage strains and the concentration of stresses will help. In the case of gears, the double spiral tooth improves durability, reduces shocks and promotes steadier action.

Bearing pressures heavier than those safe with casual lubrication must be sustained by forced oil feed. Lubricating every important bearing constantly and in generous quantity by a circulatory system will be imperative. The splash lubricating system is satisfactory for gear trains that can be enclosed. In this design the requirements of safety and efficient lubrication are solved simultaneously.

Safeguarding dangerous points in machines will become second nature with the designer and will result in a decided improvement in the appearance of machines—a fact already realized, as is evident in comparing the designs of the present with those of ten years ago.

* * *

WHAT CONSTITUTES THE BEST DESIGN

The design of military equipment is often characterized by specifications of extraordinary difficulty and reckless disregard of cost. The United States government military authorities are well-known sinners in this respect, but perhaps no worse than those of other powers. The military expert takes himself and his profession very seriously. Victory in war is to be won at all hazards and the cost of guns and battleships is limited only by what the taxpayers will stand.

Excellence of design and construction are admirable, but the degree of excellence should be tempered with good sense and some regard for the mutability of human affairs. The military experts of a European power were racking their brains to devise a method for making an accurate army rifle with a hardened barrel. Smokeless powder has rapid corrosive and erosive effects on soft steel, and some alarmist demonstrated that the infantry rifles might be completely worn out and made useless in a protracted engagement. Hence the supposed need for more durable barrels. An American manufacturer of armory equipment demonstrated the fallacy of the idea. He showed that he could make barrels of soft steel so cheaply that it was better to re-barrel the rifles than to try to make hardened barrels. Another powerful argument against the practice is the fact that the designs of military equipment change so quickly that the manufacture of superlatively good guns would be wasteful.

The design of United States seige gun carriages is a good example of difficult specification and a royal disregard of cost. The carriages are built of thin steel plates riveted together and the plates must be shaped to templets and scraped to fit each other exactly. Parts requiring planing or turning must first be riveted together and then machined even though of a very unwieldy form. A carriage when completed looks like a pretty good job of riveted sheet steel work that might cost say $500, but the actual cost is not far from $11,000!

While it is true that military equipment, like fire apparatus, earns most when not in use, no engineer can look on such costly work without a feeling of regret at the probable waste. In manoeuvres and drills, field guns are subjected to the roughest possible usage and when not in service are left to stand out in the weather and rust. In a few years they become obsolete and go to the scrap heap. Bearing this in mind, who can say what is the best design in this work—that which is comparatively cheap, and possibly open to expert criticism, or that which is superlatively excellent and correspondingly costly?

PRODUCTION TOOLS FOR REO ENGINE CYLINDERS—2

SPECIAL JIGS AND FIXTURES AND MACHINING METHODS USED BY THE REO MOTOR CAR CO., LANSING, MICH.

BY DOUGLAS T. HAMILTON*

To proceed with the machining operations on the Reo engine cylinders, the castings, after the first and second rough-boring cuts have been taken, as was previously described, pass through a long series of operations enumerated in the following. To make this description complete, reference will be made throughout this article to Fig. 1, which appeared in the previous installment.

Rough- and Finish-boring Inlet Valve Chamber Seats

The rough- and finish-boring of the inlet valve chamber seats *U* (see Fig. 1) in the cylinder casting is accomplished in the Moline adjustable spindle drilling machine shown in Fig. 10. This machine is equipped with a special fixture of the progressive type and has three work-holding slides so that it can be kept in practically continuous operation. The first two spindles carry the rough-boring cutters, and the last two the finish-boring tools. By referring to Fig. 1 it will be seen that the inlet valve chamber seat has two different diameters, namely, 2.768 inches and 2.328 inches. The larger bore penetrates 1.56 inch, and ends in a 45-degree taper leading to the 2.328-inch hole. This taper seat serves as a container for a gasket which makes the chamber steam-tight. The boring tools, which are shown at *A* in Fig. 12, are rotated at forty-five revolutions per minute, and the table is raised at a rate of 0.027 inch per revolution of the boring tools. The boring cutters *b* are made from high-speed steel and are held on the shank by a cap-screw *a*, being kept from turning by keys *c*. The upper portion of this seat is tapped later.

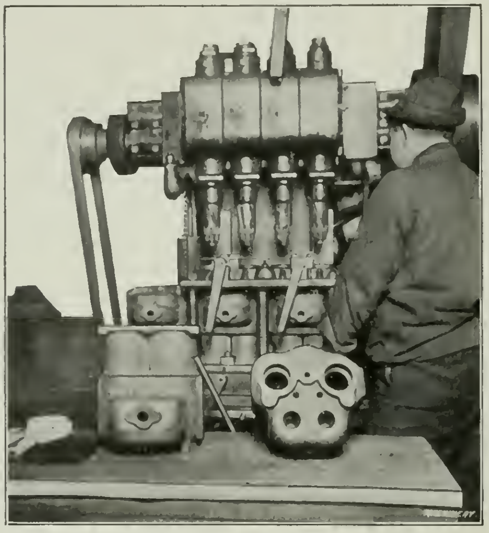

Fig. 10. Rough- and finish-boring the Inlet Valve Chamber Seats on a Moline Adjustable Spindle Drilling Machine

The work-holding fixture used on the machine shown in Fig. 10 is of interesting construction and is illustrated in Fig. 11. Upon referring to the latter illustration, it will be seen that, as in previous cases, this fixture is of open construction consisting of a bed *B* and top plate *C*, held together by upright stanchions *D* at the front; the back is a full casting with openings to provide clearance for chips and the work.

The individual work-holding slides *E*, of which there are three, fit in dovetail slides in the base of the fixture, as indicated in Fig. 11. The engine casting *A* is located on the slides from the previously reamed holes in the flange by pins *F* and held down by heel-clamps *G*. These clamps are held up by open-wound coil springs to facilitate loading and unloading. Located in the base of the fixture is a rack *H*, operated by a pinion *I*, which is rotated by a handle on shaft *J*. Fulcrumed on a pin in rack *H* is a latch *K*, held up by flat spring *L*.

In operation, the work-holding slide *E* is laid on top of the extension of the fixture, the rack *H*, prior to this, being moved out as far as it will go. The slide then butts up against the latch *K*, and as the rack is moved in again by the handle on shaft *J* the casting clamped to the slide is brought to a position under the boring and reaming tools. The adjustable stop-screw *M* butts against the casting of the main fixture when the work-holding slide has reached the proper position in alignment with the spindles of the drilling machine. The handle *N* is then operated, and as this is connected by links to cams or eccentrics *O* which are held to spring plungers *P*, a movement of this handle to the left forces the plungers into bushed holes that locate the work-holding slides in the proper relation to the spindles of the machine.

By having three slides for holding the work it is possible

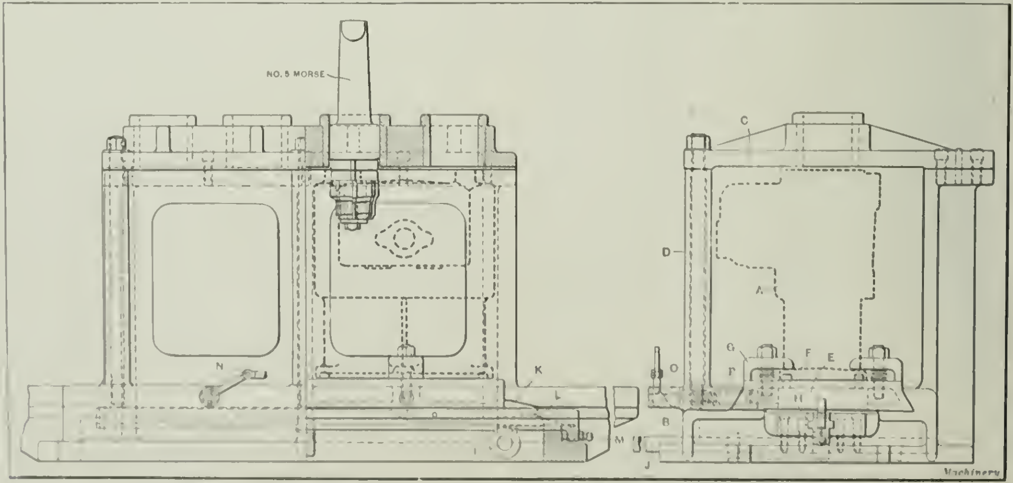

Fig. 11. Rough- and Finish-boring Fixture for Inlet Valve Chamber Seats used in the Machine shown in Fig. 10

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* Associate Editor of MACHINERY.

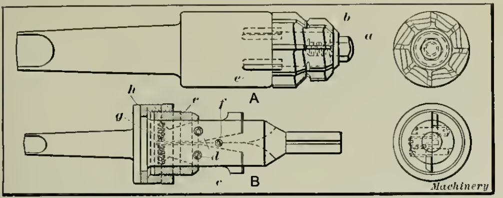


Fig. 12. Step Reamer used for rough-boring Inlet Valve Chamber Seats and Special Recessing Tool for the Valve Seats

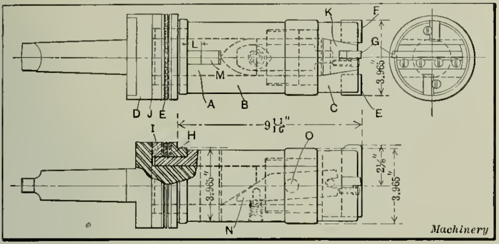


Fig. 13. Expanding Type of Tool used for recessing the Top of the Cylinder Bore

to keep this machine in practically continuous operation, and a production of 200 cylinder castings is turned out in nine hours. In addition, the fixture is very simple to operate and admirably adapted to progressive drilling of this kind. The open-type construction is also commendable.

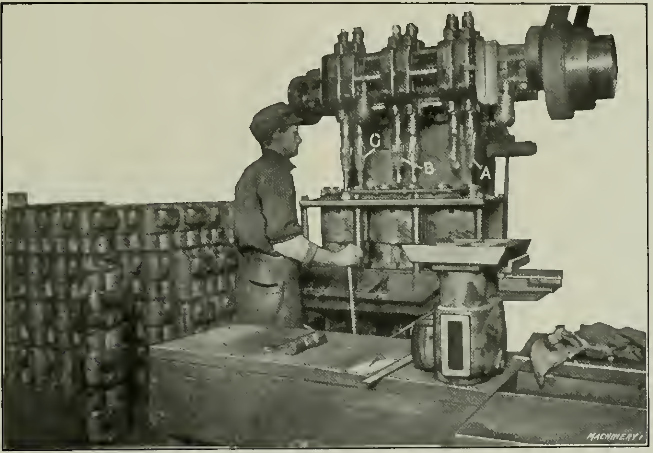


Fig. 14. Drilling, rough-boring and finish-reaming Exhaust Valve Seats

Following the rough- and finish-boring of the inlet valve chamber holes, the castings are taken to a Baker vertical high-speed drilling machine of the type shown in Fig. 19. Here the cylinder bores are counterbored to the proper depth and recessed at the top or explosion chamber. The recessing operation serves two purposes: In the first place, it facilitates grinding the cylinder bores, and in the second place obviates knocking when the cylinders have been in use for some time. As the piston travels up to the same point in the explosion chambers at each stroke, it is apparent that as soon as the bore commences to wear a slight shoulder will be formed at the upper end of the piston stroke. This causes knocking to take place in the cylinder at every stroke, and in order to obviate this trouble it has been found advisable to recess the cylinder to a diameter larger than the bore at this point, so that at the end of its up-stroke the piston will pass into a clearance space.

The tool for performing this recessing operation is shown in Fig. 13. It consists primarily of a body *A* machined to fit into the spindle of the drilling machine, and turned down on its lower end to fit into sleeve *B*. The lower end of the sleeve is formed into a cutter-head *C*, carrying two high-speed cutters *F*, which face the cylinder to depth, and two recessing cutters *G*. Driven onto the extended shank of sleeve *B* is a collar *H* and between this collar and the flange *D* of the cutter spindle is a ball thrust bearing *E*, and a thrust washer.

In operation, the action of this tool, which is shown in the position that it occupies at the final downward movement of the cutter spindle, is as follows: A slotted washer (not shown) is inserted between the spindle collar *D* and the thrust washer located directly beneath it. This holds the sleeve *B* down, causing the recessing tool *G* to collapse into the sleeve, thus making a solid end-cutting tool with two facing tools *F* exposed. The spindle is then fed downward and the cylinder faced to depth, as determined by stop-collar *H* against the flange of the cylinder.

The slotted washer is then removed, and as the tool continues to feed downward, the spindle *A* advances into sleeve *B*, and the beveled end of the spindle, contacting with the spring-controlled operating wedge *N*, forces out the cutter-slide *K*. Wedge *N* is fulcrumed on a pin *O* held in the cutter-head *C* which is screwed into the nose of sleeve *B*. The action of forcing out the cutter *G* continues until spindle collar *D* contacts with the thrust washer located beneath it, which occurs when the proper recessed diameter has been reached.

The next operation, which is of a simple character and is accomplished in a single-spindle drilling machine, is to drill, counterbore and tap for the spark plug holes *V* shown in Fig. 1. There are two of these holes to be drilled and tapped in each casting. The drills are 23/32 inch in diameter, and the tap is a ½-inch pipe tap. The hole is counterbored 1 inch diameter by 5/16 inch deep. This operation is clearly shown at the section on *M-N*.

Drilling, Boring and Reaming Exhaust Valve Seats

Another interesting method of handling automobile engine cylinders while machining the exhaust valve seats is shown in Fig. 14. The machine used is a Moline six spindle drilling machine equipped with a

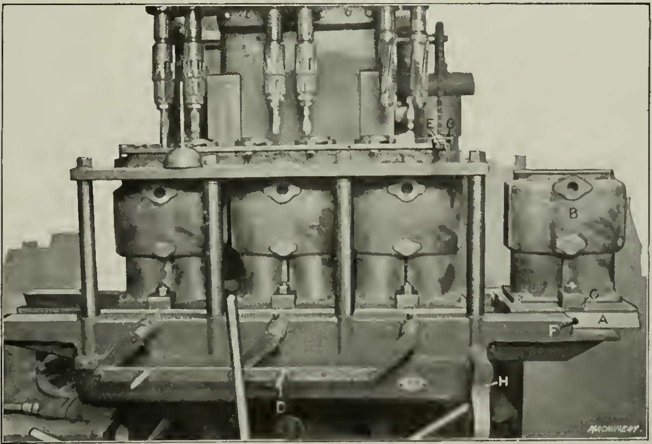


Fig. 15. Close View of Progressive Type of Jig used in the Machine shown in Fig. 14

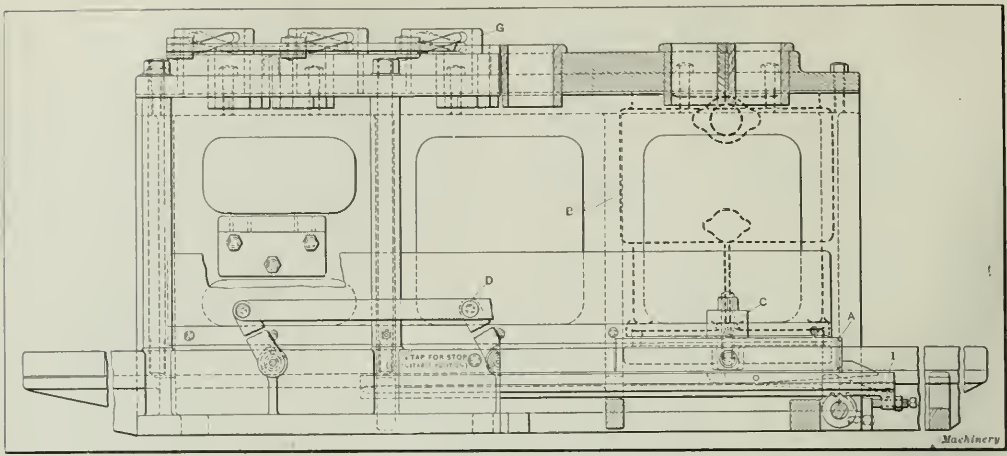


Fig. 16. Front Elevation of Progressive Type of Drilling, Rough-boring and Finish-reaming Jig used on the Machine shown in Fig. 14

special fixture of the progressive type, somewhat similar in construction to that shown in Fig. 11. This fixture, instead of having three, has four work-holding slides, and the operations performed in it are somewhat different from those previously described. Three of these work-holding slides are kept in continuous operation. The first two spindles *A* of the machine rough-drill the exhaust valve covers and valve seats, the second two spindles *B* carry tools that rough-bore the exhaust valve covers and valve seats and drill the exhaust valve stem guide holes, whereas the third two spindles *C* carry the finish-reaming tools for the exhaust valve covers, valve seats and valve stem guide holes. These tools are rotated at sixty-five revolutions per minute and the table is given an upward feed of 0.012 inch per revolution of the tools.

Fig. 15 shows a close view of the fixture. By referring to this illustration and also to Figs. 16 and 17, a good idea of the construction and operation will be obtained. All three illustrations have the same reference letters. The slides *A*, of which there are four, carry four locating pins which fit into the previously reamed holes in the flange of the casting *B*. In addition, the casting is held down on the slide by two toe-clamps *C*. The method of operating this fixture is as follows: The operator, in starting, of course, only rough-drills in the first position; then the slide is shifted to the next position. Handle *D* withdraws the locking plungers from the bushed hole *F* in the slide, and handle *E* withdraws the bushings *G* which are used as locating members and fit into the previously machined inlet valve chamber hole. Handle *H* that moves the rack *I*, see Fig. 16, is then operated and carries the next slide into position. This part of the fixture is similar in construction and operation to that shown in Fig. 11. One slide forces the other along, as the rack only carries in the outermost slide or the one located to the right in the illustration.

Upon the completion of the drilling operation, the first casting is shifted to the next position by a second slide that carries a rough casting. Then when the table is raised one casting is drilled and another one rough-reamed. Upon lowering the table, the locking plungers are again withdrawn by handles *D* and *E* and handle *H* is rotated. The next slide is then forced into position and as the table rises again three operations are being accomplished, namely, rough-drilling, rough-drilling and boring, and finish-boring and reaming. After the fixture is filled up, the operations are continued, so that a completed casting is turned out at every drop of the table.

A better idea of the method used in locating the castings will be obtained by referring to Figs. 16 and 17. Bushings *G* which are provided with cam grooves are raised and lowered by pins fitting in these grooves and operated by a lever connected by links to the various operating pins. Bushings *G* fit into the previously machined inlet valve chamber holes and serve to preserve the required relation of these holes and the exhaust valve holes. This fixture operates very rapidly, and as one idle or extra work-holding slide is provided, it is practically unnecessary for the machine to stop working, the operations being almost continuous. A production of 150 finished castings in nine hours shows that this fixture is all that could be expected in the way of efficiency.

The roughing and finishing tools used for the exhaust valve seats are illustrated in Fig. 18, which also shows the depth of the various bores. By referring to this illustration and also to the view of the cylinder in Fig. 1, the nature of the operations will be clearly understood. The lower hole *a* is drilled 0.781 inch diameter and is then reamed with the last tool to 0.8125 inch diameter. The next bore *b* is drilled to 1.6875 inch and reamed to 1.750 inch. The next diameter is drilled to 1.9375 inch by tool *A* and reamed to 2.017 inches, these being the finished dimensions, and the largest diameter is finished to 2.25 inches. The entire seats are finished complete before the casting leaves the machine, all edges being beveled to 45 degrees as indicated. The total drilling and reaming depth is about 5⅝ inches.

The roughing and finishing boring tools are worthy of particular attention. They are shown at *A*, *B*, *C* and *D* in Fig. 18. *D* shows the shank of the two tools *B* and *C*, which are similar in construction. These shanks are made from one piece of machine steel, packhardened and ground, and are bored out tapered on the lower end to carry the drill in one case and the pilot reamer in the other. The drill and reamer have tapered shanks and the rough- and finish-boring reaming tools are held on the

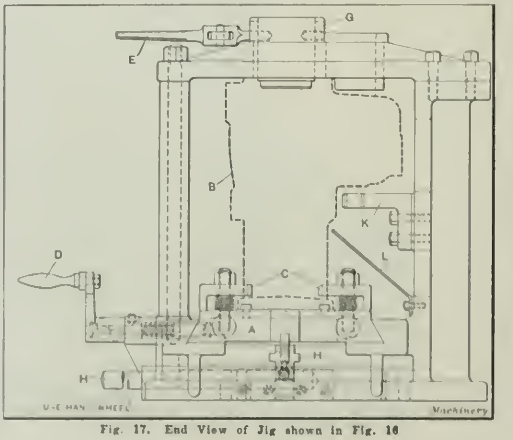


Fig. 17. End View of Jig shown in Fig. 16

main shank of the holder by a nut as illustrated. It will also be noticed that the lower faces of the two upper reamers, both roughing and finishing, are provided with slots in which the projections on the upper members of the other roughing and boring reamers fit. This prevents them from turning and avoids the necessity of having a keyway on the arbor. The holes in these rough- and finish-boring tools are made a good fit on the shank of the holder so that they are very rigidly supported, eliminating any chance of inaccuracy due to movement of these tools. The leader of the finish-reaming tool is guided by a bushing in the bracket *K* of the fixture shown in Fig. 17, and a guard *L* is also added to deflect the chips from the side of the fixture to the table of the machine.

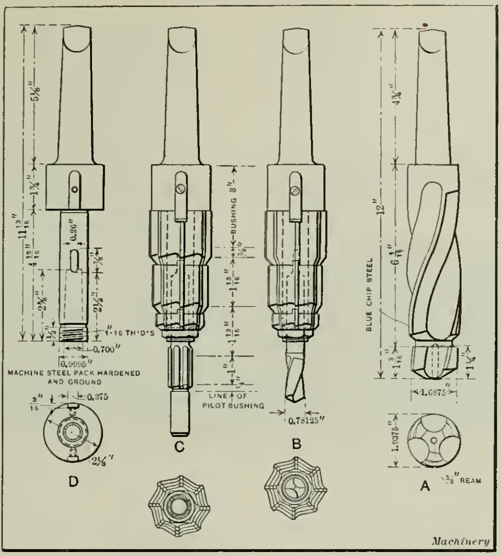


Fig. 18. Roughing Drill, Roughing Counterbore and Finish Counterbore and Reaming Tool for completing the Exhaust Valve Seats. These Tools are used in the Machine shown in Fig. 14

Facing, Recessing and Tapping Valve Holes

Following the drilling, rough-boring, finish-boring and reaming of the exhaust valve seats, the next step in the machining operations is to face the valve hole bosses, counterbore the base of the chamber *e* and recess it larger than the valve hole. Reference to Fig. 1 will make clear the operation that is performed here. This facing and recessing operation is accomplished in the Baker high-speed drilling machine shown in Fig. 19, using the tool shown at *B* in Fig. 12. This tool is built on the expanding principle.

The recessing is accomplished by two inserted high-speed steel blades *c* which are retained in a slot in the body of the holder by two fulcrum screws *d*. The adjustment of these cutters is accomplished by moving the locking-nuts along the sleeve *e*, this action forcing the cutter blades in or out, depending on the movement given to the nut, and thus increasing or decreasing the diameter due to the tapered portion of the cutters passing over the screw *f*. These cutters are kept together, that is to the smallest diameter, by an open-wound coil spring *g*, and the thrust of the adjusting nut is taken by a bronze washer *h*.

The holes for the exhaust valve cover and inlet valve chamber are then tapped in the Baker high-speed drilling machine shown in Fig. 19. The two inlet valve chamber holes are tapped 2⅞ inches by 12 pitch, the bore being 2.768 inches. The two exhaust valve cover holes are tapped 2⅛ inches by 12 pitch, the bore being 2.017 inches. It may be interesting to note here a few facts concerning the taps that are used for this purpose. They are Murchey removable chaser taps, and both of these tap holders have been in use for over a year. By supplying them with only three sets of chasers it has been possible to turn out 16,000 cylinder castings or 32,000 tapped holes with three sets of chasers.

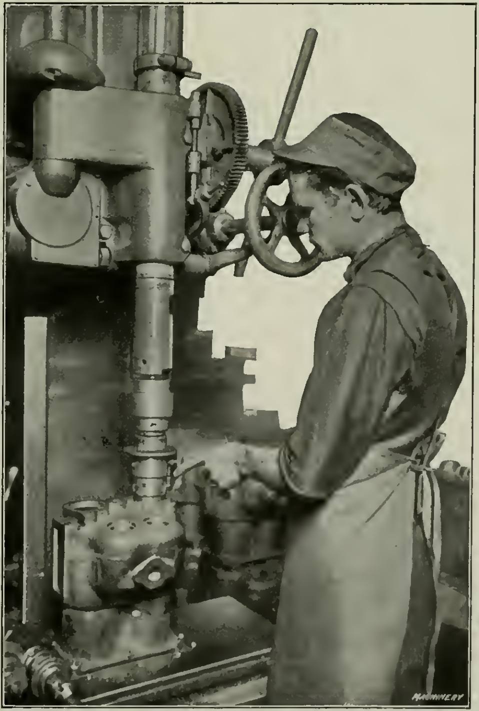


Fig. 19. Counterboring, facing and tapping Inlet and Exhaust Valve Holes

Miscellaneous Drilling, Tapping and Counterboring Operations

Following the principal operations outlined, the additional steps will be given in the order in which they are performed. The first operation is to drill six holes *f*, see Fig. 1, for the waterjacket plate. This is accomplished with a multiple drill head which carries six 13/64-inch drills. Fifty engine castings are turned out per hour in this operation. The next step is to remove the cylinder to a single-spindle drilling machine, where the two vent holes *g* are drilled; holes *h* and *i* are also drilled for the water connections, two of these being tapped, and in addition the two holes *j* for the support for the valve rocker are drilled and tapped. Following this operation, the valve stem guide holes are faced on a single-spindle drilling machine. This is a comparatively simple operation to perform and 100 cylinder castings are turned out per hour.

The next operation, which is also accomplished in a single-spindle drilling machine, is to drill and tap four holes for the inlet and exhaust water pipe connections, and counterbore two holes. Following this, the casting is removed to another single-spindle machine and three ½-inch pipe tap cleaning holes are machined. Also the holes for the inlet and exhaust pipes are reamed. For these operations the casting is held on a rotating fixture which is swung around to bring the various holes into position in line with the spindle. While these operations are of a minor character, they nevertheless count in the production of a cylinder and must be taken into consideration.

Final Boring Operation

The cylinder casting, after having had the minor operations enumerated performed, is now ready for the final boring operation. This is accomplished on a Moline four-spindle boring machine, equipped with a fixture somewhat similar in design to that shown in Fig. 10. The fixture is supplied with four slides so that while two are in operation the other two can be unloaded and loaded, thus practically keeping the machine in continuous operation. In this final boring about 0.045 inch is removed from the diameter, leaving 0.010 inch for the final

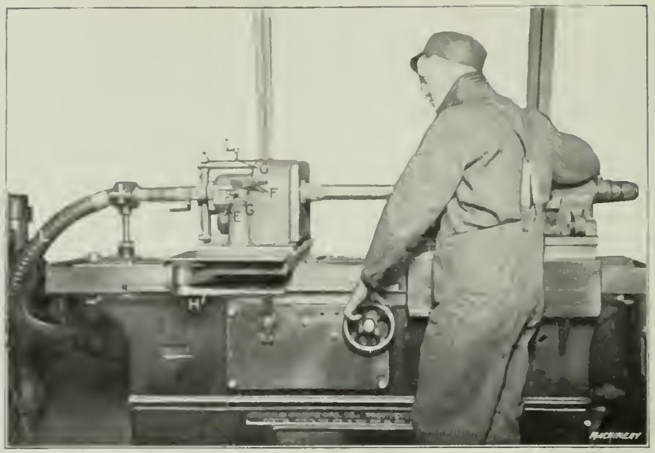


Fig. 20. Finish-grinding Cylinder Bores in Brown & Sharpe Cylinder Grinding Machine

grinding operation. In the finish-boring, 160 cylinder castings, or 320 cylinder bores, are turned out in nine hours. The object in performing three rough- and finish-boring operations on the cylinder previous to grinding is to remove all strains from the casting and to obtain a perfectly round hole as well as to get the bore absolutely straight and eliminate any possibility of securing poor work on the grinding machine. The grinding operation is primarily to secure a perfectly smooth bore, and the rough- and finish-boring operations are depended upon to make the bore cylindrical and straight. Grinding, under the most favorable circumstances, is a somewhat expensive operation, and the less material that can be removed in this operation the better. However, grinding of the cylinders is acknowledged to be about as satisfactory a method of securing a true bore as can be employed.

Finishing the Cylinder Bores by Grinding

One of the great difficulties met with in grinding cylinder bores is to get the bore perfectly true and at right angles with the base of the cylinder casting. If the boring operation has been properly done the cylinder bore can be used to a large extent to true the casting up by. This, however, is a slow operation, especially when it is necessary to move the internal grinding head. To avoid this difficulty, the Reo Motor Car Co. has designed the special fixture shown on the machine in Fig. 20 and in detail in Fig. 21. Inasmuch as there is only 0.005 inch left on the side or 0.010 inch on the diameter of the cylinder bore to be removed by grinding, it is necessary that the bore, which is 10 inches deep, be set practically parallel with the travel of the internal grinding head. Instead of adjusting the internal grinding head casting or slide to suit the position of the cylinder bore when clamped in the jig, the internal grinding head is left stationary and the jig itself is so made that adjustment can be easily and quickly effected. Reference to Fig. 21 will show how this is accomplished.

As a means of locating the cylinder casting in the fixture shown in Fig. 21, four hardened and ground plugs are fitted into the previously drilled and reamed holes in the flange of the cylinder casting *A*. These pins are depended upon to square up the cylinder and it is then held against the face of the fixture by clamping screws *B* and *C*. As the end view shows, clamping screw *C* is held in a stud, the latter acting as a locking member for the swinging lever *D* that holds the clamping screw bearing against the end of the casting.

In operation, the cylinder casting *A* is placed in the fixture and located from the hardened and ground studs previously mentioned. The swinging arm *D* is then moved into position, and screw *B* tightened, after which screw *C* is tightened. The internal grinding wheel is then brought into touch with the bore of the cylinder, and by this means the operator determines whether the casting has been clamped straight or not. If it has not been clamped straight, he re-

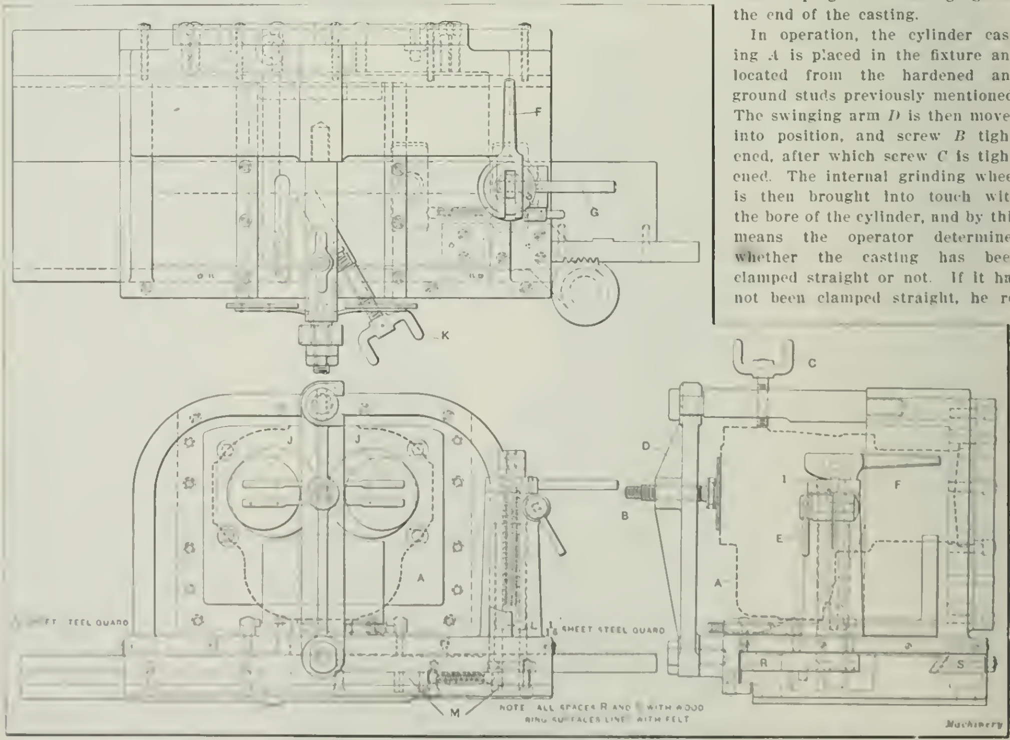
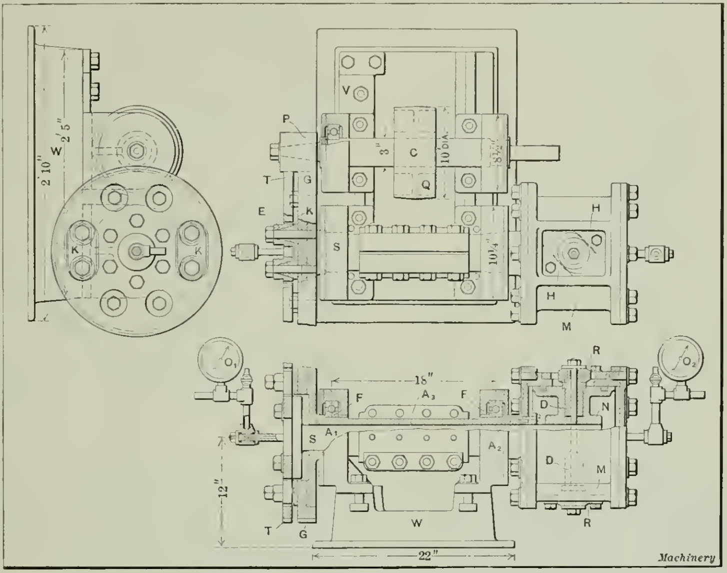

F
G
K
C
D
J
J
I
F
B
E
A
A
SHEET STEEL GUARD
SHEET STEEL GUARD
R
S
M
NOTE ALL SPACES R AND S WITH GOOD BING SURFACES LINE WITH FELT
Machinery

Fig. 21. Special Type of Fixture used on Brown & Sharpe Cylinder Grinding Machine shown in Fig. 20

leases clamp *E* and gives a slight movement to lever *G*, this giving a sidewise adjustment to the fixture carrying the cylinder casting. The collar *I* on top of the stud is graduated in thousandths of an inch so that an operator can tell just how much he has moved the cylinder, and this enables him to set it in position quickly and with great exactitude. After one cylinder bore has been ground, handle *F* is raised, which withdraws plunger *L* from index hole *M*. Handle *H* is then swung, which, by means of a pinion and rack, shifts the fixture on the cross-slide to the other cylinder bore. Lever *F* is then pulled down, inserting plunger *L* into index hole *M* corresponding with the bore to be ground.

For vertical adjustment the screw *K* is operated. This, as shown in the plan view at the top of the illustration, operates an adjustable gib which elevates or lowers the cylinder casting as requirements demand. By these two adjustments it is possible to set the cylinder bore perfectly parallel with the travel of the internal grinding head in a very short space of time and thus remove approximately the same amount of material from all sides of the bore. The fixture is well guarded against dirt by means of wooden strips and felt, the latter being used to line all the circular surfaces. The sliding portion is covered with a 16-inch sheet steel guard. Pads *J* act as connections for the exhaust pipes *L*, Fig. 20. In Fig. 21 the outline of the cylinder is indicated by heavy dotted lines which give a general idea of its position in relation to the other part of the fixture. As an example of the effectiveness of this fixture for the quick grinding of cylinder castings, it might be mentioned that thirty-five cylinder castings are completed in nine hours, that is, seventy cylinder bores are completed in this time, the grinding limit being plus or minus 0.0005 inch, and the hole perfectly true as regards variation in diameter from end to end.



Machine for testing the Strength of Gear Teeth

The last and final operation before the cylinders are passed on to the inspection department is the final water test. This is made in the same manner as that which was done prior to machining. This last test is to show up any blow-holes in the casting which might come to the surface after the machining operations have been accomplished, and it also makes sure that a perfect cylinder is turned over to be inspected. The previous examples of fixture design and application are worthy of note. They are especially recommended for the speedy production of cylinder castings with as great accuracy as is demanded by any of the automobile manufacturers now in the business, and no doubt they can be adapted to other classes of work by slight modification. They certainly represent good ideas in fixture design and construction.

* * *

GEAR TESTING MACHINE[*]

The gear testing machine shown in the accompanying illustration is the result of the writer's efforts to realize in concrete form an ideal machine for the purpose of continuing the experiments reported to the society by Prof. Guido H. Marx at the annual meeting in 1912. The possibility of testing heavier gears at higher speeds with comparatively little power occurred at once to Ralph E. Flanders and to the writer, as pointed out in their discussions of the paper, but the problem remained to design a suitable machine which might also be used to supplement the experiments made by the Committee on Standards for Involute Gears, to determine the friction losses and the running qualities of various types of gearing. After making a number of preliminary sketches the writer was about to put them in the hands of a draftsman, when he had the good fortune to meet Prof. E. P. Lesley, one of Prof. Marx's associates, who accepted the task of preparing the working drawing. The machine as it now appears is due in large measure to his careful attention and skill in the perfection of every detail, and the writer is pleased to acknowledge many helpful suggestions which have broadened the scope of the undertaking and made the design a practical possibility.

The machine proposed is based essentially upon the principle of the machine used in testing by the Committee on Involute Gears, which is to put the teeth under a working load without consuming an excessive amount of power. The design, however, has been modified to facilitate changes in the working load and in the test gears employed. At the suggestion of Prof. Lesley, it has also become possible, not only to change the amount of the working load while running, but also to change its direction, thus producing the effect of reversing loads upon the teeth while running continuously in the same direction.

The apparatus has a hollow shaft made in two parts, A_1 and A_2, united by a clamp A_3, also made in two parts to facilitate assembling. At one end of this hollow shaft is a flange to receive the steel gear ring *G*, which serves as a permanent part of the apparatus and is strong enough to resist the stresses due to testing. Besides the hollow shaft *A*, there are two solid shafts *C* and *S* on which are mounted the gears or pinions to be tested. Shaft *S* passes through hollow shaft *A* and has a flange, at one end of which is mounted test gear *T*. Shaft *C*, parallel with shafts *A* and *S*, carries the wide-faced pinion *P*, which is in mesh with both the permanent gear ring *G* and the test gear *T*.

Shafts *A* and *S* are connected at their opposite ends by a novel device through which any desired amount of load in either direction can be applied to the teeth, whether at rest or while running in either direction. To accomplish this purpose, the hollow shaft *A* is flanged to receive the pneumatic cylinder *M*, in which is the piston *N*, firmly secured to the shaft *S*. Pins *D* are driven into the piston *N* through the openings in the cylinder *M*, and upon the projecting ends of these pins rollers *R* are mounted upon roller bearings. A bolt passing through the pins, piston and shaft secures the whole in place. These rollers *R* engage helical segments *H* let into the walls of the cylinder *M*. Air pressure can be applied

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[*] Paper by Mr. Wilfred Lewis, read before the American Society of Mechanical Engineers at New Haven, Conn., November 21, 1913.

to the piston *N* on either side to give a slight amount of end motion to the shaft *S* and so, through the action of the rollers upon the helical segments, a slight angular motion is produced between shafts *A* and *S*, resulting in a pressure between the teeth of the gears upon these shafts and the teeth of the pinion on shaft *C*. Pressure gages O_1 and O_2 connecting with each side of the piston area are calibrated to record the resulting pressure on the gear teeth, taking account of the piston areas, the pitch of the helical cams *H* and the diameter of the gear wheels.

Since but little power is required to drive the apparatus, the pinion *P* is simply clamped to the shaft *C*, by a nut on its tapered end. The shaft itself is made heavy for the sake of stiffness and a pulley *Q*, between bearings, is attached for driving from a countershaft, or if preferred, a motor drive may be used in connection with the extended end. When the gear wheel *T* is to be tested, the intention is to use it in connection with a steel pinion; and when the pinion *P* is to be tested, the intention is to make it of cast iron and cut down the width of the teeth engaging with *T*, by nicking down on either side to a smaller width of face.

When a tooth breaks in the wheel *T*, or in the pinion *P*, it is important, to avoid the complete destruction of the apparatus by the jamming of the remaining teeth on their ends, to maintain the wheels *G* and *T* in proper relation to each other, and for this reason, the stops *K*, with their adjustable eccentrics *E*, are employed. The block *K* is clamped to the wheel *G* through the intervening eccentric bushings *E*. The intention is to keep one of the clamping bolts tight while the other is loosened and the eccentric adjusted to a predetermined amount of clearance on either side, after which both eccentrics are to be clamped. These stops do not come into action unless a tooth is broken or deformed. Then they cause both gears, *G* and *T*, to run together. By means of these stops it is also possible to study the effect of a predetermined irregularity in forming or spacing the teeth. For instance, an abnormally wide space or tooth can be simulated, when broken out or purposely cut away, by the position of the stops, and the pounding effect in running will be evident as the result of a certain measured irregularity.

The shafts *A* and *C* are mounted in ball bearings to reduce friction and, as a matter of expediency, the scale of the apparatus has been determined by the bearings *F* on the shaft *A*. These are of the largest commercial size and to make them available the shaft *A* was cut in two and united by the clamp A_1. The bearings for the hollow shaft are firmly bolted and doweled to a bed-plate *W*, while those for the pinion shaft are adjustable to the diameter of the pinion used, a distance piece *V* of proper width being used in every case to prevent movement under load.

It will be seen that the apparatus is capable of determining to a nice degree of accuracy a number of unsettled problems of great practical importance at a very small expenditure for wear and tear and power. Jigs will be made for drilling the gears *G* and *T* after cutting the teeth, so that the relative positions of the two wheels may be accurately fixed. Friction is practically eliminated in the ball and roller bearings, and what remains must become inappreciable under the well-known influence of vibration when running, except that due to air resistance and the friction in the teeth. With some accurate means for measuring the power consumed, both of these variables can be determined better than ever before. The apparatus in skillful hands should therefore solve the mooted question of the effect of speed on strength, and questions of durability, wear and noise can be studied at a small outlay in power and materials. It is possible that some slight modifications may finally be embodied, but the machine as shown is believed to contain the elements needed for an exhaustive examination of the subject of gearing.

* * *

The Eiffel Tower, the highest structure in the world, having a height of about 1000 feet, was only a few years ago regarded as practically useless. Now it is considered one of the most valuable possessions of France. It has made Paris the center of wireless telegraphy, because the tower has the greatest range of any existing wireless telegraph station.

TESTS OF LUBRICATING OILS FOR TRACTION ENGINE MOTORS

The Emerson-Brantingham Co. recently made a series of tests to determine what one or class of oils should be used in the motor of the traction engine built by this company. The motor used in the test was a four-cycle stock motor having four five-inch cylinders, a seven-inch stroke and designed for light tractor purposes. The actual testing period for each oil varied from 9 to 10¾ hours, and was divided into three main parts, *viz.*, the cold test or cold friction test, the power test and the hot test or hot friction test. Part 1 of these tests consisted in measuring the friction horsepower of the motor, when using the new, and also the unused oil. Part 2 was a five-hour continuous power run with a wide-open throttle and maximum load. Five hours was chosen as the length of time for the power test because it was estimated that when the motor ran under full load for five hours continuously, the oil had been subjected to the same amount of work as in an ordinary day's run in the field. During the third part of the test, the cooling water was allowed to heat up to about 210 degrees F. At this point, the ignition and fuel were cut off and the motor was immediately switched over and driven by the Diehl electric dynamometer. Friction and temperature readings were then taken. This part of the test was really the most important as it showed the differences in the lubricating value of the various oils after they had been used in the motor and subjected to heat. In this way the stability and lasting qualities of the oil were determined.

At the end of the third test the oil leakage and consumption was measured and a pint sample of the used oil was taken for analysis. The motor was then put through the cleaning process in preparation for the next oil. Twelve different oils were used in these tests, some of them being "straight run," some compounded and several especially made up for the test by refiners. Physical analysis of the oil which proved much superior to any of the others showed the following properties before use: specific gravity at 60 degrees F. (Baumé), 30.8; viscosity at 70 degrees F. (Tagliabue), 160; viscosity at 210 degrees F., 74; flash point, degrees F., 397; fire point, degrees F., 440; cold flow, degrees F., 0; chill point, degrees F., 27; animal or vegetable matter, none; per cent of free acid, none; per cent of fixed carbon, 1; per cent of ash, none.

After use this oil had changed as follows: specific gravity at 60 degrees F. (Baumé), 30.8; viscosity at 70 degrees F., 140; viscosity at 210 degrees F., 73; flash point, 284 degrees F.; fire point, 388 degrees F.; cold flow, 0; chill point, 0; animal or vegetable matter, none. Per cent of free acid, none; per cent of fixed carbon, 1.2; per cent of ash, 0.01. All of these tests were run at a speed of 700 revolutions per minute (the rated speed of the motor) but nothing was determined as to what results would have been obtained with a higher or lower speed.

* * *

EXTENSIVE INSTALLATION OF AUTOMATIC SIGNALS ON P. R. R.

When the improvements in its automatic block signal system are completed September 1, the Pennsylvania Railroad will have more four-track lines operated under automatic signals than any railroad in the world. During the past three years, $6,000,000 has been expended in equipping 253 miles of the main line with automatic signals. The main line of the Pennsylvania Railroad between Pittsburg and New York and Philadelphia and Washington will be equipped with automatic block signals when work now under way is completed. The signal system east of Pittsburg and Erie represents an estimated investment of approximately $18,000,000. The electro-pneumatic interlocking switch and signal system in the New York station and on the electric line between Sunnyside Yard, L. I., and Manhattan Transfer, N. J., alone cost $1,750,000. A normal force of 1800 men is required to maintain the total signal system of the Pennsylvania Railroad, and the cost of maintenance is about $1,500,000 yearly.

INDEXING TOOLS FOR NOTCHING ARMATURE AND FIELD DISKS

WAYS AND MEANS USED IN THE GENERAL ELECTRIC CO.'S ARMATURE NOTCHING DEPARTMENT IN THEIR FACTORY AT LYNN, MASS.

BY CHESTER L. LUCAS

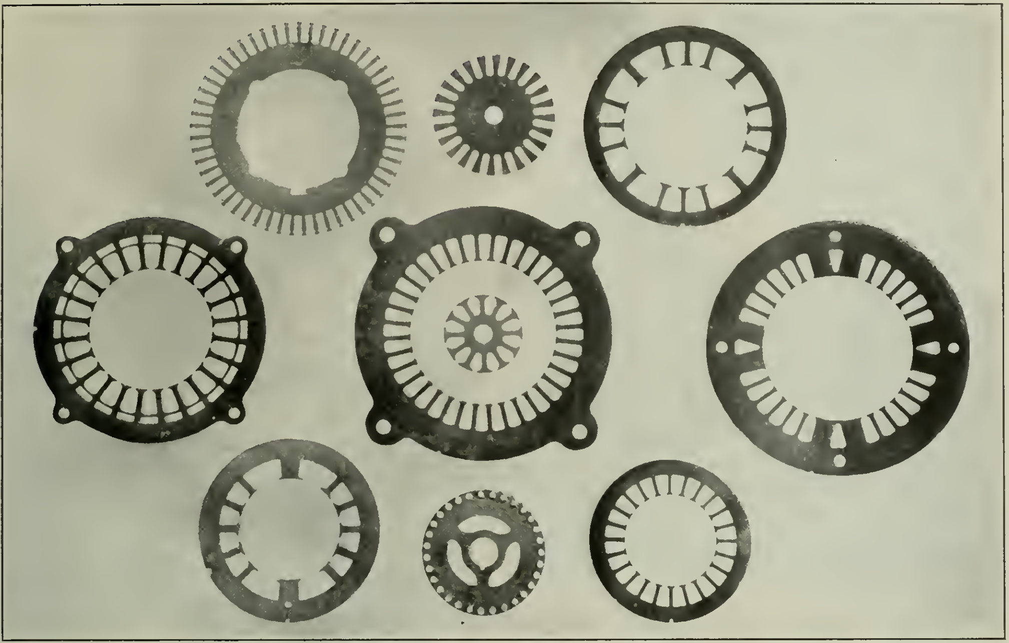

Fig. 1. Representative Armature and Field Punchings of the General Electric Co.'s Lynn Plant

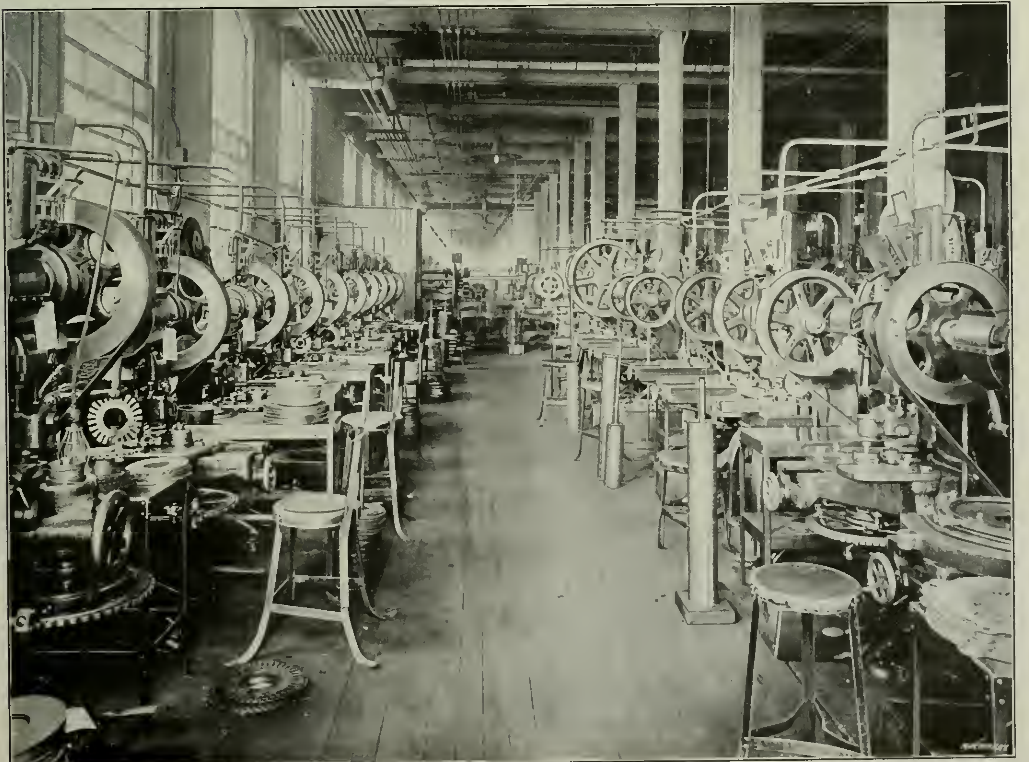

Fig. 2. View down one of the Aisles of the Notching Department

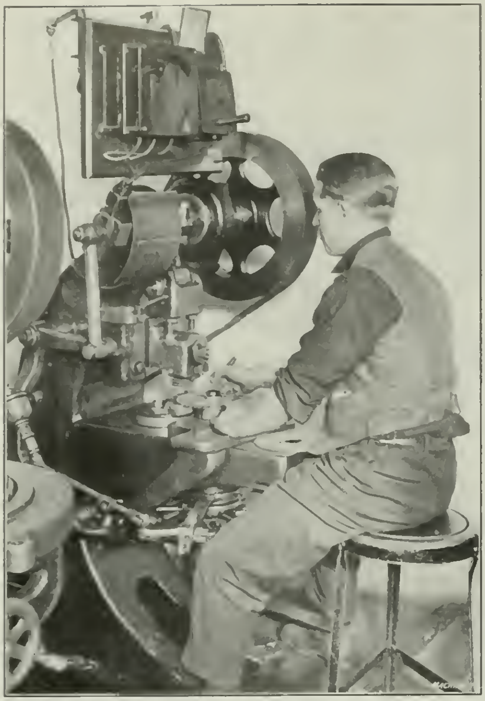

Fig. 3. Notching an Armature Disk by the Use of Indexing Tools

THE punching of the winding slots in the sheet iron disks that compose armature and fields of electric motors, is an important branch of the presswork in an electrical factory. At the Lynn Works of the General Electric Co. this work has been developed to a high degree, and an account of the presses and the work which they do, as well as processes followed in making the tools, should prove of interest. In this article only the single type of notching tools will be considered, as the compound tools are of a different order and should, therefore, be treated separately.

The ideal way of notching armature and field disks is by means of compound dies, for not only is the work of a better quality, but the manufacturing cost is naturally much less. As, however, the cost of a set of compound armature notching tools runs into the hundreds of dollars, there are many instances in which it is the better plan to make tools of the single type, and index the armature sheet by means of an automatic notching press. If there is doubt that the design of motor for which the armature disks are being notched is standard, it is, of course, better to use the single type of notching tools than to spend several hundred dollars on a set of compound tools that would be worthless in case of change of design. Similarly, if the production of a given motor is small, it would be injudicious to make a set of compound notching dies for the work. Again, if it is desired to build a new type of motor and just enough disks are wanted at once to build one or two armatures, the single type of notching tools can be built much more quickly to "bridge the gap," while compound tools are being made for the coming production.

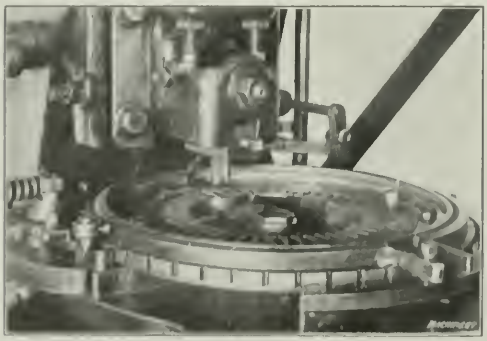

Fig. 4. A Close View of a Field Notching Operation

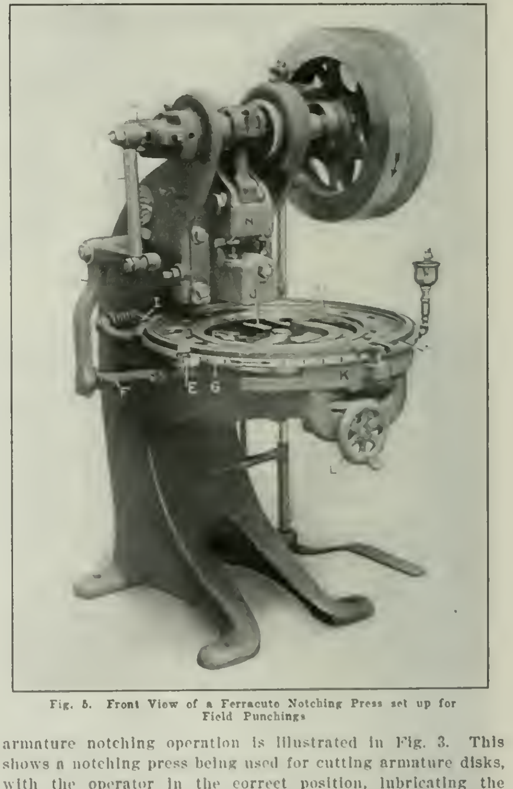

Fig. 5. Front View of a Ferracute Notching Press set up for Field Punchings

While the armature disks and field disks are the two general types of sheets to be notched, there are fifteen hundred varieties of spacings, diameters and shapes of slots. Frequently, armature sheets contain several concentric sets of winding slots of different shapes, and occasionally it is desired to have the windings spaced at irregular intervals around the sheets. While notching tools are usually of the single type, occasionally tools are made for cutting two or more slots at one stroke of the press. From this it will be seen that the subject of single type notching tools is a broad one in itself. Fig. 1 shows a group of armature punchings that gives some idea of the variety of this class of work. At the Lynn plant of the General Electric Co. there are fifty notching presses for this particular work, and a section of the notching press department is shown in Fig. 2. A typical armature notching operation is illustrated in Fig. 3. This shows a notching press being used for cutting armature disks, with the operator in the correct position, lubricating the blank as it rotates. The close-range view of the field punching operation in Fig. 4 illustrates the manner in which the tools are used when on field work. Briefly, the operation is a simple piece of press-work, the work being indexed automatically between the punch strokes. In this view the punch and die show very clearly above and below the field punching.

Presses for Armature Notching

The presses used for cutting the slots in armature disks are of special design, although they resemble in general the ordinary type of punch press. The distinguishing feature is the mechanism for indexing the armature or field disk, as the case may be, while the punching is taking place. The press has the ordinary reciprocating ram, and, in addition, the work-holding device is of a type that permits it to be adjusted with reference to the punch. This provides for the notching of sheets of different diameters. While most of the press manufacturers make notching presses, we have selected the Ferracute C-82 press as representative. As shown in Figs. 5 and 6, the press is set up for notching field punchings exclusively. When working on armature disks, the set-up of the indexing mechanism is quite different, as will be described later. The mechanism for indexing the sheet is operated from the left-hand end of the crankshaft. Here there is a slotted arm *A* in which stud *B* may be positioned with relation to the center of the crankshaft. This distance, of course, governs the length of stroke that pitman *C* makes. Pitman *C*, in turn, operates a bellcrank *D*, from which motion is transmitted to pawl *E* through rod *F*. At the end of rod *F* adjustment may be made for varying the position of the stroke with relation to the index-wheel *G*. Supported within index-ring *G*, is the work-holder *H*. At the rear is a locking device for holding the index-wheel and work stationary while the punch stroke is made. This locking mechanism is indicated at *I*. The die-holder is shown at *J* and is supported separately from the blank-holder and index-ring. These latter parts are on a separate carriage *K* that may be moved forward or backward by means of handwheel *L*. This, of course, is for varying the distance at which the punching is done from the center of the work. The difference in location of the indexing mechanism when working at different points on the slide is compensated for by the adjustment of rod *F*. Just above the index-ring is a brake *M* whose function it is to take up the inertia of the revolving disk.

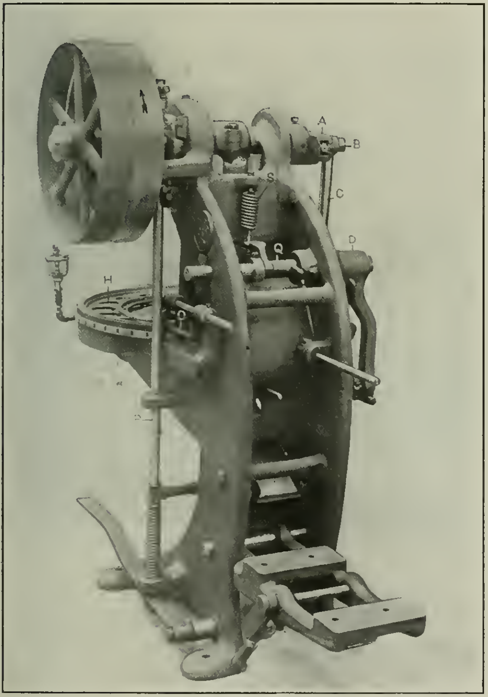

Fig. 6. Rear View of a Ferracute Notching Press set up for Field Punchings

The punch is held in the ram of the press in the usual manner and the adjustment screws *N* govern the position of the ram. The length of the stroke is constant. Now, referring to Fig. 6, which shows the machine from the rear, the method of keeping the press in continuous operation for punching all of the slots in one field punching of the treadle lock may be seen. When the treadle is depressed, treadle lock *O* is pushed up and catches upon a pad on treadle rod *P*. A branch connection of the treadle rod extends up within the press and starts the indexing mechanism. Indexing and punching continues until a trigger on the work-holding disk *H* comes around, strikes the treadle lock and allows the clutch to slip, thus stopping the press. Also in this view may be seen the mechanism that operates the lock for holding the disk between indexings while being notched. Each time the ram ascends a projection engages and rocks bellcrank *Q* which, in turn, disengages the dial lock through the rods shown and allows the pawl *E* to move the dial into the proper position for the next slot. The spring *S* is attached to the ram and acts as a counterbalance.

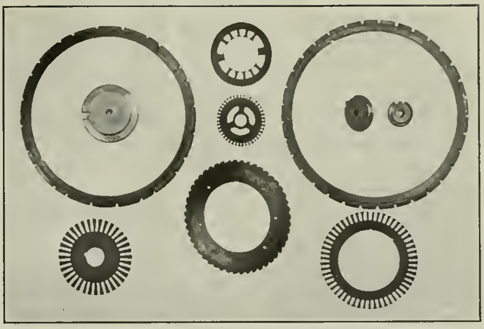

Fig. 7. Index Rings and Center Plugs for Use on Notching Presses, also Sample Punchings

By changing the bed on Ferracute notching presses, they may be set up for external as well as internal work, the external work being done on the armature disks. The view Fig. 3 illustrates the notching of armature disks, and from this it will be seen that the indexing mechanism is, in this case, beneath the bed of the press. The general principles, however, are the same as in field disk notching, although, of course, in armature disk notching the work is held on a central shaft, rather than by a hollow ring.

The operation of a notching press is as follows: The flywheel rotates toward the operator, as in other presses, and this causes pitman *C* to descend once in each revolution. This downward movement of the pitman causes bellcrank *D* to operate, which through rod *F* operates pawl *E*. This has been carefully set so that it advances dial *C* and consequently the work which is held in the blank-holder *H* in a counterclockwise direction. The punching is done while the indexing mechanism is on the return stroke and while the punching is going on, the disk is, of course, locked firmly in a stationary position. One depressing of the treadle starts the indexing and notching of a disk and this motion continues until the trigger on the blank-holder comes around and strikes the treadle lock, thus releasing it and causing the press to stop. The operator, as shown in Fig. 3, covers the sheet with a thin film of soda water so as to lubricate the punch. Armature notching presses, generally, run at speeds of from 200 to 450 revolutions per minute. The average speed of the presses at the General Electric Co.'s Lynn factory is 225 revolutions per minute, and the maximum speed employed there is 280 revolutions per minute. The field

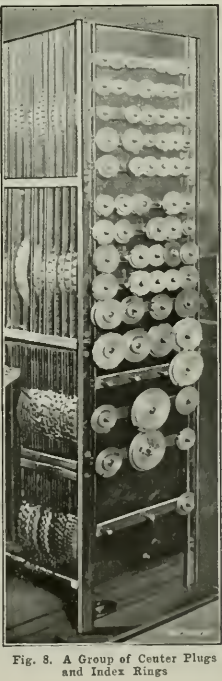

Fig. 8. A Group of Center Plugs and Index Rings

punchings are held in the work-holder by means of studs that engage holes in the edges. The armature punchings are held on the driving shaft by a center plug with a key.

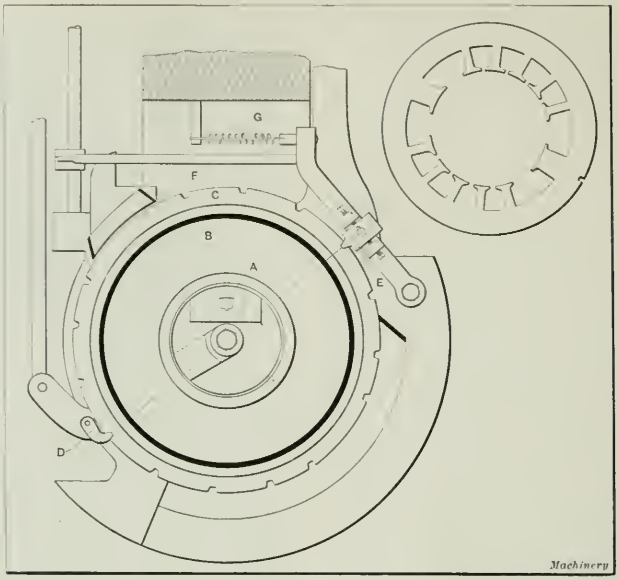

Fig. 9. Mechanism by which the Irregular Indexing is done

Variation in the Spacing of the Slots

Owing to the great variety of specifications to which motors are made, the shapes and spacing of the slots in the armature and field punchings are of great variety. Each number of slots means a separate index-ring. Fig. 7 shows three of the different index-rings used for spacing. In the centers of the two large rings may be seen three center plugs which are used for holding armature disks while notching. Each armature punching having a different size of center hole requires a different size driving plug. The blanks, of course, must fit snugly on these plugs in order to secure accurate spacing. In Fig. 8 is shown a large rack of plugs and index-rings. This gives some idea of the number of rings and plugs necessary to do the large variety of notching required on armature and field punchings.

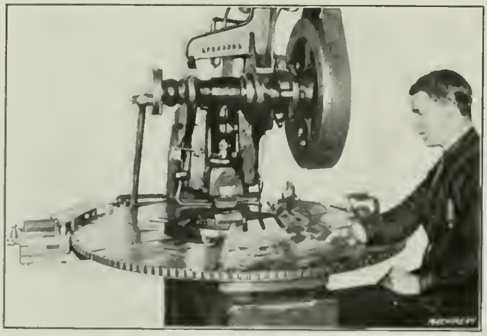

Fig. 10. Notching Operation on Turbine Field Segments

Referring again to Fig. 7, it will be noted that the index-ring on the left is notched irregularly and this is for the purpose of spacing the slots at irregular distances around a field punching like that shown in the center of this illustration. In order to space the slots irregularly in these disks, the indexing mechanism must be changed slightly. In Fig. 9 is shown an irregularly spaced field punching and the mechanism for indexing this work. In this will be seen the die at *A*, the blank-holder at *B* and the index-ring at *C*. The index pawl is shown at *D* in the usual position, but the lock has been moved from its central part at the rear to a point diametrically opposite the indexing pawl. This is shown at *E*. The stroke of the indexing pawl is made long enough to cover the longest distance between slots. As soon as the lock *E* is clear of the indexing notch, pressure from eccentric *F* is released and spring *G* draws the lock back against the index-ring, ready to snap into the slot when it comes around. The excess motion in the case of the closely spaced slots is taken care of by allowing the index finger to slip. This method of indexing irregularly could not be used if the slots were not regularly spaced opposite each other.

Special Notching Work

In addition to the regular armature and field notching operations at this factory, there are special notching operations which are of interest. One of these is the turbine armature notching press shown in Fig. 10. These turbine disks are made up of sections, and in order to notch them they are fitted into a special work-holder in succession, and as they feed around under the die, the notches are cut. The operator sits as shown, taking the punched segments from the holder and substituting blanks. When notched in this way, the assembled segments serve as well as entire sheets, and at the same time this method is a more economical way of producing them.

The special notching job shown in Fig. 11 is also of interest in that, in addition to cutting slots, the partly severed part is bent down under the sheet. One of these sheets is shown beside the press. The blank copper sheet is held on the central stud. After each slot is punched and bent down, the die automatically opens endwise and allows the blank to be indexed ready for punching and bending the next slot.

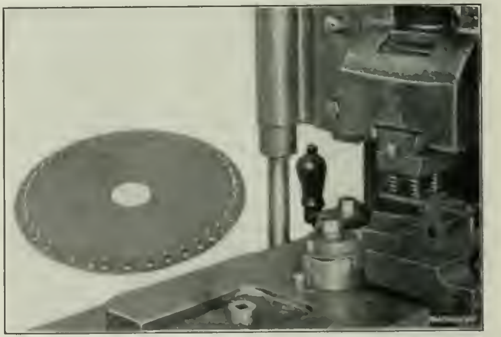

Fig. 11. Continuous Feed Cutting and Bending Notching Operation

In a following number, the making of a set of single type notching dies will be described.

* * *

A number of observations relating to the expansion of steel bridges, due to changes in temperature, are recorded by a writer in the *Engineering News*. It appears from these observations that even under almost ideal conditions of free movement at the bridge bearings, the expansion movement of the bridge does not take place smoothly and continuously, but movements occur on the roller bearings for every three to five degrees F. rise in temperature, these movements being generally accompanied by loud noise due to the sudden displacement of the bridge members.

* * *

A patent has been granted to Mr. H. I. Seddon of Portland, Oregon, which provides an erasing attachment for a typewriting machine. The erasing head is pivoted on a bar and the lever is connected to a key lever, so that it can be operated by a key on the keyboard.

THEORY OF THE STRESSES IN A CURVED BAR AS APPLIED TO HOOK DESIGN

APPLICATION OF A NEWLY DEVELOPED THEORY TO PRACTICAL DESIGNING PROBLEMS

BY WILLIAM L. CATHCART[*]

In an article in the June number of MACHINERY, answering a correspondent's question with regard to certain proportions of crane hooks, the writer cited a formula[†] deduced by Professor Karl Pearson and Mr. E. S. Andrews of University College, London, England, from which can be computed the stresses in a curved bar eccentrically loaded, which is essentially the condition of every hook. Since this formula applies generally to any curved machine member thus loaded—such as the frames of punch presses and riveting machines—it is of fundamental importance in machine design. For this reason the following brief analysis of the properties of the formula, its effects on the design of hooks, and a comparison of the stresses calculated from it with those computed by the straight-bar formula, so long in general use for this purpose, have been prepared.

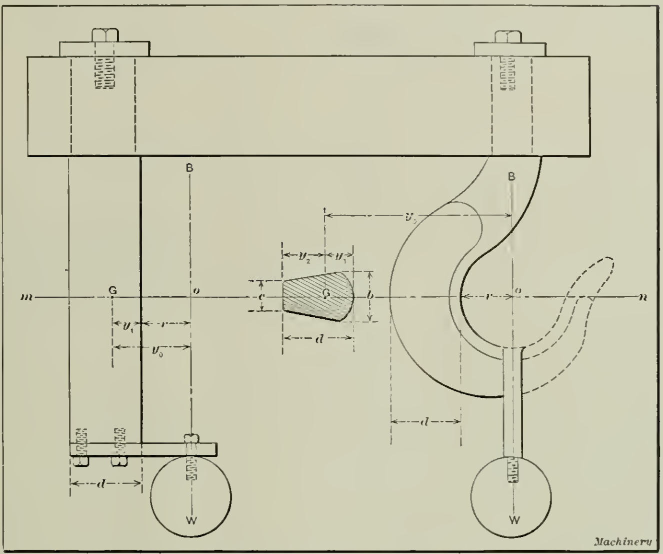

Fig. 1. Diagram showing Condition of Straight and Curved Bars eccentrically loaded

Fig. 1 shows the conditions in the two cases. Let two bars—one straight and the other curved, both being of the same trapezoidal section, b, c, d, of area A—be rigidly suspended and loaded at the lower end with the weight W at a distance y_0 from the center of gravity G of the cross-section of each. This section is taken on the line mn through the principal or horizontal section of the curved bar. Since this, as the location of the maximum stress, is the so-called "dangerous section" of a hook, it is the one requiring chief consideration; other proportions below it have less strain but their size must be increased beyond the demands of strength to provide for the effects of wear. The line mn meets the load line BW at the point o. The side of either bar which is nearest to its load is the one at which the maximum stress in the section occurs, this stress being tensile; and the distance of this side from the load line is denoted by r, which is also the radius of opening in the crane hook. The distance of the center of gravity G from the load line is $y_0 = y_1 + r$. Between the sides b and c of the cross-section, the stress changes from tensile to compressive, but the maximum compressive stress at c is always less than the maximum tensile stress at b. Hence the compressive stress need not be considered in determining the elastic limit of the hook. The question then reduces to the difference between the maximum tensile stresses which the same load W, with the same eccentricity y_0, will produce in the two bars.

In the straight-bar formula, the load W has two effects on the bar—pure tension, since the load must be supported; and bending, since the load has the leverage y_0. If f denotes the maximum tensile stress in the bar, *i. e.*, the stress at the middle of the side b of the cross-section, it must evidently be the sum of the stress due to pure tension and that due to bending. Assuming the former stress to be uniformly distributed over the cross-sectional area A of the bar, the general formula for these conditions is:

$$\frac{W}{f} = \frac{A}{1 + \dfrac{y_0 y_1}{R^2}} \qquad (1)$$

where R is the radius of gyration of the area A about an axis passing through its center of gravity G and parallel to the sides b and c. A working formula cannot be derived from this expression unless b and c are given in terms of the depth d. Taking $c = 0.22d = b/3$—which is in accord with good practice—we have for a trapezoidal section:

$A = 0.44\,d^2$
$y_1 = 0.417\,d$
$y_0 = y_1 + r = 0.417\,d + r$
$R^2 = 0.0761\,d^2$

Substituting these values in equation (1) gives:

$$\frac{W}{f} = \frac{d^3}{7.47\,d + 12.454\,r} \qquad (2)$$

Since W and f are known, the value of d for any given value of r can be found from this equation. Various values of d thus found are given in close approximation in A. E. Holcomb's table, quoted in Kent's Pocketbook, 1912, page 1161.

Curved-bar Formula

For the derivation of this formula, the reader is referred to the original investigation of its authors as cited; it is too complex and extensive to receive analytical treatment in this article. Briefly: it considers the curvature of the hook which the straight-bar formula entirely neglects; and it assumes that the centers of curvature of the inner and outer sides of the hook at b and c, respectively, coincide with the center of curvature at the point G in Fig. 1. For a hook, it is also assumed that this center may be taken at the point c without appreciable error. It assumes that only tension and compression act on the section bcd and that shear is absent;

TABLE I. VALUES FOR SUBSTITUTION IN EQUATION (3)

$\dfrac{y_1}{y_0}$	$\dfrac{1}{\left(1 - \dfrac{y_1}{y_0}\right)^{\frac{5}{4}}}$	$\dfrac{y_1}{y_0}$	$\dfrac{1}{\left(1 - \dfrac{y_1}{y_0}\right)^{\frac{5}{4}}}$
0.30	1.561	0.41	1.934
0.31	1.592	0.42	1 976
0.32	1.620	0.43	2.020
0.33	1.650	0.44	2.066
0.34	1.683	0.45	2.114
0.35	1.715	0.46	2.164
0.36	1.748	0.47	2.212
0.37	1.782	0.48	2.267
0.38	1.818	0.49	2.325
0.39	1.855	0.50	2.380
0.40	1.893	....	.....

Machinery

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[*] Address: Gwynedd Valley, Pa.

[†] "A Theory of the Stresses in Crane and Coupling Hooks with Experimental Comparisons with Existing Theory." Dulau & Co., London, England.

TABLE II. COMPARISON OF STRESSES GIVEN BY STRAIGHT-BAR AND CURVED-BAR FORMULAS

Load and Radius of Opening of Hook	Dimensions	Designed Maximum Tensile Stress f, Pounds per Square Inch		
		12,000	18,000	24,000
20,000 pounds r = 2¾ inches	d	4¾	4 3/16	3¾
	c	1⅛	15/16	13/16
	b	3⅝	2 13/16	2 7/16
	b_1	5⅝	4⅝	3⅞
	A	10.97	7.84	6.11
	A_1	15.84	11.11	8.8
	S_t	17,842	25,882	33,811
	S'_t	12,107	18,054	23,844
40,000 pounds r = 3½ inches	d	6¾	5¾	5½
	c	1½	1¼	1⅛
	b	4½	3¾	3⅝
	b_1	8	6¼	5 5/16
	A	20.25	13.37	11.53
	A_1	32.06	21.56	16.49
	S_t	19,908	28,201	35,210
	S'_t	11,943	17,938	24.013
60,000 pounds r = 4¼ inches	d	8 5/16	7 1/16	6¼
	c	1 13/16	1 9/16	1⅜
	b	5 7/16	4 11/16	4⅛
	b_1	9⅝	7 7/16	6 7/16
	A	30.12	22.03	17.19
	A_1	47.52	31.77	24.41
	S_t	19,725	27,265	35,877
	S'_t	12,017	18,030	23,990
80,000 pounds r = 4⅝ inches	d	9⅝	7 15/16	7 1/16
	c	2 1/16	1¾	1 9/16
	b	6 3/16	5¼	4 11/16
	b_1	11⅝	8 11/16	7 13/16
	A	38.67	27.79	22.06
	A_1	63.00	41.15	33.04
	S_t	20,152	28,497	35,897
	S'_t	12,005	18,021	23,958
100,000 pounds r = 4½ inches	d	10 5/16	8¾	7¾
	c	2¼	1 15/16	1 11/16
	b	6¾	5 13/16	5 1/16
	b_1	13 5/16	10 3/16	8¾
	A	46.59	33.91	26.16
	A_1	80.21	53.11	40.45
	S_t	21.862	29,461	38,651
	S'_t	11,946	18,096	23.954

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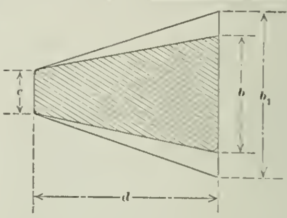

and finally, the formula does not apply beyond the limits at which the stress is proportional to the strain, *i. e.*, broadly speaking, beyond the elastic limit. While there is a true neutral axis in the section, the stresses given by the formula do not vary simply as their distance from that axis, as in a straight bar, and the stress due to pure tension is not distributed uniformly over the cross-section, but differs in intensity at various points, being a maximum at the middle of the side *b*. This latter point is of primary importance. The formula, as applied to crane hook sections, is:

$$S_t = \frac{W}{A}\left[\frac{1}{F_2}\left[\frac{1}{\left(1-\frac{y_1}{y_0}\right)^2} - F_1\right] + 1\right] \qquad (3)$$

where S_t = tensile stress, in pounds per square inch, at point of maximum stress (middle of side *b*) in the cross-section;

W = load on hook, in pounds;

A = area of cross-section of hook at middle section of depth *d*, in square inches;

y_1 = distance from center of gravity *G* of cross-section to point of maximum stress, in inches;

$y_0 = y_1 + r$, in which *r* is the radius of opening of the hook, in inches;

R = radius of gyration of cross-section about an axis passing through center of gravity *G* and parallel to the sides *b* and *c*;

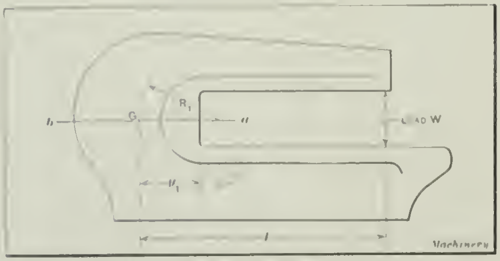

Fig. 2. Condition of a Shear Frame under Load

F_2 = a function whose value, for hook sections, may be taken as $\frac{Ry_1}{1.2y_0^2}$;

F_1 = a function whose value, for hook sections, may be taken as $1 + 1.1\,F_2$.

As noted in the previous article, the values of F_1 and F_2 apply to hook sections only, and are merely approximate. They are, however, sufficiently close for the general comparison of stresses given in Table II. In applying Formula (3) to a curved member considered as a bent beam, such as the frames of punching, riveting and shearing machines, the fraction $1/F_2$ is replaced by l/R_1F_2. As shown in Fig. 2, *l* is the distance from the load-line of the machine to the center of gravity *G* of the cross-section *ab* which is under the greatest strain, and R_1 is the radius of curvature of the cross-section at the point *G*. The radius of curvature is, in this case, simply the radius of the arc passing through the centers of gravity of several cross-sections very close to that at *ab*. The functions F_1 and F_2 would, of course, have values depending on the section and shape of the member and differing from those given above. In hook sections, *l* and R_1 may each be taken as equal to y_0, and hence the fraction l/R_1F_2 reduces to $1/F_2$. While Formula (3) is apparently complex, its solution for any given case involves only simple though somewhat tedious algebraic processes; and the data of Table I will facilitate the work. An example is given below.

Examples and Applications

Example 1: Take the hook given in Table II with load $W = 60{,}000$ pounds, radius *r* of opening = 4¼ inches, and maximum stress *f* given by the straight-bar formula as 18,000 pounds per square inch. Assuming $c = 0.22d = b/3$, we have by Equation (2), $d = 7\frac{1}{16}$ inches, $c = 1\frac{9}{16}$ inches and $b = 4\frac{11}{16}$ inches. Then:

$$A = d \times \tfrac{1}{2}\,(b + c) = 22.03 \text{ square inches.}$$

$$W/A = 60{,}000/22.03 = 2724 \text{ pounds.}$$

$$y_1 = d/3 \times (b + 2c) \div (b + c) = 2.35 \times 1.25 = 2.94 \text{ inches.}$$

$$y_0 = y_1 + 2.94 + 4.25 = 7.19 \text{ inches.}$$

$$R = \sqrt{\frac{d^2}{18} \times \frac{b^2 + 4bc + c^2}{b^2 + 2bc + c^2}} = \sqrt{2.77 \times 1.37} = 1.95.$$

$$F_2 = Ry_1 \div 1.2\ y_o^2 = 0.092.$$
$$F_1 = 1 + 1.1\,F_2 = 1.1012.$$
$$1/F_2 = 1 \div 0.092 = 10.87.$$

$y_1/y_o = 0.41$ and from Table I $\left(1-\dfrac{y_1}{y_o}\right)^{\frac{5}{4}} = 1.934.$

Substituting in Equation (3): $S_t = 2724 \times [10.87 \times (1.934 - 1.1012) + 1] = 27{,}265$ pounds per square inch, as compared with the 18,000 pounds given by the straight-bar formula.

Comparison of the Stresses Derived from the Two Formulas for the General Range of Hook Sections

In Table II there are given the data for hooks of average radius of opening, with loads varying from 20,000 to 100,000 pounds inclusive, and designed for maximum tensile stresses of 12,000, 18,000, and 24,000 pounds per square inch, these stresses being those frequently used for crane hooks of cast steel, wrought iron, and hammered steel, respectively. The stresses computed from the curved-bar formula in two alternative sections for each hook are given in Table II. The stress S_t is the maximum tensile stress in the original section of area A, whose dimensions b, c, and d are derived from the straight-bar Formula (2) on the assumption that $c = 0.22d = b/3$. Hence, for this section, f represents the designed stress by Formula (2) and S_t the actual stress by Formula (3). The stress S'_t is the similar maximum stress in the alternative section of area A_1, in which c and d remain the same and b is increased to b_1 in order to make $S'_t = f$. As the nearest 1/16 inch was taken for all computed dimensions, S'_t is not exactly equal to f. For these sections and their designed maximum stresses, Table II gives an average ratio S_t/f of 1.567, *i. e.*, for a section proportioned by the straight-bar formula, the curved-bar formula will indicate a maximum stress 1.57 times greater than the designed stress. The average ratio b_1/b is 1.686, *i. e.*, to reduce the maximum stress S_t in the area A to the designed stress f, we must make $b_1 = 1.69b$, on the average. This increase gives the average ratio $A_1/A = 1.514$, *i. e.*, in these conditions and for this range of stress and load, the curved-bar formula gives an average area A_1 which is 1.51 times greater than that given by the straight-bar formula.

TABLE III. ANALYSIS OF HOOKS TESTED

Rated Capacity	Load at Elastic Limit, Pounds			
	30-ton, Cast Steel	20-ton, Cast Steel	15-ton, Wrought Iron	10-ton, Wrought Iron
By test....................	56,000	30,000	16,000	16,000
By straight-bar formula ..	115,000	70,000	73,000	26,000
By curved-bar formula....	55,080	29,925	15,000	15,000

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The values of the three ratios found in the preceding paragraph are not strictly accurate for two reasons: first, the curvature of the hook section shown in Fig. 1 has been disregarded for simplicity, and the section has been treated as a trapezoid; second, all results from Formula (3) depend on the values of the functions F_1 and F_2 and the values we have used are, as stated, merely approximate. The resultant error seems, however, rather to favor the straight-bar formula than otherwise, as the tests[*] of Prof. Walter Rautenstrauch, given in Table III, indicate. For example, the 30-ton, cast steel crane hook was strained to its elastic limit at the point of maximum tensile stress by a load of 56,000 pounds. The calculated elastic limits of the hook were: by the straight-bar formula, 115,000 pounds; and by the curved-bar formula, 55,080 pounds, which gives a ratio of calculated elastic limits of $115{,}000/55{,}080 = 2.08$, as compared with the average ratio $S_t/f = 1.57$, previously determined. Considered as a straight bar, as in Formula (2), this hook should have withstood a load of 115,000 pounds before yielding at its elastic limit.

Ratio S_t/f as Given by the Two Formulas

Substituting the values of the functions F_1 and F_2 in Formula (3), solving Formula (1) for f, and dividing it into (3), we have:

$$\frac{S_t}{f} = \frac{1.2y_o^2 \times R}{y_1(R^2 + y_oy_1)}\left[\frac{1}{\left(1-\dfrac{y_1}{y_o}\right)^{\frac{5}{4}}} - \frac{0.1\,R \times y_1}{1.2\,y_o^2} - 1\right] \quad (4)$$

This is the ratio between the stress given by the curved-bar formula and that for the same cross-section from the straight-bar formula. Formula (4) is not strictly accurate, owing to the approximate values of the functions. These ratios, found from Table II for the range of hooks covered, are given in Table IV.

Example 2: From the data of the previous example, we have $y_1 = 2.94$, $y_o = 7.19$, $1.2\,y_o^2 = 62.04$, $R = 1.95$, $R^2 = 3.8$, and $\dfrac{1}{\left(1-\dfrac{y_1}{y_o}\right)^{\frac{5}{4}}} = 1.93.$

Substituting these values in Formula (4) gives:

$$\frac{S_t}{f} = \frac{120.98}{73.32}(1.93 - 1 - 0.009) = 1.519.$$

Experimental Verification of Curved-bar Theory

In the article published in the June number of MACHINERY, there were cited the tests on crane hooks of Prof. John Goodman[†] of the University of Leeds and Prof. Walter Rautenstrauch[‡] of Columbia University. Both of these investigators found a very close agreement between the elastic limits of the hooks as given by tests and as computed from the curved-bar formula. The divergence from the elastic limit as found by Formula (2) was marked in each of the two series of tests. In the course of their investigation, Prof. Pearson and Mr. Andrews made various tests, the results of which indicated in every case the truth of their theory. But one of these tests need be cited here—that of a coupling hook for a railway car. The principal section of this hook was rectangular with an area of 6 square inches. The old theory gave a stress at the elastic limit of 12,000 pounds per square inch, the new theory a stress of 23,000 pounds. A tensile specimen from an unstrained part of the hook showed later an elastic limit of 21,000 pounds. The curved-bar formula was therefore less than 9 per cent in error, as compared with 75 per cent for the straight-bar formula.

TABLE IV. VALUES OF RATIO S_t/f

Load and Radius of Opening of Hook	Designed Maximum Tensile Stress f, Pounds per Square Inch			Average Ratios
	12,000	18,000	24,000	
20,000 lbs. $r = 2\frac{3}{4}$ inches..	1.487	1.438	1.409	1.445
40,000 lbs. $r = 3\frac{1}{2}$ inches..	1.659	1.567	1.467	1.564
60,000 lbs. $r = 4\frac{1}{4}$ inches..	1.644	1.515	1.495	1.551
80,000 lbs. $r = 4\frac{3}{8}$ inches..	1.679	1.583	1.496	1.586
100,000 lbs. $r = 4\frac{1}{2}$ inches..	1.822	1.637	1.610	1.690
Average ratios............	1.658	1.548	1.495	1.567

Machinery

Relations of the Curved-bar Theory to Hook Design

The experimental verification of this theory has been sufficiently full to warrant careful consideration of it in the design of the principal section of hooks. Its fundamental principle, the effect of the curvature of the bar on the stresses produced, is not recognized by the straight-bar theory. In Formula (2), the quantity r is—so far as its effect on the stresses produced is concerned—not really a radius, but simply the distance from the load line to the inner side of the principal section. If r, b, c, and d in Fig. 1 be kept the same, hooks of an indefinite number of shapes between the principal section and the load line could be made, and by Formula (2) all should be equally strong, which seems scarcely a rational engineering proposition. As a matter of fact, the straight bar seems to be really a hook of infinite radius, whose stresses have been taken as those of a hook of the same section and of any finite radius which the designer may require. With regard to the curved-bar formula, we note:

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[*] Transactions American Society of Mechanical Engineers, Vol. 31.
[†] Proceeding of the Institution of Civil Engineers, Vol. 167.
[‡] Referred to in a preceding paragraph of this article.

1. According to the general and approximate comparisons given in Table II, it shows a maximum tensile stress which is 1.57 times greater than the straight-bar formula gives as an average, with a corresponding average increase in area to attain the designed stress of 51 per cent. This would indicate, not that hooks designed by Formula (2) are dangerously weak, but that their factors of safety are much reduced and that their principal sections are uneconomical in form.

2. Of course, it is not assumed that the section of area A_1, used for comparison only in Table II, is by any means the most economical. With regard to the most satisfactory form of section from the standpoint of equal maximum tensile and compressive stresses, Prof. Rautenstrauch states: "It has been pointed out by Prof. Pearson that a section with such proportions is approximately an isosceles triangle with a radius of curvature of 1.75 of the height." This statement is confirmed by the fact that Formula (3) gives a maximum compressive stress at the outer side of the section which is much lower than the corresponding stress given by the straight-bar theory. Hence, metal between the center of gravity G of the section and this outer side is not nearly so effective as that between G and the inner side. There are two reasons for this: the metal at the inner side must meet the greatest strain and the greater area should be there; and, second, the more metal there is between the center of gravity G and the inner side, the nearer G will be to that side and hence the less the value of y_1 will be and consequently the leverage of the load.

3. Both the theoretical proportions previously mentioned, for equal maximum tensile and compressive stresses and Formula (5) which follows, show that the curved-bar theory requires hooks whose depth d is less and whose internal width b is considerably greater than those usual in American practice. Thus, taking the hook sections as triangular and the radius of curvature as y_0, we have $y_0 = 1.75d$, and, as the center of gravity of a triangle is situated at one-third of the height from the base,

$$y_0 = 1.75\,d = r + y_1 = r + 0.33\,d$$

Hence $d = \dfrac{r}{1.42}$.

If, as in Example 1, $r = 4.25$ inches, d would be 3 inches instead of 7.06 inches as given, and b would be much greater in order to secure the necessary area. Again, the curved-bar formula for the maximum compressive stress at the middle of the outer side c is:

$$S_c = \frac{W}{A}\left[\frac{1}{F_1}\left(F_1 - \frac{1}{\left(1 + \frac{y_2}{y}\right)^3}\right) - 1\right] \qquad (5)$$

where y_2 is the distance from the center of gravity G of the section to the side c.

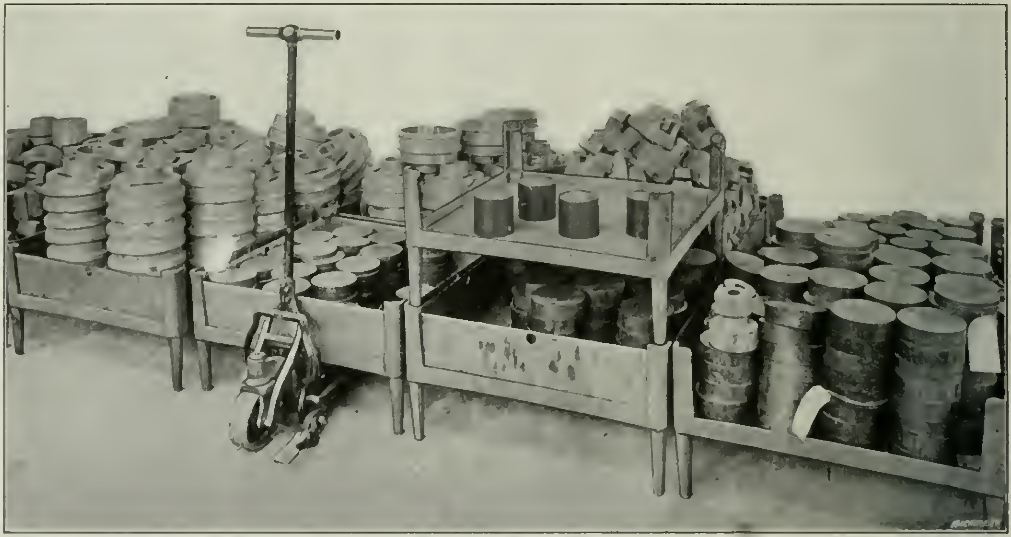
Example 3: Substituting in Formula (5) the quantities given in Example 1, and making $y_2 = d - y_1 = 4.12$, we have $S_c = 13{,}059$ pounds per square inch, which is less than 48 per cent of the maximum tensile stress in that section, as given by Formula (3). Both of these calculations show that the most economical form of section by the curved-bar theory is one of shallow depth d and of considerable internal width b. There are, however, practical objections to very wide hooks, in wearing qualities, facility in use, and especially when they are required for such bearings as the trunnions of a ladle, in which the bending moment and required diameter of the trunnion become larger, the greater the width of the hook. The theory should be of service, however, in checking up the stresses in existing hook sections and, when desired, in modifying those sections, in some degree, in the directions indicated above.

* * *

IMPROVED TYPE OF WORK-HOLDING BOX

The Jones & Lamson Machine Co., of Springfield, Vt., is using in the new factory an improved form of tote-box or work-stand for holding machine parts in process of manufacture. This form of container has several advantages over the ordinary work-holding box, principal among which is the fact that they may be stacked up one above the other and thus form practically a continuous stock rack. Also, the space beneath allows an elevating truck to be run under as shown in the photograph and the entire box or stack of boxes picked up easily and transported to any other part of the shop. If the work is small or of such a nature that it would easily tumble out at the sides, sheet iron strips are placed at each side, being held in position by lugs cast integral with the bottom of the box. Two of these lugs may be seen at the rear corners of the top box in the foreground. The stacking is made possible by providing the top corner posts with seats into which the legs of another box may be seated, thus holding the boxes securely in position. As the entire box is made of a single casting requiring no machining, the cost of making is low.

C. L. L.



Work-holding Boxes in the Jones & Lamson Factory

* * *

There are 7500 manufacturers engaged in the wire and wire goods industries in Germany, employing about 125,000 operators. Of this number, 41,000 are engaged in the manufacture of nails, tacks and wire ropes, 7000 in the manufacture of pins and needles, 18,000 in the manufacture of wire goods, and 10,000 in land and submarine cables. The value of the goods produced is estimated at $119,000,000 a year, of which one-half is exported.

SCREW MACHINE TOOL EQUIPMENT AND ATTACHMENTS

SPECIAL TOOL EQUIPMENT AND MAGAZINE ATTACHMENTS USED ON THE CLEVELAND AUTOMATIC SCREW MACHINE

BY DOUGLAS T. HAMILTON*

THE variety of work adaptable to an automatic screw machine can often be greatly increased by the addition of simple attachments. In many cases, all the operations on a piece can be completed before it is removed from the machine, while without the attachments a second operation would be necessary. In other cases, automatic screw machine attachments can be used for handling second-operation work; they are also adapted to work on forgings and castings, performing such operations as drilling, tapping, counterboring, etc. Magazine attachments covering most of these points will be described in the following article.

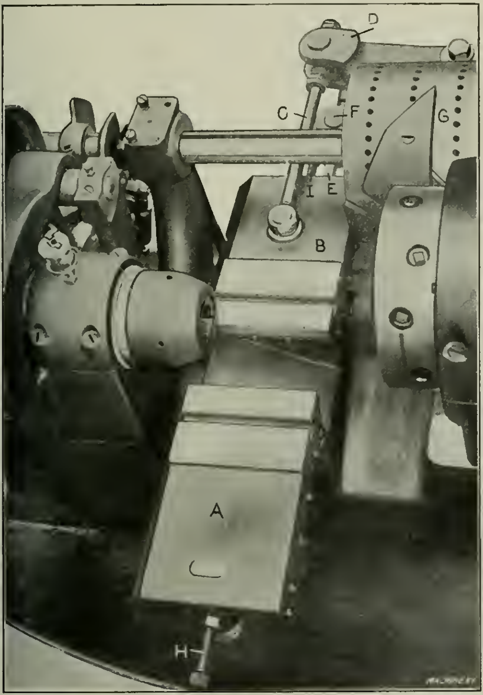


Fig. 1. Double Cross-slide for Independent Control of Cross-slide Tools

Double Cross-slides

For work on which both forming and cutting-off tools can be used to advantage at the same time, the double cross-slide arrangement shown in Fig. 1 is provided. In this case the front slide *A* and rear slide *B* are operated independently. Slide *B* is controlled by connecting-rod *C* and bellcrank lever *D*, whereas slide *A* is operated by connecting-rod *E* and bellcrank lever *F*. Connecting-rod *F* passes beneath both slides and is connected to the front slide *A* as illustrated. Both of these slides are operated by cams on the drum *G*. Positive stops *H* and *I* are provided to secure accuracy in forming, and these come in contact with a hardened plug in the base of the machine. The double cross-slides eliminate all lost time between the forming and cutting-off operations, as the cutting-off tool can be brought into position before the forming tool has finished cutting. Forming tools can be carried on both these slides when necessary, an independent cutting-off attachment, as described later, being used for cutting off the work.

Multiple Cutting-off Toolpost

The particular toolpost shown set up and in operation on the Cleveland automatic in Fig. 2 is arranged for carrying four cut-off blades *A*, which can be used for cutting off four pieces at once. Any reasonable number of tools may be applied in this manner, and the number of parts which may be cut off is limited by the depth of the hole which can be drilled or the length of the work that can be handled without springing away from the cutters. The holder *B* can be supplied with different widths of filling blocks which are placed between the blades and locate them at the proper distances for cutting off different thicknesses of work. The ejector bracket *C* is attached to the front of the bed below the cross-slide and carries an adjustable plunger *D* which strikes the stripper plate *E* and ejects the work from the blades when the cross-slide backs away. This ejector is operated by two springs *F* which bring the ejecting slides *G* back into the normal position when the cross-slide carries the cutting tools toward the work. This attachment effectively prevents the work from sticking between the cutting-off blades.

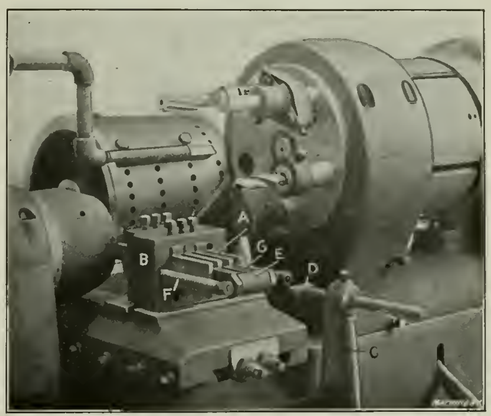


Fig. 2. Multiple Cut-off Toolpost

Independent Cutting-off Attachment

The attachment shown in Fig. 3 is used for cutting off the work when the tools on the rear and front of the cross-slide are used for forming operations. This attachment consists primarily of a swinging arm *A* mounted on a stud which is attached to the spindle head of the machine. The cutting-off blade is mounted in a holder *B*, at the forward end of the

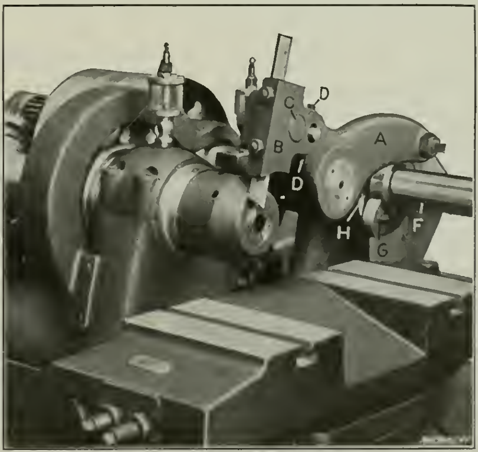


Fig. 3. Independent Cut-off Attachment

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* Associate Editor of MACHINERY.

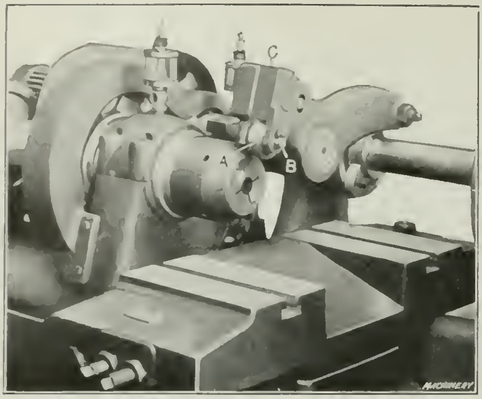

Fig. 4. Thread-rolling Attachment

swinging arm *A*; the holder *B* is fulcrumed on a bolt *C* which is provided with a locking nut on the opposite side for clamping the tool-holder in the desired position. The proper setting of the cutting-off blade is secured by means of the set-screws *D* which operate against a pin driven into the arm. To make this adjustment, it is necessary to release the nut on the clamping bolt *C*. This attachment is operated by the cam *G* held on the camshaft *F*, the cam being adjustably mounted on the disk *H* as illustrated. This cam contacts with a roll held in arm *A* and gives it the required movement at the desired time. The roll is carried on an eccentric stud, for fine adjustment of the cutting-off blade. The blade is clamped in the holder by two clamping bolts as illustrated.

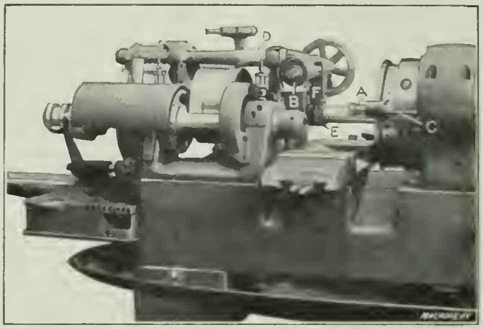

Fig. 5. Slotting and Slabbing Attachment

Slotting and Slabbing Attachment

The attachment shown in position on the Cleveland automatic screw machine in Fig. 5 is used for slotting the heads of screws, slabbing operations and similar work. The operation is accomplished while the turret tool is working, so that there is no time lost by slotting. The operation on a screw is as follows: After the part has been finished, and is ready to be cut off, the turret advances carrying the screw slotting conveyor *A* which takes hold of the screw as it is severed from the bar. The stock is then fed forward and the turret tool commences on the next piece; at the same time the conveyor *A* carrying the screw that has just been cut off, brings the head into contact with the slotting saw *B*. By the time the turret tool has finished its cut, the saw has also completed its operation. The finished part is ejected from the conveyor by means of a pin *C*, upon the backward stroke of the turret. The slotting arm *D* carrying the saw *B* is a slight distance back from the face of the chuck hood so that it clears all the turret tools except when the conveyor *A*, carrying the screw, comes into line with it.

This attachment consists of the arm *D*, mounted in bearings secured to the spindle head. This arm carries the saw spindle which is driven by a belt from the countershaft. The drum which carries the chuck opening and closing cams carries, in addition, another cam which operates the slotting arm *D*. This cam moves the saw toward the turret when the conveyor *A*, held in the turret, advances with the part to be slotted. The bracket *E* is a good sliding fit on the rear shaft to permit of this movement. The entire slotting arms is returned to its original or neutral position by the coil spring shown, after the roll on arm *D* comes out of contact with the operating cam.

To fit up this attachment for slabbing operations, two slabbing cutters are mounted on the saw spindle in the same manner as the slotting saw *B*, and the same movement takes place as in slotting. It is also possible by means of a special slotting arm *D* to cut a groove or slot of any shape or depth lengthwise of a piece by raising the center of the saw spindle, so that the work will pass under the milling cutter or saw.

Thread-rolling Attachments

Fig. 4 shows the thread-rolling attachment. This is identical in construction with that shown in Fig. 3, except that the roll holder replaces the cut-off blade holder. As Fig. 4 shows, the thread roll *A* is held on a pin *B*, the latter being retained in position in the holder *C* by means of a collar-head screw. This thread-rolling attachment is used for producing a straight or taper thread behind a shoulder, and is particularly adapted for threading brass work. Thread rolling of steel has not been very satisfactory because of the difficulty experienced in securing a roll which will stand up to the work.

Die-closing Attachment

Self-opening dies equipped with chasers can be used with excellent results on the Cleveland automatic screw machine when an attachment for closing the die is provided. On the turret type or model A machine, an attachment of the kind illustrated in Fig. 6 is used. This consists of a bracket *A* which is fastened to the front side of the turret cap directly over the locking spline of the turret. The pin *D* in the die head comes in contact with swinging dog *C* and revolves the chaser cam ring a little beyond the locking position of the die head just as the turret has revolved to its locking position. This insures the positive locking of the die head when the turret advances; when the turret comes back into this position, the pin *D* strikes the edge of dog *C*, which swings back and allows the turret to turn to the next locking position.

Oil-feed Attachments for Turret Tools

The attachment shown in Fig. 7 is adapted to all turret model A machines, and also to the three-hole turret full automatic model C machine. It is used to supply oil to each of the turret tools. The valve mechanism which controls the flow of oil to the different turret tools permits the oil to flow

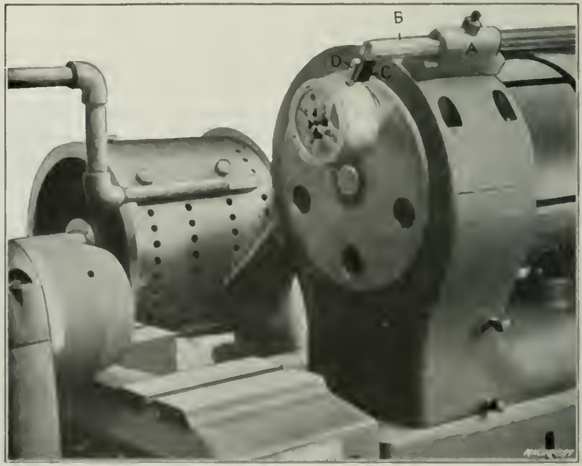

Fig. 6. Die-closing Attachment

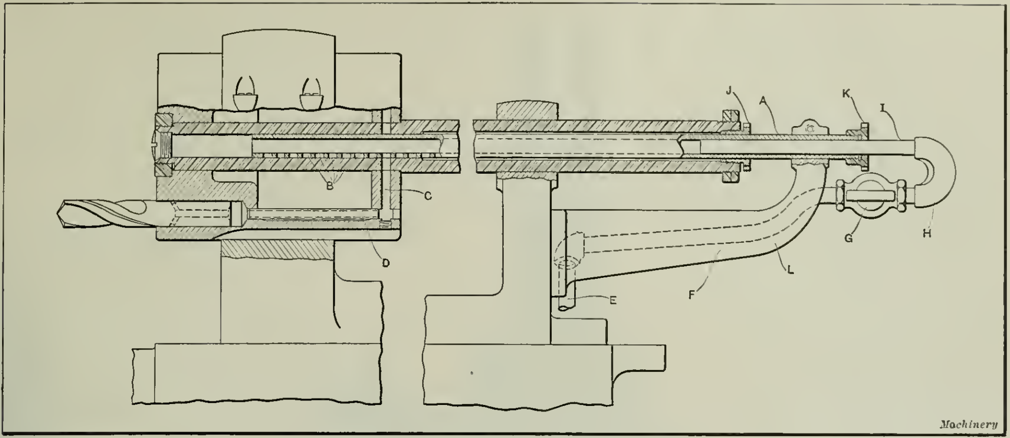

Fig. 7. Oil-feeding Attachment

only to the tool which is actually cutting and shuts it off from all the other turret holes. The starting and stopping of the flow is accomplished by the forward and backward motion of the turret shaft. The oil tube *A*, which extends inside the turret shaft, is the valve that controls the flow of oil. At the forward end of this main oil tube *A* will be seen a series of holes *B* which is a single row of holes at the lower part of the tube and extends for a length equal to the stroke of the turret. As the oil tube is held stationary in the bracket *F* at all times, the turret shaft, when moving forward or backward on the regular turret stroke, allows the hole *C* in the turret to pass over the series of holes in the tube, resulting in a flow of oil through these holes and the tube *D* to the turret hole and from there to the oil tubes in the tools.

The oil is received from the pump under pressure through the pipe *E* which is supported by the oil feed bracket *F*. The oil passes through the shut-off valve *G*, which is provided so that it can be shut off if not required or so that the amount can be regulated to suit the tools in the turret. From here, the oil passes through the return bend *H* into the short pipe *I*, and discharges into the main oil tube *A*. The stuffing-boxes *J* and *K* make oil-tight joints to prevent leakage. This system of oiling from the turret is much more efficient than from pipes located above the tools, because it serves to force the oil directly to the point of the tool where the actual cutting is being done and washes the chips out. Drilling speeds considerably in excess of those recommended when ordinary oiling facilities are supplied can therefore be used when an oil feed attachment of this type is applied to the turret tools.

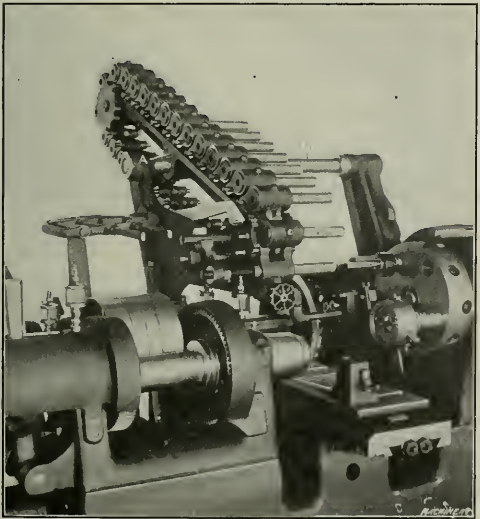

Fig. 8. Rotary Tilting Magazine Attachment in Position to have Work removed by the Conveyor held in the Turret

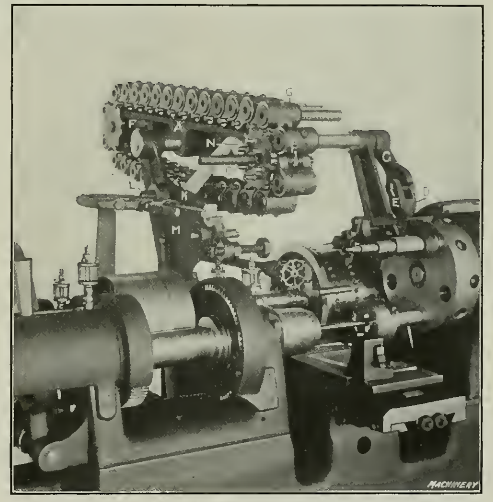

Fig. 9. Rotary Tilting Magazine Attachment tilted up to clear the Turret Tools

Vertical Magazine Attachment for Studs and Similar Work

Fig. 10 shows a magazine attachment which is adapted to the models A and B Cleveland automatics. It is used principally for feeding studs or similar work to the chuck for second-operation work. The sides of the magazine can be adjusted for different lengths and diameters of work by means of the adjustable strips *A* and the removable bushing *B*. The pieces feed down to the bushing *B* by gravity and are pushed into the rear end of the spindle by a rod *C* which is operated by cams on drum *D*. The entire magazine attachment may be removed by taking out the screws *F*, when the feed yoke *E* is swung into working position and the machine is then ready for bar work. The attachment illustrated is exceptionally easy to operate and is efficient for handling studs which must be threaded after cutting off, or work that requires threading on both ends, counterboring, tapping, etc.

Rotary Tilting Magazine

Two views of a rotary tilting magazine attachment are shown in Figs. 8 and 9. Referring to Fig. 8, the frame *A* is mounted on the shaft *B*, which has a long spline milled on the upper side, allowing the frame, which is fitted with a square key, to slide in any position to suit the work to be machined. Lever C, Fig. 9, is made fast to shaft B and is slotted on its lower end to engage a roller in lever D. This roller is mounted on an eccentric bolt E which allows adjustment for wear by swinging the magazine up and down. Lever D is pivoted on a stud in its center and carries a roll at its lower end, which engages a disk cam on the main cam-shaft of the machine. With the rotation of the cam-shaft, the disk cam brings the magazine down as shown in Fig. 8. The frame A, Fig. 9, has an adjustable bearing at each end; the bearing F at the upper end can be moved to tighten or loosen the link-belt G; the bearing at the lower end can be moved forward or backward to maintain the alignment of the hole in the links with the turret hole when the magazine is in the position shown in Fig. 8.

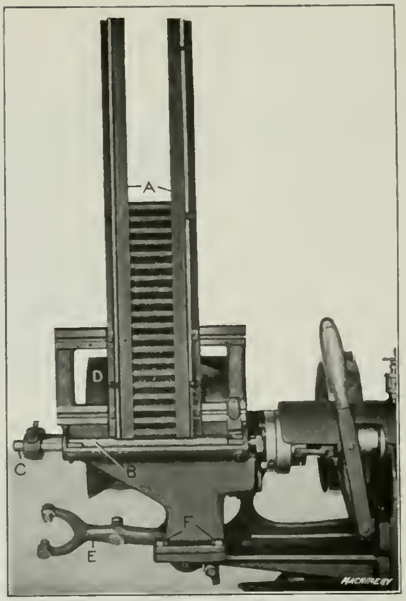

Fig. 10. Vertical Magazine Attachment

The sprocket wheels upon which the link-belt G is mounted are rotated upon the downward motion of the magazine, as it comes into the working position. This is accomplished through the medium of the pawl K which swings on a stud L in arm M, and engages pins N in the lower sprocket wheel. When the magazine swings up, this pawl K drops onto the pin O. The links G are fitted with rollers P which allow the chain to pass freely over the top of frame A. Each link G is provided with a bushing especially shaped to suit the work to be machined, and can be adapted to any irregular shape that can be gripped in the chuck. Fig. 8 illustrates the magazine in its working position with the conveyor advancing to remove the work. The magazine is brought into this position as soon as the turret is indexed and swings up into the position shown in Fig. 9, as soon as the turret starts to index to its next position.

* * *

FORMULAS FOR CHORDAL THICKNESS AND CORRECTED PITCH DEPTH

BY JAMES T. BROCKWAY*

When special accuracy is desired in the cutting of bevel gears so as to obtain a theoretically correct thickness of the tooth, as in automobile practice, etc., designers find it necessary to compute the "corrected pitch depth" (or the distance $d + x$, Fig. 1) and the chordal thickness of the teeth at the pitch line. First it is necessary to determine the angle b, Fig. 1, subtended by lines from the apex o_1 of the back cone (see also Fig. 2), which intersect one side and the center of the tooth, respectively, at the pitch line. The conventional formula for determining this angle is as follows:

$$\text{Angle } b = \frac{1}{2}\left(\frac{360^\circ}{\dfrac{\text{Circumference of back cone distance circle}}{\text{Circular thickness}}}\right) \qquad (1)$$

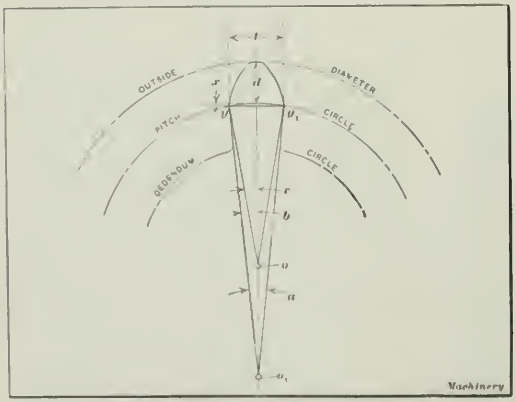

Fig. 1. Diagram of Bevel Gear Tooth, with Notation used in Formulas

The "back cone distance circle" referred to in the formula is a circle having a radius o_1y (Fig. 2); the term "circular thickness" relates to the thickness of the teeth along the arc yy_1, Fig. 1.

This formula has proved both long and cumbersome and the writer has devised an improved formula which shortens the calculations considerably. The derivation of this formula is as follows: In Figs. 1 and 2, o is the center of the gear; oy and oy_1 are pitch radii; o_1 is the apex of the back cone, and o_1y and o_1y_1 are back cone radii, or, expressed in another way, o_1y is the back cone distance, and wy is the pitch cone distance. In Fig. 1, where, for the sake of clearness, only one tooth of the gear is represented and that enlarged, it is evident that

$$\text{Angle } c = \frac{360^\circ}{\text{No. teeth} \times 4} = \frac{90^\circ}{\text{No. teeth}}. \qquad (2)$$

From Fig. 2:

$$yo_1 = \frac{yo}{\text{cos pitch angle}}.$$

$$\sin b = \frac{\tfrac{1}{2}t}{yo_1} = \frac{\tfrac{1}{2}t \text{ cos pitch angle}}{yo}. \qquad (3)$$

$$\text{Sin } c = \frac{\tfrac{1}{2}t}{yo}. \qquad (4)$$

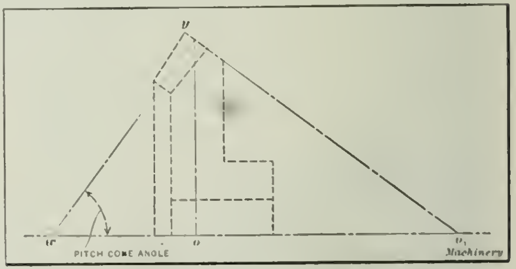

Fig. 2. Diagram showing Relation of Points o and o_1 Fig. 1, to Bevel Gear

Therefore combining Equations (2), (3) and (4),

$$\text{Sin } b = \text{Sin}\left(\frac{90^\circ}{\text{No. teeth}}\right) \text{cos pitch angle.} \qquad (5)$$

When the thickness of the tooth is not half the circular pitch, then Formula (5) becomes

$$\text{Sin } b = \text{Sin}\left(\frac{90^\circ}{\text{No. teeth}} \times \frac{\text{circular thickness}}{\tfrac{1}{2}\text{ circular pitch}}\right) \text{cos pitch angle.} \qquad (6)$$

The "corrected pitch depth" $(d + x)$ and "chordal thickness" (t) Fig. 1, are then found by the usual method, *i. e.*,

$$d + x = d + [o_1y\,(1 - \cos b)]$$

$$t = 2 \times o_1y \sin b$$

* * *

A patent on marking negatives for identification at the time of exposure was sold for $300,000.

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* Address: 325 Field St., Rochester, N. Y.

DISK-AND-BUTTON METHOD OF LOCATING HOLES

PRACTICAL TOOLMAKING METHODS OF IMPORTANCE IN ACCURATE WORK

BY GUY H. GARDNER[*]

EVERYONE who has had experience with the button and micrometer method described by D. Dalton in the June number of MACHINERY—and I suppose all of us who are engaged in toolmaking employ it almost daily—must recognize its excellence and also its one fault.

The accuracy of work done by this method is limited only by the skill and painstaking care of the workman, but it consumes a great deal of time.

By a little modification, using what is sometimes called the "disk-and-button method," a large part of this time can be saved without any sacrifice of accuracy. While the disk-and-button method is extensively used in many shops, it is a curious fact that many highly skilled toolmakers have never even heard of it. Buttons are used, but they are located in the center of disks of appropriate diameters. As three disks are used in each step of the process, it is sometimes called the "three-disk method."

Mr. Dalton's first example of work presents an ideal opportunity to demonstrate the superior celerity of this way of working. It calls for the location of six holes, equally spaced, in the circumference of a circle six inches in diameter. To locate these one needs, besides the buttons, three disks three inches in diameter, each having a central hole exactly fitting the buttons. It is best to have, also, a bushing of the same diameter as the buttons, which has a center punch fitted to slide in it.

First the center button is screwed to the templet, and one of the disks *A*, Fig. 1, is slipped over it; then a second disk *B* carrying a bushing and center punch is placed in contact with disk *A* and a blow on the punch marks the place to drill and tap for No. 2 button, which is kept in its proper place while tightening the screw by holding the two disks *A* and *B* in contact. Next the third disk *C* is placed in contact with disks *A* and *B* and locates No. 3 button, and so on until the seven buttons are secured in position. The templet is then ready to be strapped to the lathe faceplate for boring. A man who recently tried this method on a templet identical with the one referred to (except for dimensions) informs me that the time, aside from drilling and tapping the holes, was less than forty-five minutes, and he is confident that he can reduce this materially on the next job. This templet was examined by a very critical and "fussy" inspector who reported, "No measurable inaccuracy."

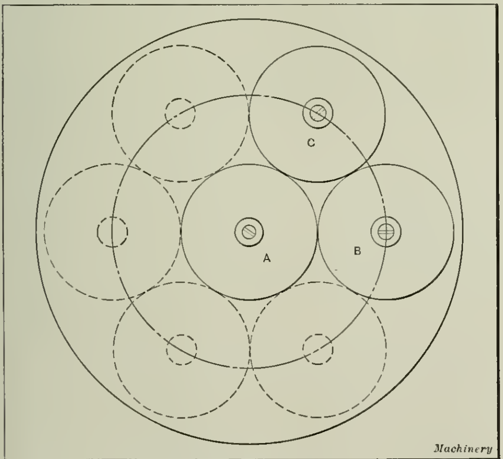

Fig. 1. Disk-and-button Method of locating Six equally spaced Holes

All cases, however, cannot be handled with disks of "standard" sizes, but making a special disk is easy, and its cost is insignificant as compared with the time saved by its use. One who employs this method, especially if he also uses disks to lay out angles, soon accumulates a stock of various sizes. While it is desirable to have disks of tool steel, hardened and ground, or, in the larger sizes, of machine steel, casehardened and ground, a disk for occasional use will be entirely satisfactory if left soft.

The hinge jig templet shown in the article previously referred to can also be handled advantageously by this method. Sketch *A*, Fig. 2, gives its dimensions and sketch *B* shows the disk-and-button way of locating the holes. A steel square is clamped with its stock against the right-hand edge of the templet and its blade extending across the top. The lower edge of the blade should be located 0.250 inch from the upper edge of the templet by the use of size blocks. A 2½-inch disk, touching both blade and stock, locates hole *C*. Another 2½-inch disk, touching the first disk and the square blade, locates hole *B*.

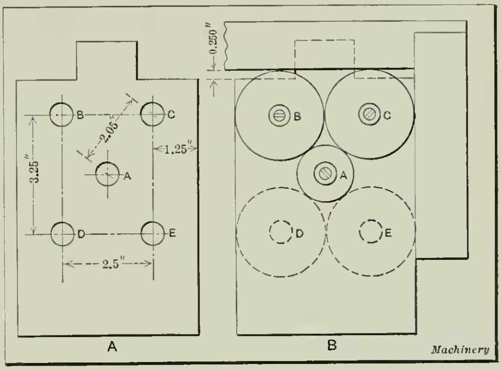

Fig. 2. Locating Five Holes in Jig Templet by the Disk-and-button Method

Next a disk 1.600 inch diameter is placed in contact with the two upper disks and locates the center hole *A;* and, finally, the disks for holes *B* and *C* are used to locate holes *D* and *E*.

Two other jobs that illustrate this method may be of interest. The first one, shown in Fig. 3, required the locating of nine equally spaced holes on a circumference of 7⅜ inches diameter. In any such case, the size of the smaller disks is found by multiplying the diameter of the circle by the sine of half the angle between two adjacent disks. In this case 7⅜ inches × sin 20° = 2.5224 inches; 7⅜ — 2.5224 = 4.8526 inches, which is the diameter of the central disk.

The templet shown in Fig. 4 required two holes on a circumference 6½ inches diameter, with their centers 37 degrees 20 minutes apart. 6½ inches × sin 18° 40′ = 2.0804 inches, which is the diameter of the two smaller disks. The diameter of the larger disk = 6½ — 2.0804 = 4.4196 inches.

This method has one unavoidable defect which, however, is seldom noticeable in the ordinary run of shop work. It is impossible to calculate certain dimensions with absolute accuracy, nor could we work to them if they were known. For instance, in the class of work of which Fig. 3 is an example, if the diameter of the small disks is determined to, say, the sixth decimal place, it will be followed by a + sign, and we know that there would still be the + sign if we carried the calculation to sixty or even to six hundred places of decimals; hence when figuring to six places and working to the nearest 0.001 inch, we may find either that the outer disks seem too large and will not assemble properly or that they appear small, leaving a slight shake between them.

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[*] Address: New London, N. H.

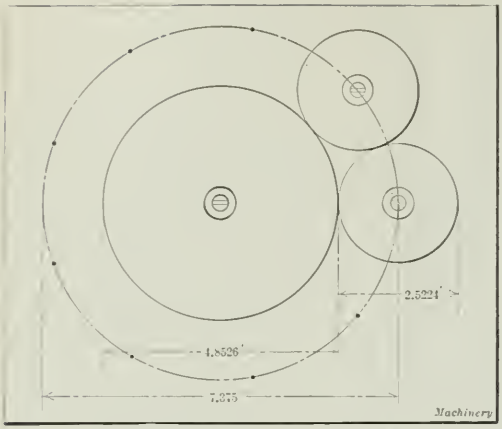

Fig. 3. Another Application of the Three-disk Method

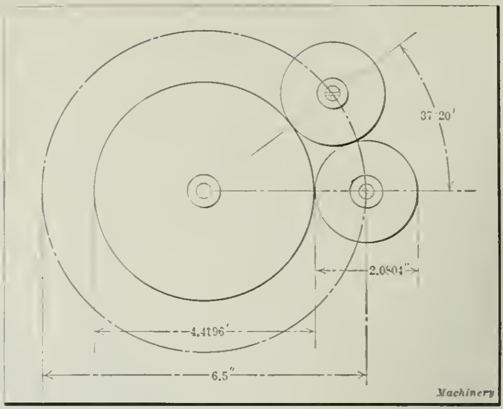

Fig. 4. Illustrating Use of Disks for locating Holes at a Given Angle

This error, however, is too small to be measured and is of no importance except in work requiring very unusual accuracy, and even then can be avoided by leaving the central disk a little full, and, if trial shows it to be necessary, returning the central disk to the lathe and giving it a very light touch with a lap.

Of course, absolute exactness is equally unattainable with buttons and micrometer or any other method, but the micrometer does not show the slight inaccuracy in any one chordal measurement, while in using the disks the error is cumulative and the insertion of the last disk in the series shows the sum of the errors in all the disks. It is only in cases like Fig. 3 that we note this, and there, though in correcting the error we may change the diameter of the circle by a small fraction of a ten-thousandth, a more accurate division of the circumference is secured than is attainable by any other method.

A piece of work requiring a high degree of accuracy was successfully handled by an extension of the three-disk method, after an excellent workman had attempted to do the work on the shop's best milling machine. The accuracy obtained with the milling machine was everywhere well within a 0.0005 inch limit, but the work was rejected because it was not close enough to the required dimensions.

The drawing called for fourteen holes in a space hardly larger than a silver half-dollar, and, though it gave dimensions from the center of this circle, the actual center could not be used in doing the work, as there was to be no hole there; moreover, a boss slightly off center prevented the use of a central disk, unless the bottom of the disk were bored out to receive this boss, which was not thought expedient. Hence, the method adopted was to make the plate thicker than the drawing prescribed, and then bore it out to leave a rim of definite diameter, this rim to be removed after it had served its purpose as a locating limit for the disks.

As the holes *A* and *B* (see enlarged view, Fig. 5), which were finished first, were 0.600 inch apart and 0.625 inch from the center, the rim was bored to 1.850 inch, and two 0.600-inch disks, in contact with the rim and with each other, located these holes. As hole *C* was to be equi-distant from holes *A* and *B*, and its distance from the center was given, the size of the disk for this hole was readily determined. The disks for holes *A*, *B* and *C* have two diameters. The upper diameters are made to whatever size is required for locating the disks of adjacent holes, and they also form a hub which can be used when setting the disks with an indicator. Hole *D* was 0.4219 inch from *B*, and calculations based on this dimension and its distance from the center showed that it was 0.4375 inch from hole *C*.

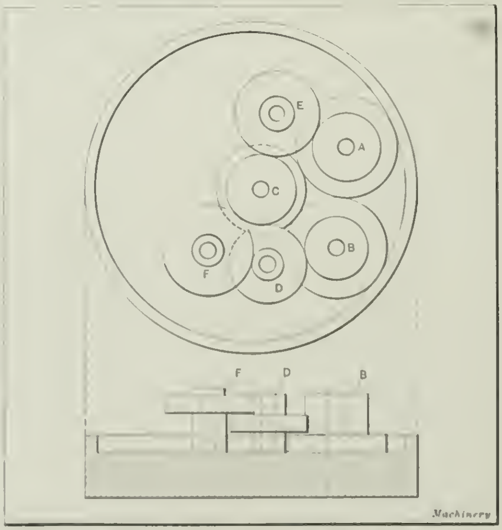

Fig. 5. Accurate Method of locating Holes by Means of Temporary Annular Rim on Work and "Two- and Three-story" Buttons or Disks

A "three-story" disk or button was made for hole *D*. The diameter of the large part was 0.46875 inch and it overlapped disks *C* and *B* (the upper sections of which were made 0.375 inch and 0.40625 inch, respectively), thus locating *D*. Then hole *F* and all the remaining holes were located in a similar manner. The upper diameters of disks *E* and *D* were used in locating disks for other adjacent holes, as well as a hub for the indicator; for instance, to locate a hole with reference to holes *C* and *D*, the diameter of the new disk and the diameter of the upper part of disk *D* were varied to give the required location.

It had been decided that no screws should be used in attaching the buttons or disks to the work, as it was feared that the tapped holes would introduce inaccuracy by deflecting the boring tools; therefore, a method was employed which was new to all who saw it, though I am told that it is frequently used in certain branches of the trade. After all the disks were fastened in place by clamps, a soft solder of low melting point was flowed about them, filling the work to the top of the rim. When the solder had cooled, the clamps were removed, the job transferred to the lathe faceplate, indicated in the usual way, and the holes bored by a "D" or "hog-nose" drill, guided by an axial hole in each disk, which had been provided for that purpose when the disks were made.

It had been freely prophesied that the unequal contraction of the solder and the plate in cooling would throw the holes "out of square," and I am by no means sure that it did not. However, careful measurements by several men failed to show any error.

PATENTS FROM A PATENT ATTORNEY'S VIEWPOINT

BY FORD W. HARRIS*

I have been reading Bell Crank's article on "Filing your Own Patent" in the July number of MACHINERY, and like most of the material in MACHINERY it contains a great deal of good common sense. It is, however, always well to get the other fellow's viewpoint, and it might be well to consider the patent attorney's way of looking at the matter.

In the first place as to searches: the average shyster patent lawyer will give you to think that the government is in some way involved in making searches. This is not correct. The only way that you can get the patent office to make a search is to present to them a formal application for a patent. The so-called search or preliminary examination that the average inventor buys is made by a Washington lawyer. This lawyer may be on sufficiently good terms with some of the examiners so that he can get a tip from them as to the classes or sub-classes in which interfering patents may be found, but in general he makes the search entirely on his own resources. The value of the search is a direct function of the personality of the searcher. If he is a conscientious man, he will make a pretty good search and the result may be depended on within certain limits. These limits are due to causes quite beyond the control of the searcher. In the first place, it must be understood that there are no adequate facilities for searching foreign patents, and a foreign patent is quite as valid a reference against an application as a domestic patent; in addition, no search will tell you just what there is pending in the office. A search is merely an indication of what may be expected. If the searcher finds patents that disclose the invention, it is conclusive; if he does not, there is no guarantee that those patents do not exist. The usual charge for such a search is five dollars, and it is evident that no competent man can put in much time at that figure. Personally, I believe it generally pays to have a search made by a good attorney.

As to attorneys, I do not believe in doing business with any attorney who advertises in any other way than by a business card. If he uses catch phrases such as "no patent, no pay," "meretorious inventions financed," etc., or if he advertises lists of inventions wanted or the like, I figure that he is a good man to leave alone. Personally, I believe in local attorneys, and I want to know that my attorney has been in business for some time, and I also want to know one or two satisfied clients of his before I do business with him. In addition, I want to see a few of the patents that he has obtained. I figure that if he gets broad claims for one man, he can get them for another.

There is no doubt that any inventor will make money by prosecuting a few patents for himself. He will get a lot of hard knocks and may get a very poor patent, but it is well worth trying. I would not trust any of my masterpieces to a green prosecutor, but there is no reason why an inventor cannot try out his hand on some simple case first and see how he gets along. He cannot hash it up much worse than a poor attorney, and he certainly will get a line on what such prosecution means.

As to the thoroughness of patent office searches I must differ a little with Bell Crank. The average office search is not thorough and that is one of the chief reasons for the present distrust of patents. If the patent office had the men and facilities to make good searches there would be very few invalid patents. A patent is usually invalid because some infringer can produce proof that the invention was not original with the patentee. The need for better examinations is the one big need in the patent office today. No man who has handled a large number of cases before the office will deny this. It is shown in two ways. The first is in the large number of patents that are declared invalid by the courts, and the second, in the fact that it is often possible to get claims that the inventor himself knows are clearly anticipated by the prior art. This is, however, a relative matter. As compared to the usual preliminary examination made by a patent lawyer the office search is perfect. As compared with what it should be it is not so good. I think we should pay higher filing fees and allow the patent office to spend the money in salaries and facilities for better examinations. Our patent system is the pivot around which many industries revolve and we ought all of us to pull for higher efficiency in the office.

As to the requirements for admission to practice before the patent office, Bell Crank is absolutely correct. The requirements are not hard, not one-tenth as hard as they should be. I understand that they are a little more strict than they used to be, but they ought to be tightened up a great deal more. It is no secret that there are many men who are absolutely incompetent who are registered attorneys. I do not think, however, that legal training has much bearing on the matter. The prosecution of cases before the office involves many questions of fact and a very few of law. The legal questions are not very knotty, and a few months study of elementary law, to get the proper attitude of mind, and a diligent study of one or two law books on patents will give a man all the equipment he needs to be a successful practitioner. On the other hand, the average lawyer who is thoroughly educated in general law will be about the worst man to whom to take a case that could be found. A patent lawyer should be about eight-tenths engineer or inventor and two-tenths lawyer. If he has the mechanical gifts he can pick up the law, but unless he has a constructive imagination and the mechanical sense he will never get it by studying law books.

I have been particularly interested in reading the closing paragraph of Bell Crank's letter. Here again he is right, but there is a great deal to be said on the other side. It is correct that no patent lawyer makes a practice of taking cases and taking an interest in the patent as payment. This is undoubtedly correctly attributed to the fact that the lawyer knows that the majority—the big majority—of patents will never pay the cost of prosecuting. This is not all the story, however. The lawyer knows that most patents are of no value, but he does not know which ones are of value. In other words, he cannot tell before he prosecutes a case whether he is going to get a good patent on it or a poor one. Allowing that nine patents out of ten are of no value, the tenth one may bring in ten times the cost of all the others. The bad patents are the quartz in which the values are imbedded and they must go to the mill before the good patent can come into its own. This matter of looking at a set of drawings and telling an inventor whether he can make money out of his invention is about like predicting the weather a year ahead. Years ago I thought I could do it, but as I get more experience I become more and more careful about expressing an opinion. Moreover, it is sometimes possible to make money on a poor patent and on a poor invention by going after the business end of it vigorously. I remember very well an old gentleman who came to me once to get my opinion on an invention that he was thinking of purchasing. The patent had not been allowed and the invention itself was a little indefinite as to its novelty. After an examination of the device itself it seemed pretty evident to me from my knowledge of the art that the inventor was not going to get much of a patent. I had had a similar case in which I had had several references that completely anticipated the alleged invention in this case. I told the intending purchaser this, and, moreover, I told him that I believed that a certain pipe that figured actively in the operation of the invention had really no useful function at all; that is, I believed that it would work just as well if this pipe were left off. The old man looked at me.

"Mr. Harris," he said, "there are just two people in the world that know that; you are one and I am the other. I got suspicious of that pipe about a month ago and slipped in here and plugged it with a cork stopper, and I find it works even better plugged than it did open."

I then asked him what he was going to do about purchasing in view of the fact that it was very unlikely that he could get a patent and in view of the fact that this apparently essential pipe which formed so large a part of the supposed invention was nothing more than a fake. He then explained that he already owned the manufacturing rights under a royalty and that the inventor proposed to sell his royalty rights for a certain sum—two thousand dollars to be exact. He had consulted me merely to get a confirmation of his own opinion that the invention considered as an invention was of very little value. He then asked me to have the necessary papers drawn up to cover the transfer of this royalty to him, and said that he would give me a check payable to the inventor which I could hand to him when he signed the assignment. I was naturally a little surprised and showed it, and he went on to say that he had already sold fifteen thousand dollars worth of the devices, that he expected to sell as many more, and that he was only giving the inventor a small slice of the money he had made.

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This case has always seemed to me to show the absolute impossibility of judging in advance of the money making possibilities of any invention. If the inventor had come to me to handle this particular case I would have refused to have anything to do with it. It was a meretorious device, but with the pipe left off it was not patentable. The pipe looked plausible and helped to sell it and the natural merit of the remaining parts sold others. I cannot see that anyone was really essentially cheated, as it did the work for which it was sold better than any device then on the market, and the public was well pleased with it. The inventor got two thousand dollars plus considerable royalty on the early sales, and my client got the profit on a great many that he sold. Judged by any practical standard it was a good invention. Judged by its merit in a patentable sense it was a joke.

Then again I have seen some of the cleverest things that apparently were destined to make a great deal of money turn out to be rank failures; so I do not blame a patent lawyer for taking the business as it comes and getting the best patents that he can. I do blame him if he misleads the inventor as to his chances of getting a good patent, or as to the nature of the patent that is finally allowed. Once upon a time during a stringency in my personal finances I tried the job of making patent office drawings for a local attorney. There was an old draftsman and myself in the office in addition to the usual clerical force. One day the junior partner brought in a client—a young mechanical draftsman—who had invented a new style drawing instrument, or rather had made a simple change in one of the common tools we all of us use. The junior partner showed it to me and asked me what I thought of it. I did not think it was new, but I hesitated to tell the inventor so, and while I was debating just what to say, the junior partner saw that I was not going to become enthusiastic and he switched to the old man asking him if he had ever seen anything like it. The old man said that he had not.

"Well," said the junior partner, "I have been in this business for fifteen years and Mr. Jones here has been in it for forty-five, and we have neither of us seen anything like it, so I guess it is all right," and he took the young man out to enter the case. After they had gone out the old man came over and showed me practically the same thing on one of his tools. I asked him why he had not told the junior partner about it and he grinned.

"This used to be his," he said, "he gave it to me when he got promoted from the drawing-board."

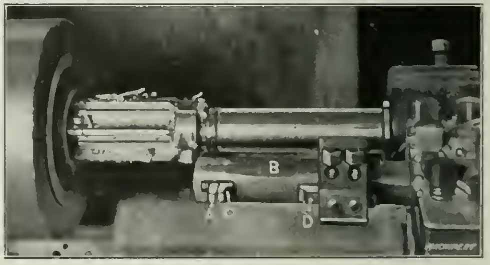
I did not stay long enough to find out whether the inventor got a patent or not, but I did stay long enough to find out that one way to be a "successful" patent lawyer was to say that every invention was fine, and to tell every inventor that he was a genius.. This particular attorney has allowed one of the finest patent practices in this part of the country to go to seed and it is only a question of time when he will have little or no practice left. It is his kind that have made the name patent attorney a joke to those who are at all well posted, and who have put into the office thousands of worthless applications and caused the inventors of the country the loss of hundreds of thousands of dollars.

I believe in patents good patents. They offer about the only legitimate road to fortune for the working man who does not have exceptional qualities and superhuman luck. All this talk about inventions being "no good" is to my mind foolishness. Edison is occasionally quoted as saying something of the kind. I notice that he is a busy little bee putting in applications, however. A good patent is a very valuable piece of property and there are more of them than one thinks. There is a great deal of foolishness in patent practice that must be eliminated. We need a better patent office and better attorneys, and we can get along very nicely with about one-third of the patents that are now issued. I think that we are going to have some legislation some day that will materially clear up the present situation, and any changes must favor the inventor. If you have an idea that you think is of value, spend a few evenings studying the subject and take a try at prosecuting an application yourself. If it comes along all right, it may pay you to get a good lawyer. If you can get a first-class patent on a good invention there is money in it, but remember that push and grit are as necessary to an inventor as to any other man, and that money will not drop in your lap just because you have turned up a bright idea.

* * *

RAPID BORING AND REAMING OF BABBITT-LINED BUSHINGS

In finishing the babbitt-lined bushings for use in the Pierce-Arrow engine, the Pierce-Arrow Motor Car Co. of Buffalo, N. Y., uses a very effective type of tooling on a Gisholt lathe.



Boring and Reaming Tools for Babbitt-lined Bushings

The bushings are of the split type and the two halves are held in a collet and bored with tool *A* held in a fixed position on the bar *B*, which in turn is attached to the cross-slide of the lathe. After boring, bar *B* is run through the bushing so as to bring tools *C* and *D* at the exact edges of the hole. These being in fixed positions are fed toward the operator, thereby cleaning off the ends of the bushings and chamfering the corners. This being done, the hole in the bushing is rough-reamed and finally, as shown in the photograph, is finish-reamed, using McCrosky adjustable reamers. The result is a mirror-finish hole, and moreover the work is produced at the rapid rate of from thirty to forty pieces an hour.

C. L. L.

* * *

A riveted sheet steel siphon ten feet in diameter carries water to Los Angeles across the Antelope Valley. Recently a great storm visited the valley and the resulting flood undermined the supports of the aqueduct, causing it to break in two. The shell being unsupported by internal pressure and being subjected to external pressure due to the flood, collapsed for a distance of nearly two miles. Apparently the pipe would have to be reconstructed at great expense, but the engineer in charge decided that it could be restored to shape by simply stopping the broken ends of the pipe and turning the water pressure into it. This was done, the result being that the pipe assumed its normal shape and very few leaks developed.

* * *

The summit of the Vigiljoch mountain in Switzerland, 3780 feet high, has been made accessible by means of a wire rope railway in two sections, worked electrically. The length of the slope is 7216 feet, the longest span being 656 feet horizontally. There are two cars for each section, with a capacity for carrying fourteen passengers, one car traveling up when the other is coming down.

METHODS OF HANDLING ECCENTRIC WORK

CONSTRUCTION AND OPERATION OF SPECIAL DEVICES FOR ECCENTRIC TURNING AND BORING

BY ALBERT A. DOWD*

CASTINGS or forgings having two or more cylindrical surfaces eccentric to each other may be machined by a variety of methods, that most suitable for any particular case being dependent upon a number of variable factors. In order to handle the work to the best advantage, these factors must be carefully considered. In the first place the machine most suited to the work must be selected, and this point is partially dependent on the size and shape of the work itself. The number of pieces to be machined is an important factor, in that it has an influence on the permissible tool outlay, for it is apparent that a high tool cost would not be expedient in the case of a lot of 200 pieces; whereas, if 5000 pieces were to be machined the cost of tooling and fixtures could almost be neglected provided substantial gains in production were to be made by some improved method of handling. There are cases when the work can more profitably be handled in two settings by means of a fixture, while in other instances the use of an eccentric turning device seems to offer the best solution of the problem. In the first case, a fixture of some sort is required and this usually presents no serious difficulties to the designer unless the work is very complicated. However, if an eccentric turning device seems warranted (as might be considered advisable if a great number of pieces were to be machined), it would then be necessary to design something on this order which would produce the work in the shortest possible time.

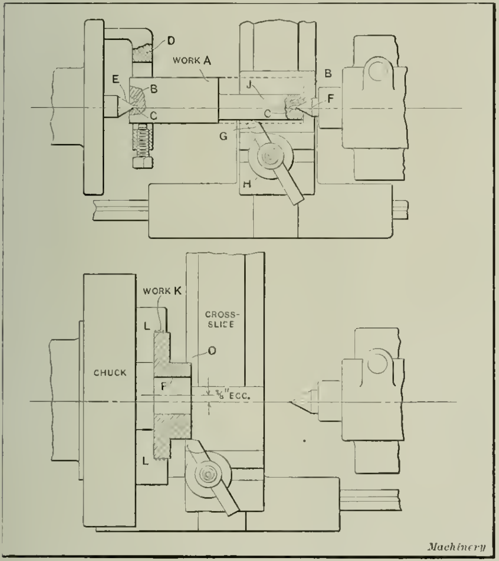


Fig. 1. Eccentric Turning in the Lathe

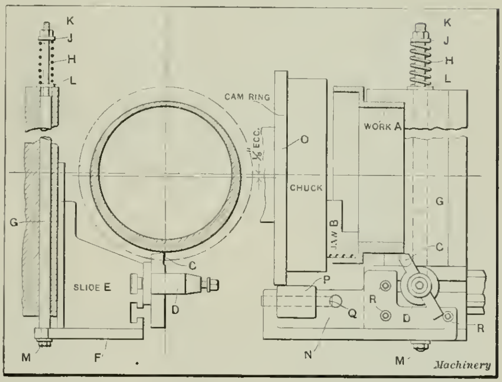


Fig. 2. Eccentric Turning Attachment for Engine Lathe

In the design of fixtures and devices for eccentric work there are a few points which require most careful consideration. Let us first give our attention to those which relate to special fixtures, for these points may be quickly summarized: If the work is to be finished in one setting, then some form of indexing fixture must be designed which will give the correct amount of "throw" when it is set over, and a great deal of care is required so that no change in the clamping of the work will be necessary between the first and second settings of the fixture. Indexing points, bushings and pins should be protected from dirt and chips so that inaccuracies will not occur due to imperfect contact at the locating points. When the work requires two settings the piece must be carefully located from a previously machined surface which bears a positive and fixed relation to the eccentric portion. The clamping must be rapid and must be so arranged that it will not distort the work. When it is desired to use an eccentric turning device, the following points in design will be found of value.

Points in Design of Eccentric Turning Devices

1. Rigidity. All brackets and castings should be made of ample section not only to withstand the stresses to which they may be subjected but also to deaden the vibration which may be caused by cutting action of the tool. A bracket may be strong enough to perform its functions and yet not have sufficient metal in it to prevent vibration. Proportions of moving shafts should be generous and bearing surfaces of good length.

2. Direction of the cam thrust. This should be such that it tends to throw the tool into the work rather than in a con-

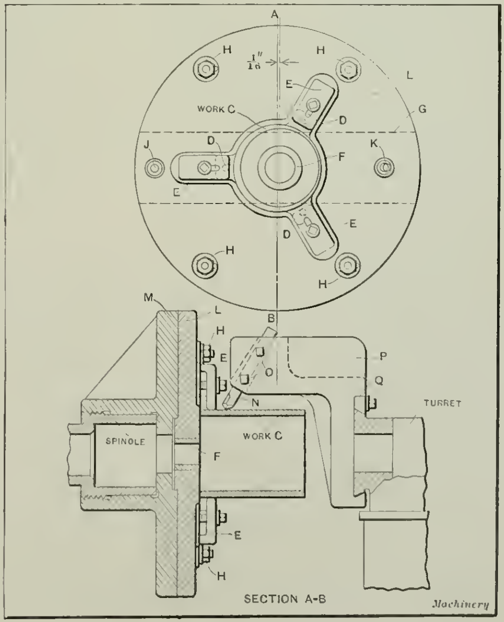


Fig. 3. Eccentric Turning Fixture for Horizontal Turret Lathe

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trary direction. Springs or weights can be arranged to prevent the tool from "digging in." This arrangement is desirable but not absolutely essential, for conditions are sometimes such that the cam must be arranged so that it throws the tool away from the work. When it is found necessary to make it in this way the springs or weights should be made very stiff so that a positive contact with the cam is assured at all times.

3. Proportions of cam roll. In cases where a rolling contact is used, the pin on which the roll revolves should be not more than one third the diameter of the roll. If not so proportioned the friction on the pin, caused by the pressure of the contact with the cam, will be so great that the roll may not always revolve and this will naturally have a tendency to make flat spots in the roll due to unequal wear.

4. Chip protection. All moving parts should be carefully guarded so that chips and dirt will not get in and cause imperfect work.

5. Provision for oil. This matter should be taken care of on the eccentric turning device just as if it were a part of the machine itself, for many a good attachment has been seriously injured by lack of oil. Oil cups are cheap and easily applied and an operator has no excuse for neglecting to oil a fixture when oil cups are in plain sight.

6. Simplicity and economy in cost of attachment. These points should receive due consideration, always bearing in mind the number of pieces to be machined and making the cost in proportion as far as possible.

A number of illustrations of eccentric work are shown and they will be discussed and criticised in this article.

Eccentric Turning on the Engine Lathe

The upper illustration in Fig. 1 shows the simplest problem in eccentric turning which may be met with in ordinary shop practice. The steel eccentric shaft *A* is to be machined so that the smaller end *J* will be eccentric to the larger portion by half an inch. The centers *B* and *C* are first carefully put in at the correct distance from each other, after which the work is placed in the lathe (on the centers *B*) and the entire shaft turned concentric. In turning the portion *J*, the centers *C* are used, the dog *D* being used as the driver. The work revolves on the centers *E* and *F* in the spindle and tailstock of the lathe, and the tool *G* in the cross-slide toolpost *H* is used to do the turning. It is obvious that several cuts are necessary to bring the work down to the proper size. Work which requires machining in this manner is not at all unusual, and this method of handling is familiar to every machinist and toolmaker.

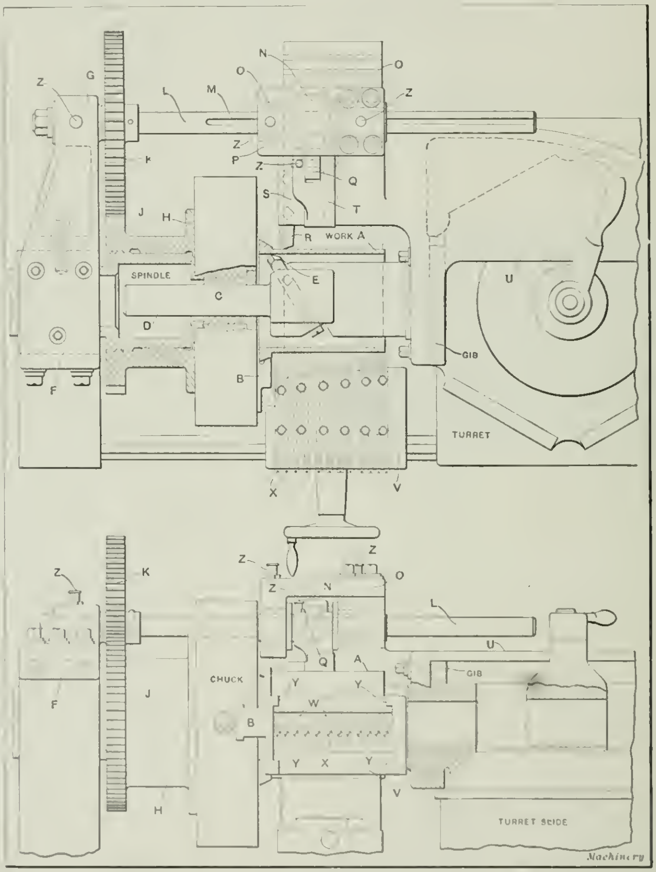


Fig. 4. Eccentric Piston Ring Turning and Boring Attachment

Sometimes work which requires eccentric turning is of such a nature that the use of centers is not desirable. Such an instance is shown at *K* in the lower part of Fig. 1. In this case the flange and the hole *P* are concentric, but the hub *O* is 3/8 inch eccentric. There are several ways in which this piece of work could be handled: It could first be held in a four-jawed chuck by the hub *O*, the jaws being thrown off center until the flange runs approximately true. The flange could then be turned and faced and the hole *P* chucked out and reamed. An eccentric arbor could then be used in the hole and the hub *O* turned on this arbor. This method would require a special arbor with the proper eccentricity. In order to avoid this expense let us consider that we have performed the first operation as mentioned and are now ready for the eccentric turning. By using a four-jawed chuck and holding the work in the jaws *L* by the flange it is a very simple matter to indicate an arbor or stud placed in the hole *P* and set the jaws off center until the desired eccentricity has been obtained.

Eccentric Turning Attachment for the Engine Lathe

The two methods given in Fig. 1 are more suited to work not made in quantities, and may be used in cases where one or two pieces are required. The device shown in Fig. 2 was used for a number of pieces, there being fifty in the lot. This arrangement was applied to an old Pratt & Whitney lathe which had a taper turning attachment at the rear of the bed, this machine being selected because it could be adapted quickly to the work in hand without great expense. This example is given not because it is of great value but simply to call attention to a "makeshift" method of handling a job which was "rush" and which, therefore, had to be gotten out in the shortest possible time. One of the hubs on the work *A* was eccentric to the other by 1/4 inch and the work was held by the inside in the jaws *B*. A cam ring *O* was set eccentric and fastened to the back of the chuck by four screws not shown. A cast-iron bracket *N* was screwed to the top of the cross-slide *E* by the three screws *R*, these screws entering shoes in the T-slots. A hardened steel roller *P* revolves on the pin *Q* at the outer end of the bracket. A steel plate *F* fastened to the front of the cross-slide overhangs the end and acts as a support for the rod *G*, being held in place by the nut and washer at *M*. This rod runs entirely through the carriage and is threaded at its outer end to receive the nut *K*.

A stiff coil spring *H* bears against the two washers *J* and *L*, and serves to keep the slide drawn forward at all times so that the roll *P* is continually in contact with the cam ring *O*. A tool *C* held in the toolpost *D* serves to turn the eccentric. It will be noted that the cam roll *P* is made long enough to give contact during the required cut.

Eccentric Turning Fixture for a Horizontal Turret Lathe

Packing rings such as are used on automobile gas engines are usually eccentric and these are handled in many cases by an automatic or semi-automatic machine which is provided with some sort of an eccentric turning device. There are instances, however, when the expense of a device of this kind is not warranted by the amount of production required. Fig. 3 is an example of this sort, the rings being required in small quantities. The ring pot *C* is of cast iron and has been previously faced on the back of the lugs, approximately square with the pot proper. Holes have also been drilled at *D* by the use of a jig. The work is located by these three holes on the pins *D* which are fixed in the sliding plate *L*. The three clamps *E* are used to hold the pot firmly, and these clamps are slotted to facilitate rapid removal. The bushing *F* is concentric with the interior of the pot and is used in another operation as a guide for the pilot of the boring-bar. The plate *L* is tongued at *G* to fit a corresponding groove in the faceplate *M*. This faceplate is well ribbed and is screwed to the spindle. After the boring has been done, the four nuts *H* are loosened, the locating pin *J* is removed from its bushing, and the plate is pushed over until the pin *J* can be pushed "home" in the other bushing *K*. It will be noted that it is not possible to locate the two indexing bushings side by side on account of the small amount of eccentricity, this being only 1/16 inch in this case.

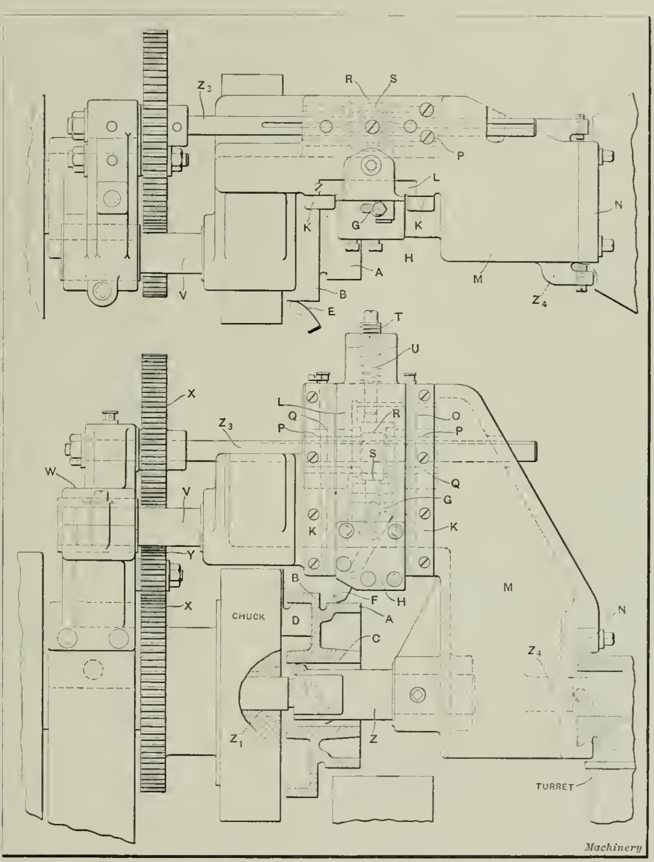


Fig. 5. Eccentric Turning Device for Cast-iron Eccentric

After the plate has been set over, the nuts *H* are tightened and the turning tool *N* is used to turn the eccentric surface. This tool *N* is firmly secured in the body *P* by the two set-screws *O* and it should be noted that the slot in which it rests is tapered toward the lower end so that a swinging adjustment may be made. The body of tool *P* is secured to the dovetailed face of the turret by gib *Q*. This fixture, although somewhat slow, gave excellent results.

Eccentric Ring Turning Device for a Horizontal Turret Lathe

The device shown in Fig. 4 was designed and manufactured by the Pratt & Whitney Co. for use on its horizontal turret lathe, and it has been remarkably successful in the production of eccentric piston rings for gas engine work in a minimum amount of time. The construction of the entire device is such that it may be applied to a standard machine without injuring it for other work. The component parts of the device can be removed quickly from the turret lathe, leaving the machine ready for regular chucking work. A special faceplate *H* is used to hold a three-jawed geared scroll chuck having special jaws *B* which grip the angular flange of the ring pot. This flange is made so that it is concentric with the interior of the pot. The faceplate *H* is furnished at its rear end with a spur gear *J* which meshes with another of the same size *K*. The cast-iron bracket *F* is fastened to the top of the spindle cap and has a hub *G* at its outer end which acts as a bearing for the spline shaft *L*. It will be noted that the gear *K* is pinned to this shaft by a tapered pin. A large cast-iron bracket *U* is fitted to the dovetailed faces of the turret and extends entirely across it, being secured by the gibs shown. A boring-bar of tool steel, having a hardened and ground pilot *D*, is mounted in the turret, and the pilot is guided by a bushing *C* in the chuck. The boring tool *E* sets at an angle of 30 degrees in the bar and is secured by two square-head set-screws. Fine adjustments are obtained by means of the backing-up screw shown. The piloting of the bar in the chuck bushing gives great rigidity.

A steel block *S* holds the tool *R* which does the eccentric turning. This block is mounted on a dovetail slide *T* which has an adjustable taper gib securing it to the outer end of the bracket *U*. A small L-shaped bracket *O* is tongued to the top of a lug on the main bracket and acts as an outboard bearing for the cam quill *N*. This quill has a roll with the correct eccentric turned on it and it is supported at each end in two hardened and ground steel bushings, these bushings being forced into their places in the bracket and lug, respectively. A smaller roll *Q* is mounted on the top of the dovetailed slide and is held constantly in contact with the cam roll by the action of an adjustable spring of heavy section, concealed in the body of the slide and adjusted by means of a screw. (To avoid complicating the drawing this spring is not shown in the illustration.) The cam quill is furnished with a long key which passes completely through it, this key engaging and being free to slide in the spline *M* in the shaft *L*. A tool-block *V* of solid steel is mounted on the front of the cut-off slide, and attention is called to its construction. The two side pieces are tongued at *Y* and are screwed fast to the top and bottom pieces of the tool-block, the tongues serving to take the thrust of the holding-down screws and making for a very rigid construction. A supplementary block is fitted so that it slides freely in the holder and in this block the cutting-off tools *X* are mounted. Fine adjustment is provided in the backing-up screws. The tools themselves are clamped in position by the blocks *W* which bear along their upper edges and are secured by means of the square-head set-screws in the tool-block cap, two tools being gripped by each block. The cutting ends of these tools are ground to an angle of 5 degrees with the center line of the spindle so that their action in cutting off will be progressive, and the rings will drop off one at a time without breaking. In the spacing of the cutting-off tools an allowance of 0.010 to 0.012 inch is made for grinding the sides of the rings. These tools are very carefully made and surface-ground on the side so that they are a nice push fit in the tool-block slots. Oil cups for the various bearings are shown at *Z*.

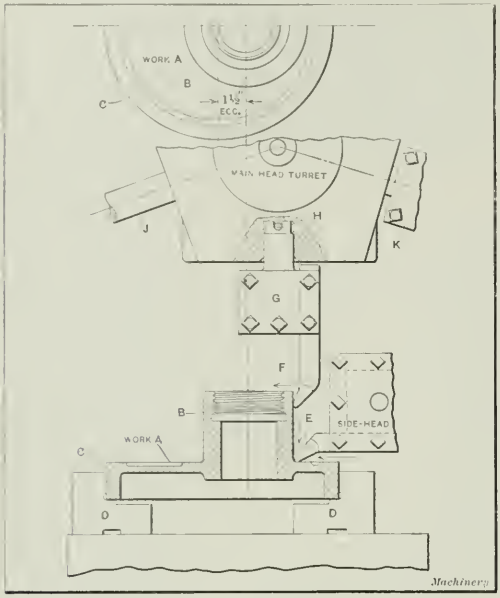


Fig. 6. Method of machining Eccentric Hub on Vertical Turret Lathe

The operation of the device is as follows: As the spindle revolves the spur gear *J* meshing with *K* revolves the spline shaft *L* once while the spindle revolves once, and the quill which is keyed to a sliding fit on the spline shaft revolves the cam roll *N*, thus forcing the slide *T* in and out and forming the eccentric on the outside of the pot. As the turret moves forward, it will be seen that the boring tool *E* is working on the concentric inside while the tool *R* is in opposition to it on the outside. After the turning and boring have progressed about an inch and a half, the cross-slide feed is thrown into engagement and the cutting-off tools part the rings one by one. A great number of these equipments have been sold by the Pratt & Whitney Co., and have given universal satisfaction.

Eccentric Turning Device for a Cast-iron Eccentric

The cast-iron eccentric shown at *A* in Fig. 5 has the flange *B* and the hole *C* concentric, while the portion *A* is one half inch eccentric to these surfaces. The work is held by the inside of the flange in the special jaws *D*, a three-jawed geared scroll chuck being used. The faceplate of this chuck has a spur gear *X* cut on its rear end. This gear meshes with an idler *Y* which, in turn, transfers the motion to the upper gear *X*, this being of the same diameter as the faceplate gear. The gear *Y* is mounted on a stud which has a bearing in the bracket *W*, this bracket being mounted on the spindle cap. The shaft *Z*, on which the upper gear *X* is mounted, is splined to receive a key which extends the entire length of the cam quill *P*. This key is fitted so that it has an easy sliding fit in the shaft. The bracket *M* is of cast iron, box section, and it is mounted on the dovetail face of the turret and secured by the gib *N*. The two lugs *Z*, each contain a set-screw which is used partly to adjust the heavy bracket into position when assembling, and partly to prevent its working loose on account of the jar incident to the shock caused by indexing the turret. The piloted boring-bar *Z* is mounted in a boss in the bracket and is used to bore the hole in the hub while the eccentric turning is being done. The bushing *Z*, in the chuck acts as a guide for the bar and also assists in preventing chatter. It is well to note that the boring tool stands in a vertical plane. The bracket has a pilot *V* at its forward end and this enters a bushing in the spindle cap bracket. The hub or boss which holds it is split and is clamped tightly on the bushing by means of the collar head screw shown. The tool *F* which turns the eccentric is mounted in a steel block *H* and it is backed up by the screw *G*.

After the rough-turning operation is over, the tool *F* is removed and a finishing tool substituted for it, the backing-up screw acting as a gage or stop against which the ends of the tools rest so that diameters can be duplicated without trouble. The boring-bar also can be quickly removed and the finishing bar substituted for it by simply loosening the screw which holds it in place in the hub. The tool-block is secured to the slide *L* by the screws shown and the slide is held in place by the two strap gibs *K*. A taper gib with a backing-up screw is provided to take up wear on the slide. A projecting lug at the top of the slide provides a means of holding the adjusting screw *T* which is used to stiffen the heavy coil spring which holds up the slide. The bracket *O* which furnishes one of the bearings for the cam quill is tongued on its upper surface and is screwed fast to a projecting portion of the main bracket. The two ends *P* of the cam quill are carried in bushings *Q*. The cam roll *R* is ground to the correct eccentricity and controls the movement of the slide through the contact of the roller *S* which is mounted between the lugs shown on the back of the slide. A cored opening in the main bracket permits the free passage of the lugs without interference.

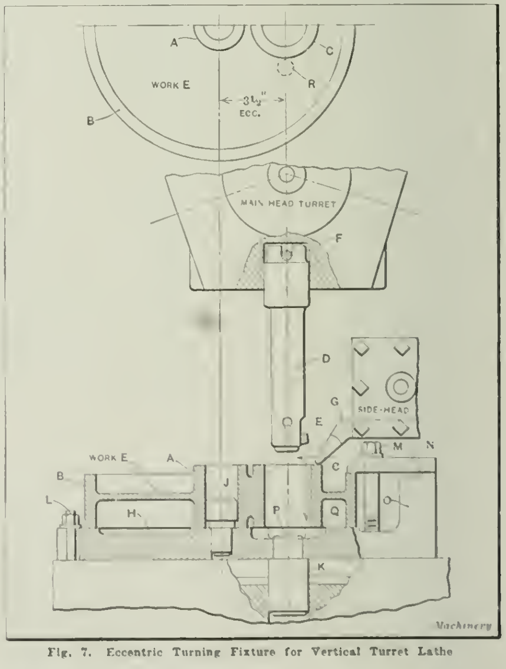


Fig. 7. Eccentric Turning Fixture for Vertical Turret Lathe

During the operation of the eccentric turning device and the boring of the hole (power feed being thrown in for this work), the tool *E* which is held in a regular toolpost on the front of the cut-off slide is fed by hand along the concentric portion of the casting *B* and is also used for facing the end. While the finish turning and boring are being accomplished by the eccentric device, a finishing tool on the rear of the cut-off slide is used to finish the surface *B* (this tool is not shown on account of lack of space). Oilers are provided for all bearings. It may be noted that the operations of turning eccentric and concentric and boring the concentric hole are all going on at the same time. The device is somewhat top-heavy and rather expensive, but it is capable of handling a number of pieces of varying eccentricity by substituting cam quills of the proper "throw," and making the necessary boring-bar adjustments. The coil spring *U* is of 3/16-inch stock, square section, and is very stiff, as it has to support the weight of the slide and keep the tool from pulling in. Attention is called to the fact that the action of the cam roll is such that it forces the tool to take the correct path so that an absolutely correct eccentric is formed.

Machining an Eccentric Hub on the Vertical Turret Lathe

The work shown at *A* in Fig. 6 has a hub *B* which is eccentric to the gear *C* on the outer rim by 1½ inch. In the machining of this casting it was first held by the inside of the flange in a three-jawed chuck having special jaws permitting the edges of the flange to be faced. In the setting shown in the illustration, a four-jawed chuck was utilized, the jaws *D* being set off center sufficiently to produce the desired eccentric on the hub. As there were only a few of these pieces to be machined the expense of an eccentric turning device was not warranted, so that this method, although somewhat slow, was considered the best for the purpose. Two of the four jaws were left set after the first piece had been machined so that in placing the other pieces in position, these two jaws acted somewhat like a V, and greatly facilitated the setting up. A conical plug was used in one of the turret faces to assist in approximating the cored center of the hub. This plug is not shown in the illustration but its action will be readily apparent. The tool *F* is mounted in a tool-holder *G*, the stem of which enters the turret hole and is driven by the pin *H*. This tool is obviously used for rough turning and facing the hub. While this operation is going on, the tool *E* in the side-head is used for facing. A boring-bar *J* is next used to bore the hole and while this is being done a finishing tool (not shown), in the side-head turret, is swung into place and is used for finish facing and turning the hub. A tool-holder *K* in the main head turret contains a grooving tool for the thread recess, while a thread chasing bar is used to cut the thread.

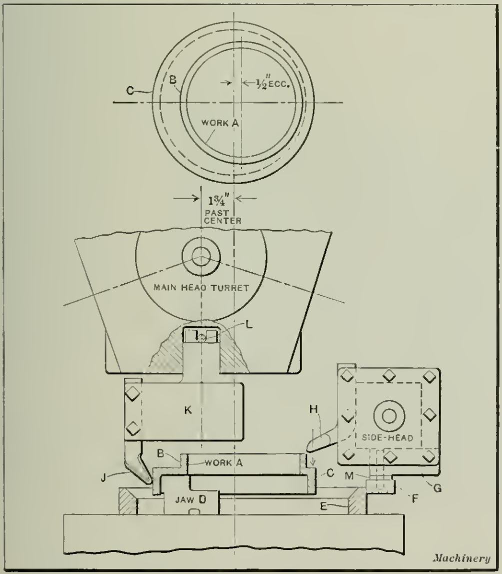


Fig. 8. Eccentric Turning by means of Eccentric Guide Ring

Eccentric Turning Fixture for the Vertical Turret Lathe

The piece of work shown at *E* in Fig. 7 represents a condition somewhat out of the ordinary, in that the eccentric throw is 3½ inches. By referring to the upper part of the illustration it will be noted that the small hub *A* and the rim *B* are concentric, while the hub *C* is eccentric, the amount previously stated. As there were a number of these pieces to be machined, and as the eccentric throw was so great, it was considered expedient to design a fixture on which they could be handled. Previous to the setting shown, the work had been machined on the periphery *B*, the edges of the flange had been faced, together with the hub, and the hole in the hub *A* had been bored and reamed. The body of the fixture *H* on which the piece is now held is of cast iron and is centered on the table by means of the plug *K*, while it is held in position by the T-bolts *L*. A hardened and ground steel plug *J* is located at the proper distance from the center of the table and on it the work locates. A plug *R*, shown in the upper view, strikes against the larger hub and acts both as a locater and driver for the work. The three clamps *N* are drawn down on the edge of the flange by the screws *M*, the lugs *O* on the fixture body being used to support the outer end. These clamps are of the type usually termed U-clamps so that they may readily be pulled back out of the way when releasing the work. A pocket *Q* under the large hub allows the end of the boring-bar to pass through the hole. An opening *P* allows easy removal of chips. The boring-bar *D* fits the turret hole and is driven by the pin *F* in the turret. This bar is made by the Bullard Machine Tool Co., and is provided with a set of slip cutters and reamers for any size hole within its capacity. (The construction of the bar was fully described in MACHINERY, March, 1914.) The tool *G* in the side-head turret is used for facing the hub during the boring operation.

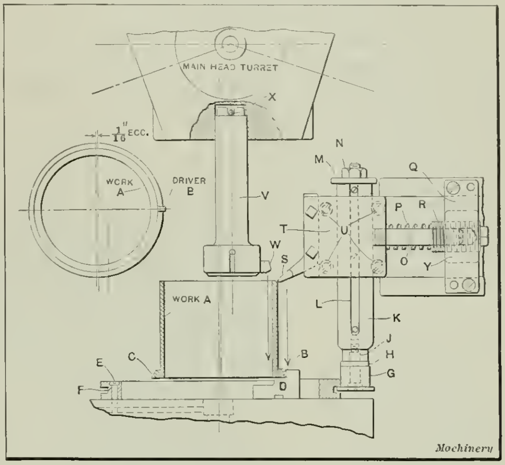


Fig. 9. Device for boring and turning Eccentric Ring Casting

Fig. 8 shows a makeshift arrangement for machining the work *A* on a vertical turret lathe. In this instance the portion *B* is eccentric to *C* ½ inch.

The work is held by the inside in the jaws *D* of a three-jawed table, so that the portion *C* is concentric with the center of the table. A steel ring *E* is bolted eccentrically to the center of the table by the same amount as the desired eccentricity on the work. This ring is beveled on the inside to allow clearance for the turning tool *J*. This tool is held in a special holder *K* which has a shank running up into the turret hole and there driven by a pin *L* in the usual manner. A hardened and ground tool steel roll *F* is mounted on a shouldered screw which enters the rectangular holder *G*, a thrust washer *M* being interposed between the moving surfaces. The two sides of the roll holder *G* are ground parallel, so that the roll will always be in a position parallel to the outside of the cam *E*. It will be seen that if this roll were not so located, there might be a possibility of cramp developing when pressure was applied. The tool *H* is, obviously, used for turning the eccentric. Attention is called to the fact that in the use of this device the operator's constant attention is necessary in order to produce accurate work. The cam roll *F* must be forced against the cam *E* by the pressure of the feed lever crank on the side head, and the pressure applied must be sufficient to overcome any tendency of the pressure of the cut to push the roll away from the cam. It can, therefore, be readily seen that the operator's task is by no means easy in this instance.

Boring and Turning an Eccentric Ring Pot on the Vertical Turret Lathe

The detail view to the left in Fig. 9 shows a plan of the ring pot *A*, the outer surface of which is eccentric to the hole by 1/16 inch. Attention is called to the driver *B* which obviates the necessity of a great amount of pressure being used in setting up the jaws to hold the work, this lug being twisted around when placing the piece in position, so that it comes against the side of the jaw and greatly assists in driving the work. The jaws *D* are formed to the same bevel as the flange and the table is of the three-jawed type. The boring-bar *V* is of the same type as that previously described, being driven by the pin *X* in the turret. The tool *W* is, obviously, used for boring the concentric interior of the ring pot. A special cam ring having a groove *F* on its periphery is eccentrically set on the table and secured in position by the screws *E*. These screws pull up on shoes placed in the table T-slots. A special side-head *T* is used in connection with this device (the regular side-head turret being removed), and it is held securely in position by the four screws *U* which are tapped into it through the rear of the slide.

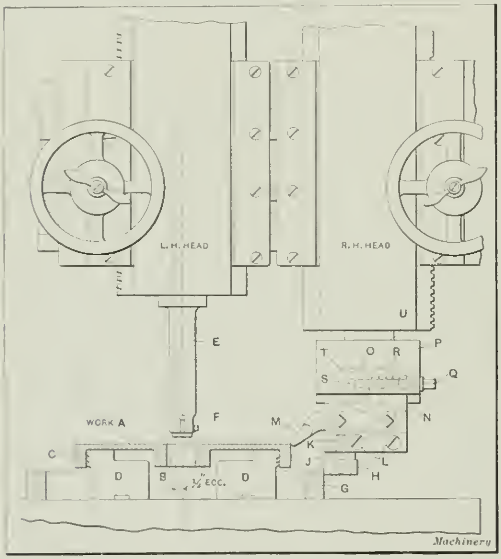


Fig. 10. Eccentric Turning on Vertical Boring Mill

A hardened and ground tool steel bar *K* passes through this special block and is prevented from turning by the key *L*. A nice sliding fit is made between the bar and the block and the upper part of the bar is provided with a collar *M* and a nut *N*, in order to prevent its dropping out of position when the side-head is pulled back. The lower end of the bar is fitted with a shouldered screw *J* on which the flange roller *G* revolves. A thrust washer *H* is interposed between the roll and the end of the bar. A bracket *Q* having a shape somewhat in the form of a U is fastened to the side-head saddle, and bridges across the slide in the manner shown. On the under side of the bracket is the boss *Y* which is tapped out for the adjusting screw *R*. The pin *O* is screwed into the side-head and acts as a guide to keep the spring *P* from buckling. This spring is of 1/4 inch square section and is very stiff. It will be noted that the pressure of the spring can be regulated to a nicety by means of the screw *R*. The tool *S* is used for turning the eccentric and it is held in place by the two screws shown.

In the operation of this device the side-head slide is moved forward by the pressure of the spring so that the roll *G* is kept in contact with the cam. The down feed of the side-head is then thrown into engagement and the tool *S*, following the movement of the cam, produces the eccentric on the outside of the ring pot. As the side-head moves downward the flange on the cam roll strikes the lower part of the groove *F* in the cam and allows the side-head to slip easily downward on the bar *K*. While the outside turning is in process the boring tool *W* in the main head turret bores the interior of the pot concentric. The two tools *W* and *S*, acting in opposition to each other, tend to eliminate vibration in the shell and also assist in maintaining the sizes.

Eccentric Turning on the Vertical Boring Mill

The work *A* shown in Fig. 10 is of cast iron and has a hole *B* 1.2 inch eccentric to the rim *C*. The machine on which this work is done is a vertical boring mill having two heads. The work is gripped by the inside of the rim in a four-jawed chuck, two of the jaws *D* being shown in the illustration. These jaws are special and are set off center sufficiently to bring the hole *B* in the center of the table. A boring-bar *E* with a set of slip cutters *F* is used in the left-hand head to bore and ream the hole. This operation, however, does not take place while the outside turning is going on, as the boring would be too slow to be profitable. A tool-holder with a facing tool in it is used in place of the bar to face across the web while the eccentric turning is taking place. The tool-holder is then slipped out and the bar *E* placed in position, after which the table is speeded up and the hole bored.

A cam ring *G* is fastened to the table in the proper position to produce the correct eccentricity. A special device is mounted in the right-hand head, the body *P* being of steel and having a shank *U* which enters the hole in the ram. The lower portion of this block is dovetailed and to it the sliding tool-holder *N* is fitted. The lug *O* enters a recess in the block *P* and gives a surface against which the spring *R* thrusts. This spring is of heavy section and is adjusted by means of the screw *Q*, the end of which is turned down to fit the inside of the spring and prevent it from buckling. The end *S* pilots in a hole in the lug. The cam roll *H* is of tool steel hardened and ground and it revolves on the cylindrical portion of the shouldered screw *K*, the thrust washer *J* being interposed between the roll and the block. The holder is rectangular in shape and accurately fits a slot in the slide *N*. The two screws *L* hold it in place and incidentally tie the open side of the slide together. The tool *M* enters the upper portion of the slot and is held in place by the two screws shown. It can readily be seen that the action of the spring *R* tends to force the slide *N* forward, thereby keeping the roll *H* continually in contact with the cam *G*. As the tool *M* is held in the slide *N* it is obvious that it will follow the path generated by the roll and produce the desired eccentric.

* * *

Notwithstanding the fact that high-speed steel has effected a revolution in machine shop practice generally, it is claimed that all the improvements in tool steels made in the last twenty years have not displaced certain brands of carbon steel for some classes of metal cutting. Among them is the turning of chilled cast-iron rolls. Carbon steel still holds its own. High-speed steel that gives good service on the toughest alloy steels falls down completely in roll turning. The cutting speeds are so low—from one to three feet per minute—that the red hardness characteristic of high-speed steel is not developed, and the superior hardness of carbon steel at low temperatures enables it to stand up to the work.

* * *

According to the latest statistics, there are approximately 1,140,000 automobiles in use in the United States. New York state has 133,000 automobiles, Illinois, 95,000 and Ohio 87,000. Pennsylvania comes fourth with 79,000 and Iowa fifth with 77,000. The smallest number of cars is in Nevada, where there are about 1150; Wyoming has 1600 and New Mexico, 2000 cars.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

LATHES FOR CUTTING THREADS OF COARSE LEAD AND ODD PITCH

The article in the April number of MACHINERY by Russell K. Annis describing an ingenious homemade device for cutting a spiral on a Lodge & Shipley lathe, and the discussion of the same matter by Guy H. Gardner in the June number, indicate that special thread gearing for lathes may be a suitable topic for general consideration. Those two articles describe methods of cutting what are in the true meaning of the word spirals, that is, plane curves. The other Lodge & Shipley equipments shown by the accompanying illustrations were designed for chasing coarse-pitch screws and worms (often spoken of as spirals) and may be of further interest.

Fig. 1 illustrates the rear of a 22-inch by 14-foot patent-head lathe and shows the additional special lead-screw at the back of the bed through which the coarse leads are obtained. This lathe is also provided with regular quick-change gearing, lead-screw, apron, etc., at the front for standard feeds and threads. When the coarse-pitch threading attachment is in use, the headstock back-gears are thrown into mesh and the drive is from the large back-gear through the change gears mounted on the bracket at the rear of the bed to the special lead-screw. This screw is solidly supported at frequent intervals by long shoes bolted to pads on the back of the bed.

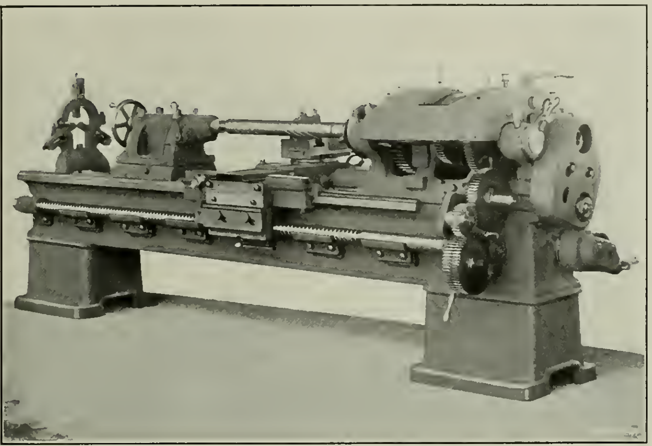


Fig. 1. Lodge and Shipley Lathe with Coarsa-pitch Chasing Attachment

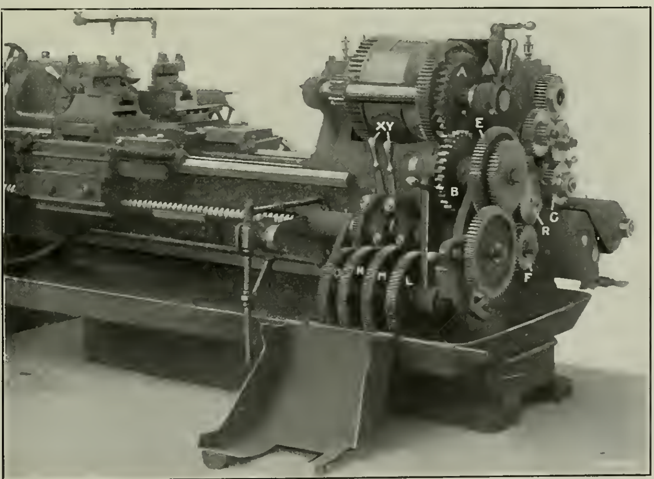


Fig. 2. Chasing Attachment for Metric, Whitworth and Module Coarsa Pitches

A long half-nut on the back of the carriage is so arranged that it may be raised or lowered by a cam so as to clear or engage the threads of the screw. This cam, which is clearly seen in the illustration, is operated by a handwheel at the front of the apron, which transmits motion through a pinion and sector located on the left carriage wing. For leads from 1/32 inch to 2 inches, the regular quick-change gears and screw at the front of the lathe are used. Leads from 2 inches to 15 inches are obtained by the coarse-pitch attachment at the back.

Fig. 2 shows the thread gearing of another 22-inch lathe which is arranged for chasing both standard and coarse-pitch threads, but with the addition to the coarse-pitch threading attachment just described of gearing to permit cutting the coarse pitches either in metric or Whitworth systems or module pitches in either. By "module pitches" we mean pitches being a multiple of π (that is, 3.1416) times the lead expressed either in millimeters or inches; a module pitch would be necessary for a worm which had to mesh with a gear the teeth of which were cut according to diametral pitch measurement. This lathe also has regular quick-change gears and a lead-screw for standard pitches. The initial driving gear *E* of the coarse-pitch threading attachment may be driven at two rates of speed. When driving from the sliding tumbler shaft through gears *C* and *R*, one set of leads is obtainable at the rear screw, coarser than the standard leads of the regular quick-change gearing. When the drive to gear *E* is from the back-gear shaft through gears *A* and *B*, the rear screw revolves much faster relative to the spindle than under the condition just named and, therefore, a set of still coarser leads will be obtained.

Change gears for different pitches may be placed on the quadrant below gear *E*. The same gears are used for both the metric and Whitworth leads because the translating gearing is placed between the quadrant and the screw. The four pairs of gears to the left of the quadrant comprise the metric and the module translating gears. When levers *X* and *Y* are in the positions shown, the four pairs of gears *L*, *M*, *N* and *O* are not operative, and the drive is direct from gear *F* through a long sleeve to the coarse-pitch screw. This gives coarse metric pitches because the screw has metric lead. Throwing handle *X* to the right engages the module translating gears *N* and *O*, and if handle *Y* remains as shown in the illustration, this would give module metric leads. Throwing handle *Y* to the right engages the metric to the Whitworth translating gears *M* and *L*; this will result in chasing Whitworth pitches if lever *X* is to the left, and Whitworth module pitches if lever *X* is to the right. Gear covers are provided to enclose all of the gearing.

Cincinnati, Ohio HENRY M. WOOD

CLOTH SCREENS FOR DRAFTING-ROOM WINDOWS

Few of the drafting-room problems are as serious as the elimination of dust and dirt from the boards, tables and drawings while maintaining a circulation of fresh air through open windows. Especially in the city shops and railroad offices is this most serious, where not only fine dust fills the air at all times but cinders and large matter is continually sifting through open windows onto drawings and, on account of its sooty condition, is not so easily or cleanly removed as the finer particles of dust.

While an ideal system of ventilation, without dust, is seldom secured except at a large expense, the following simple scheme can be depended on to give satisfactory service in eliminating the greater part of dust and soot from drafting offices and, at the same time furnishes practically the same circulation of air as the open windows. Frames, made to fit the window opening, similar in every respect to ordinary screen frames, covered with cheese cloth on both sides and placed in the window the same as wire screens, serve as an air strainer. The loose texture of the cloth permits the uninterrupted circulation of air and its gauzy strands strain out the soot and dust from the incoming air. Another feature of their use is that they eliminate the strong drafts. The space between the outer covering and the inner serves to further promote the free circulation of air and the thin inner covering still further eliminates the dust and dirt.

Such screens may be used either at the top or bottom of the window. They do not affect the lighting value of the open space materially, unless they are allowed to become too dirty and discolored, and they should be renewed when excessive dust has accumulated in the strands. It is desirable that the cloth used should be pre-shrunk and stretched slightly on the frame, as loosely covered openings tend to stop the free circulation of air. These screens can be installed at a slight expense and should be well worth the cost.

Winter Hill, Mass. FRANK H. JONES

FULL-SIZED DRAWINGS

Draftsmen who have had little or no practical experience in the pattern shop cannot understand why patternmakers in general so often "kick" against working from a reduced scale drawing. I have just completed four patterns made from a reduced scale drawing. Three of these drawings I was obliged to re-draw full size, to guard against mistakes in both shape and dimensions. A great many pattern shop foremen insist on reproducing all reduced drawings to full size; however, this should not be done by the patternmaker, as the draftsman has every convenience in the drawing-room, and this is where drawings should be made full size when possible.

If conditions call for a reduced drawing do not try to put every detail piece on one sheet in order—as our draftsman puts it— "to save tracing cloth and space in the filing drawer." Never offer this economy "stunt" to a patternmaker as an excuse for not drawing full scale, especially when he is struggling with one of these drawings in a shop where the patternmaker must work from the drawings furnished by the drawing office. I have worked in a number of shops where this is the rule, and it's a mighty poor rule.

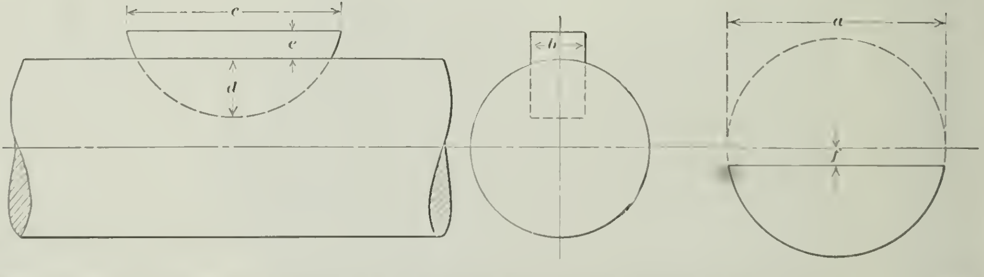
Give me a shop where the drawing—when it's possible—is made full size. Past experience has proved to me that in this shop the work is turned out at a low cost and with fewer mistakes in the drafting-room pattern shop and machine shop.

Detroit, Mich. JOHN GREEN

DIMENSIONS OF WOODRUFF KEYS

In the November, 1907, number of MACHINERY two data sheets were published giving the dimensions of Woodruff keys. The information given in these tables was undoubtedly useful, but they failed to show the depth to be milled in the shaft to receive different sizes of Woodruff keys. The writer had occasion to use this information, and being unable to find it, Tables I and II were compiled. These tables

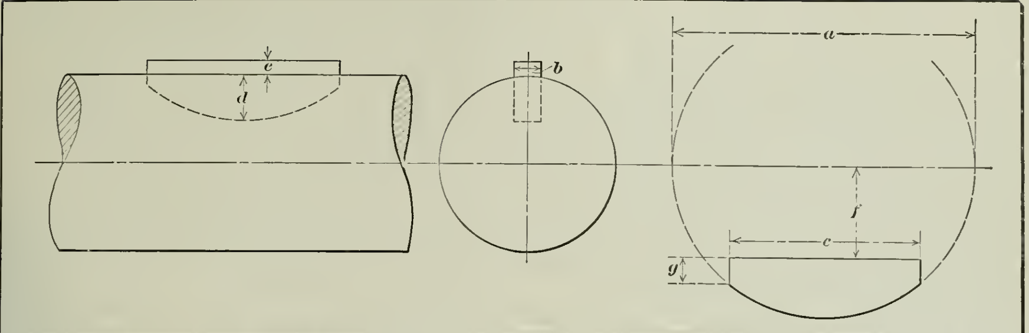
TABLE I. DIMENSIONS OF WOODRUFF KEYS



No. of Key and Cutter	Diameter of Cutter a	Thickness of Key and Cutter b	Length of Key c	Depth to be Cut in Shaft d	Depth of Keyway e	Center of Stock from which Key is made to Top of Key f	No. of Key and Cutter	Diameter of Cutter a	Thickness of Key and Cutter b	Length of Key c	Depth to be Cut in Shaft d	Depth of Keyway e	Center of Stock from which Key is made to Top of Key f
1	1/2	1/16	1/2	0.172	1/32	3/64	B	1	5/16	1	0.282	5/32	1/16
2	1/2	3/32	1/2	0.157	3/64	3/64	16	1 1/8	3/16	1 1/8	0.391	3/32	5/64
3	1/2	1/8	1/2	0.141	1/16	3/64	17	1 1/8	7/32	1 1/8	0.375	7/64	5/64
4	5/8	3/32	5/8	0.203	3/64	1/16	18	1 1/8	1/4	1 1/8	0.359	1/8	5/64
5	5/8	1/8	5/8	0.187	1/16	1/16	C	1 1/8	5/16	1 1/8	0.328	5/32	5/64
6	5/8	5/32	5/8	0.172	5/64	1/16	19	1 1/4	3/16	1 1/4	0.454	3/32	5/64
7	3/4	1/8	3/4	0.250	1/16	1/16	20	1 1/4	7/32	1 1/4	0.438	7/64	5/64
8	3/4	5/32	3/4	0.235	5/64	1/16	21	1 1/4	1/4	1 1/4	0.422	1/8	5/64
9	3/4	3/16	3/4	0.219	3/32	1/16	D	1 1/4	5/16	1 1/4	0.391	5/32	5/64
10	7/8	5/32	7/8	0.297	5/64	1/16	E	1 1/4	3/8	1 1/4	0.360	3/16	5/64
11	7/8	3/16	7/8	0.281	3/32	1/16	22	1 3/8	1/4	1 3/8	0.469	1/8	3/32
12	7/8	7/32	7/8	0.266	7/64	1/16	23	1 3/8	5/16	1 3/8	0.437	5/32	3/32
A	7/8	1/4	7/8	0.250	1/8	1/16	F	1 3/8	3/8	1 3/8	0.406	3/16	3/32
13	1	3/16	1	0.344	3/32	1/16	24	1 1/2	1/4	1 1/2	0.516	1/8	7/64
14	1	7/32	1	0.329	7/64	1/16	25	1 1/2	5/16	1 1/2	0.485	5/32	7/64
15	1	1/4	1	0.313	1/8	1/16	G	1 1/2	3/8	1 1/2	0.454	3/16	7/64

Machinery

TABLE II. DIMENSIONS OF WOODRUFF KEYS



No. of Key and Cutter	Diameter of Cutter	Thickness of Key and Cutter	Length of Key	Depth to be Cut in Shaft	Depth of Keyway	Center of Stock from which Key is made to Top of Key	Width of Flat	No. of Key and Cutter	Diameter of Cutter	Thickness of Key and Cutter	Length of Key	Depth to be Cut in Shaft	Depth of Keyway	Center of Stock from which Key is made to Top of Key	Width of Flat
	a	b	c	d	e	f	g		a	b	c	d	e	f	g
126	2 1/8	3/16	1 3/8	0.313	3/32	21/32	5/32	R	2 3/4	1/4	2 5/16	0.625	1/8	5/8	1/8
127	2 1/8	1/4	1 3/8	0.281	1/8	21/32	5/32	S	2 3/4	5/16	2 5/16	0.594	5/32	5/8	1/8
128	2 1/8	5/16	1 3/8	0.250	5/32	21/32	5/32	T	2 3/4	3/8	2 5/16	0.562	3/16	5/8	1/8
129	2 1/8	3/8	1 3/8	0.219	3/16	21/32	5/32	U	2 3/4	7/16	2 5/16	0.532	7/32	5/8	1/8
26	2 1/8	3/16	1 23/32	0.437	3/32	17/32	3/32	V	2 3/4	1/2	2 5/16	0.500	1/4	5/8	1/8
27	2 1/8	1/4	1 23/32	0.406	1/8	17/32	3/32	30	3 1/2	3/8	2 7/8	0.750	3/16	13/16	3/16
28	2 1/8	5/16	1 23/32	0.375	5/32	17/32	3/32	31	3 1/2	7/16	2 7/8	0.718	7/32	13/16	3/16
29	2 1/8	3/8	1 23/32	0.344	3/16	17/32	3/32	32	3 1/2	1/2	2 7/8	0.687	1/4	13/16	3/16
R_x	2 3/4	1/4	2	0.469	1/8	23/32	0.1625	33	3 1/2	9/16	2 7/8	0.656	9/32	13/16	3/16
S_x	2 3/4	5/16	2	0.437	5/32	23/32	0.1625	34	3 1/2	5/8	2 7/8	0.625	5/16	13/16	3/16
T_x	2 3/4	3/8	2	0.406	3/16	23/32	0.1625	35	3 1/2	11/16	2 7/8	0.593	11/32	13/16	3/16
U_x	2 3/4	7/16	2	0.375	7/32	23/32	6.1625	36	3 1/2	3/4	2 7/8	0.562	3/8	13/16	3/16
V_x	2 3/4	1/2	2	0.344	1/4	23/32	0.1625	..	..	..	...	.....	..	..	..

Machinery

are the same as those published in MACHINERY in 1907, except that they give the depth to be milled in the shaft and also the dimensions of new sizes of Woodruff keys which have been brought out since 1907. In milling the shaft to receive a Woodruff key, the shaft is brought against the cutter until a flat of the same width as the thickness of the cutter is formed; the cutter is then fed into the shaft to the required depth.

Indianapolis, Ind. FRANK E. SCHULTZ

OVERHEAD COST

What is "overhead"? It is something we pay for and for which we get the money from the customer afterward; or else we get it from the customer first and pay for it afterward. It is an unavoidable expense and nothing is a success if it is ignored, but it must be repressed and kept as unobtrusive as possible. The time has passed when any employer expects to cut wages or even to maintain them at the present level. On the contrary, the various payment schemes, with which all of us are more or less familiar, have been devised with the intent of encouraging the workman to earn more. Likewise the purchasing agent cannot hope for great, if any, reductions in the price of the material he buys, as it is largely affected by the cost of the labor entering into it.

The management can, however, very profitably study "overhead," and I venture to say there is not yet any business so perfectly managed as to render this study profitless. Efficiency consists not only in "speeding up" production, but also in "speeding down" non-production. We hear a great deal recently of the uselessness of "interlocking" directorates, but in many plants there is equally useless "interlocking" work. But at a casual glance every one seems busy and no one has any too much time to ascertain of just what this apparent industry consists. For example, the inspection department's rejections often cover minor defects which affect neither the utility nor the selling value of an article, yet the business must bear the expense of correcting the defect or consigning the material to the scrap heap.

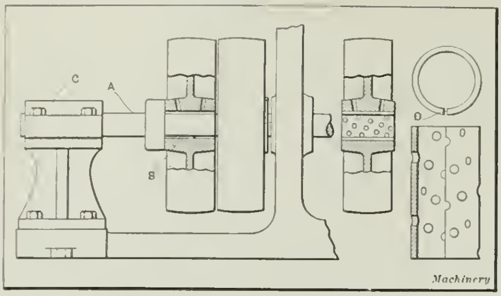
In our enthusiasm for scientific management we are too prone to engulf ourselves in a vast amount of red tape in putting work through the shop; and not infrequently we find material halted because a delivery slip has been lost, those who are responsible being more interested in proving that someone else lost it than in sending the work merrily on its way. Perhaps fixed charges are not so easily reduced, it being necessary to lay out considerable money, for instance, in order to obtain even a moderate reduction in insurance rates. But power is full of possibilities, and if any one has an opportunity to profit from the suggestion box, the engineer is that one. I have touched on only a few points, and but lightly on those; but this phase of manufacturing is as important as increased skill and labor saving invention.

Jersey City, N. J. H. D. MURPHY

BUSHING FOR A WORN LOOSE PULLEY

The accompanying illustration shows a method which we adopted some time ago in repairing a loose pulley which gave trouble through chattering. The shaft *A* on which this pulley was mounted was in such a position that considerable difficulty would have been experienced in removing it from the machine. As the bearing *B* was worn nearly 1/32 inch from the original size—although comparatively round—it appeared that the prevention of play between the shaft and pulley would be a difficult matter. Owing to wear of the shaft and pulley, this play amounted to considerably over 1/16 inch, the pulley being rather more badly worn than the shaft.

The method of procedure which we finally adopted was as follows: The housing *C* was removed and the loose pulley taken off and bored out sufficiently to receive the split bushing *D* which is shown enlarged at the right-hand side of the illustration. The bore of this bushing was machined out to the proper size to make it a good running fit on the worn part of the shaft and a sliding fit in the loose pulley. The bushing was then split on one side, as shown in the illustration,



Method of bushing a Worn Loose Pulley

and numerous holes were drilled to receive the lubricating grease. The bushing was then sprung over the large part of the shaft and pushed along to its position *B*, the split construction allowing the bushing to come together to fit snugly on the smaller diameter. A brass liner was placed in the slot, after which the pulley was slipped over the bushing. When the belt was put on and the machine once more placed in operation, it was found that a very satisfactory repair had been accomplished.

Hamilton, Ontario, Canada. JAMES H. RODGERS

SUB-PRESS PIERCING DIE

One day when I had finished a job on which I had been working for several hours, I went to the foreman and asked him for a new assignment. He handed me a piece of steel window sash and told me to make a set of dies for piercing it. The problem was a difficult one and I studied it for a long time before finally developing the sub-press die which forms the subject of the present article. In a shop where the tool designing is handled by a special department, it is possible that they might have accomplished the same result with less expenditure in time and effort, but the tool that I finally produced gave very satisfactory results. The piercing of these holes was formerly done by hand and required from one to two hours for each hole.

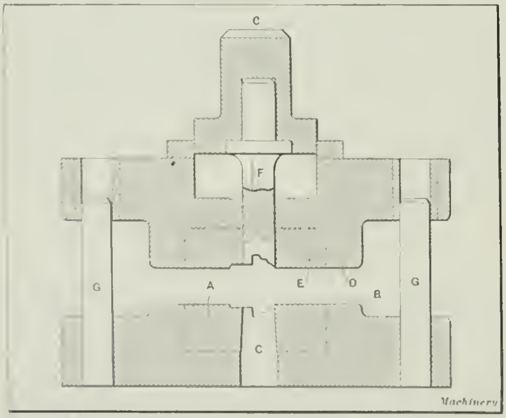


Fig. 1. Sub-press Die for piercing Metal Window Sash

This die is used in a double-acting press and a general idea of its construction will be obtained by referring to the cross-sectional view. The lower die *A* is made of tool steel and grooved across its top face to receive one-half of the section of the window sash to be pierced. This die is supported by the cast-iron bolster *B* and a hole *C* is cut through the die and bolster so that the piercings can drop out into a receptacle placed under the press to receive them. A cross-sectional view of the window sash is shown at *J* in Fig. 2 and the shape of the hole to be pierced is illustrated at *K*. The upper die-holder *D* is also made of cast iron and supports a tool steel die *E* which is machined similar to the lower die. This die also has a hole machined through it of the same shape as the hole in the lower die. This hole does not have any clearance, however, as it is provided for the piercing punch *F*. The cast-iron block *D* is fastened to the outer slide of the press, and the stroke of this slide can be adjusted by means of screws so that it comes down to a point where the faces of the dies *A* and *E* are almost in contact. In this position, the work is securely held in the transverse groove which runs across the faces of the die members. This will be readily understood by comparing the form of the dies with the cross-sectional view of the window sash shown at *J* in Fig. 2. The punch *E* is of tool steel and, as formerly mentioned, it pierces a hole of the form shown at *K* in Fig. 2. The punch is carried by the inner slide and is a snug working fit in the upper die. After the work is gripped between the dies, the inner slide descends and the punch *F* pierces the hole.

Four hardened and ground pins *G* are pressed into the bolster *B* and these pins slide in hardened bushings in the upper die-holder. These pins are provided for the usual purpose of maintaining absolute alignment between the upper and lower die members. Another form of steel window sash is shown at *S* in Fig. 2, a simple punch being used to cut out the slot shown at *L*. At *T*, the piece of sash shown straight at *R* is illustrated after it has been bent open so that the hole *K*—pierced by the die illustrated in Fig. 1—is enlarged to the form shown at *Q*. The piece of sash *S* is then slipped into this opening *Q* and moved along so that the slot *L* can drop over the flange at *O*. The piece *T* is then bent back around the piece *S* so that a firm joint is produced. The finished joint is shown at *U* in Fig. 2.

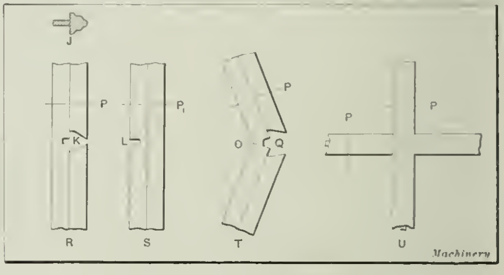
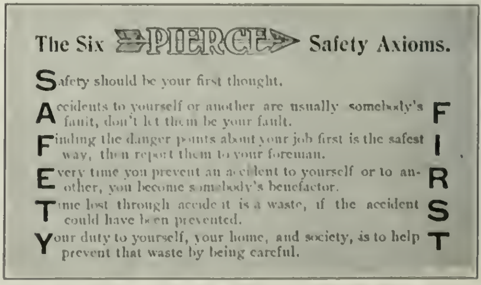


Fig. 2. Work done by Die shown in Fig. 1

Toronto, Canada. SPRING CRAIG

PIERCE-ARROW SAFETY AXIOMS

The Pierce-Arrow Motor Car Co., Buffalo, N. Y., has recently inaugurated a strenuous campaign with the view of eliminating the possibility of the occurrence of avoidable accidents in its plant. Realizing that success in such a movement is dependent upon cooperation between the employer and the employe, several methods of securing the workmen's interest in this movement have been adopted. A large bulletin board is used, upon which photographs, articles and notices



The Six PIERCE Safety Axioms.

Safety should be your first thought.

Accidents to yourself or another are usually somebody's fault, don't let them be your fault. F

Finding the danger points about your job first is the safest way, then report them to your foreman. I

Every time you prevent an accident to yourself or to another, you become somebody's benefactor. R

Time lost through accident is a waste, if the accident could have been prevented. S

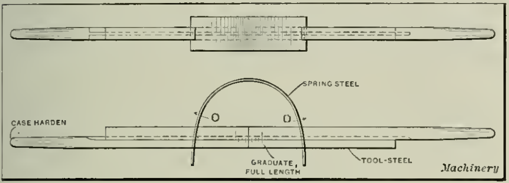
Your duty to yourself, your home, and society, is to help prevent that waste by being careful. T

Safety Axioms printed on Pierce-Arrow Pay Envelopes are posted, relative to ways and means for the prevention of accidents. Another useful idea consists of having what are known as the "Six Pierce-Arrow Safety Axioms" printed on the pay envelopes in which the men receive their wages. This calls the question of safety to the attention of the men in a very forcible way and it appears that the idea is one which other companies would do well to adopt.

Buffalo, N. Y. George B. Morris

ADJUSTABLE PIN GAGE

As the old-fashioned pin gage is still used by many machinists, I present a design of an adjustable gage which I worked up from a tool in the possession of a shop-mate. Although the gage in question was made more than fifty years ago, it would still be considered a useful tool for transferring sizes where a wide variation exists. The ability of this pin gage to stay set is surprising, and the quickness with which it can be adjusted for the requirements of a wide range of work—without necessitating the insertion of extra rods—is another strong point in its favor. The contact points at each end of the gage should be hardened and I would suggest graduations on the side reading to at least 1/16 inch. The arrows *O* represent the direction in which the tension of the spring acts.



An Adjustable Pin Gage

Denver, Colo. Stanley Edwards

DRILLING EQUI-DISTANT HOLES IN A STRAIGHT LINE

In Machinery for July, G. L. C. describes an excellent way of drilling a number of holes in a straight line, one inch between centers. There is another method which will, I think, give fully as accurate results in a somewhat shorter time. Two one-inch disks, such as we use for setting micrometers, are provided with bushings to suit the drill to be used. Fig. 1 shows the method, so a description is hardly necessary. The disks are clamped to the work, in contact with each other and with a straightedge located at the proper distance from the desired line of holes. When two holes have been drilled No. 1 disk is shifted to the place indicated by the dotted lines and No. 3 hole is drilled, and so on.

Of course, the same plan can be used for holes the centers of which are not one inch apart, by utilizing standard disks, if one has a pair of the required diameter, or, if these are lacking, by turning up a pair for the purpose.

A recent job required two rows of holes, as shown in Fig. 2, the holes being ⅞ inch between centers, the lines of holes also being ⅞ inch apart, and the holes "staggered." Two ⅞-inch disks, with their bushings, located the lower line of holes. To determine the diameter of the disk *D*, it was necessary to find the distance *x*, which proved to be 0.97828 inch. Subtracting from this 0.4375 inch (the radius of the ⅞-inch disk) leaves 0.54078 inch as the radius of *D*, which was accordingly made 1.0816 inch diameter.

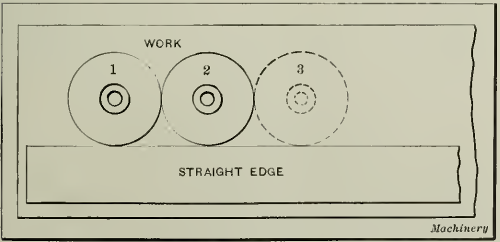


Fig. 1. Locating Equi-distant Holes in a Straight Line by Means of Disks and Straightedge

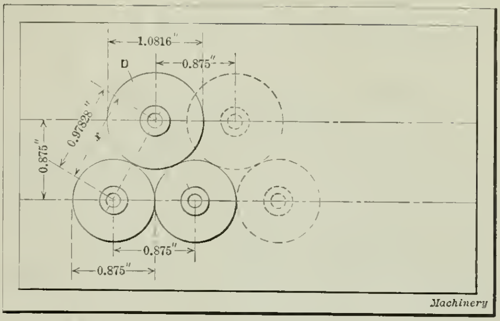


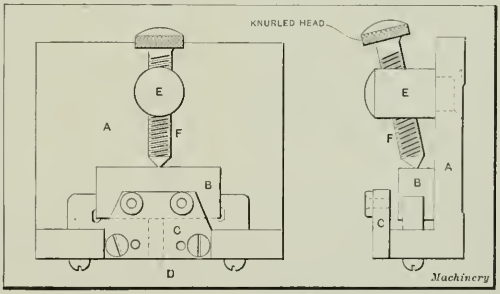
Fig. 2 Locating Parallel Rows of "Staggered" Holes by Means of Disks

Anyone who has much of this kind of work to do, whether in a jobbing shop or in toolmaking, will find that with a few drill bushings and disks (the latter made from machine steel, when hardened disks are not available) many jobs can be done quickly and accurately that without these simple aids would entail a considerable expenditure of time and trouble.

New London, N. H. Guy H. Gardner

DRILL JIG FOR RAPID PRODUCTION

A drill jig having several points of merit is shown in the accompanying illustration, which is presented in the hope that the same idea may be found of value in the design of tools for use in the production of similar classes of work. The base is a simple casting *A* which is provided with feet or pads and with a rib running along one edge. In order to explain the operation of this tool, assume that the work to be drilled is shown at *B*, the piece having two holes to be drilled in it. For locating these holes a bushing plate *C* is fastened to the top of the rib on the base casting, and is fitted with bushings of the required size. A hole *D* is drilled through the rib to provide for the use of a knock-out pin, should it be required.



Drill Jig with Quick-acting Clamp

This completes the jig with the exception of the locking mechanism which is its chief feature. The shoulder post *E* is riveted to the base so that it can just be turned with the thumb and finger. Then a knurled headed screw *F* with a conical point is mounted in the post *E*, as shown in the illustration. The screw *F* is used for clamping the work in the jig and provides sufficient leverage so that the post *E* can be easily turned. When the drilling has been finished on a piece, less than half a turn releases the screw *F*, after which the screw is turned through 90 degrees so that the work may be lifted out of the jig and a fresh piece substituted in its place. It is evident that this arrangement is the means of saving a great amount of time which would otherwise be occupied in screwing up the clamp-screw to engage the work and then loosening it sufficiently to enable the finished piece to be removed from the jig.

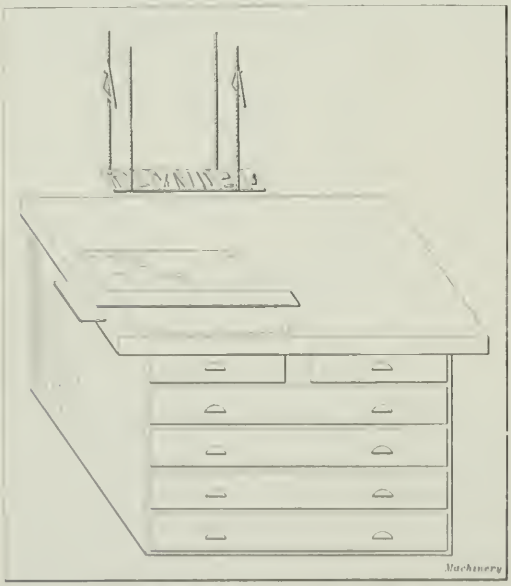
Middletown, N. Y. **Donald A. Hampson**

HANGING SHELF FOR DRAWING INSTRUMENTS

Every draftsman knows how difficult it is to keep drawing instruments convenient and safe under ordinary conditions. If they are put on the drawing table they are sure to be temporarily lost by being covered with drawings or other papers; or worse, they will be pushed off the table and be more or less damaged. Many draftsmen try to overcome this difficulty by keeping the instruments in a drawer, but as this interferes with movement around the desk and necessitates keeping some tools on the board, it does not obviate the trouble.

However, the arrangement which is here described avoids these objections and while not at all complicated gives the draftsman greater freedom in moving about the table and arranging the various implements and accessories which he must use from time to time. This arrangement consists of a plate glass shelf hanging over the drawing table. The shelf should be held up by chains secured to the ceiling and should be fastened to them in a way that will prevent the chains from creeping along the shelf. This can be accomplished by stretching a rubber band across the glass and tying it to the chains. This arrangement will usually give the necessary friction to keep the shelf in place on the chains. The height of the shelf should be about six inches above the draftsman's eyes when working over the board; this will prevent him hitting his head against it and also enable him to look up and see where his tools, books, etc., are located on the shelf. This height is also convenient for him to reach, especially when he wants one of the drawing instruments.

By using chains for supporting the shelf, the draftsman can readily insert hooks in the links to hold his triangles, T-square and other special and somewhat unwieldy tools. To provide means for separating the various kinds of drawing instruments, all that is necessary is to place rubber bands around the shelf, as only a small ridge is required for the purpose. Ink can be placed on the shelf when not in use; at other times it is essential to have it on the drawing board, and, of course, it should be in a substantial holder to prevent it being knocked over. The only other feature that it is often necessary to look out for is the electric light which the draftsman may have over his desk, and this in many cases can be tied to the shelf itself.



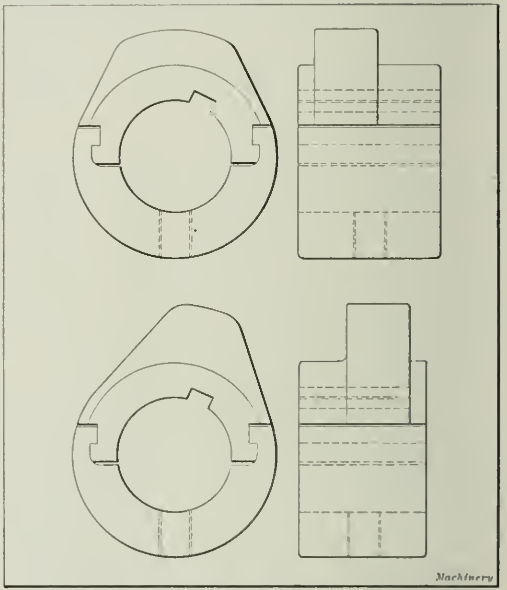
Convenient Hanging Shelf for Drawing Instruments

A shelf of this kind is remarkably convenient after it has been in use for a little while, because it then becomes an easy matter to raise one's hand to the shelf for whatever is desired. The transparency of the glass makes the actual location of all accessories apparent, and it is safe to say that the draftsman, after once becoming used to such a shelf, will wonder how he ever got along without it. The saving it makes in lessening the knocking of instruments and pencils off the drawing board more than pays for any cost it may entail.

Washington, D. C. **A. P. Connor**

SLIP-ON ASSEMBLING CAMS

The accompanying illustration shows special assembling cams used for locating the exhaust and intake cams on heavy gas engines. It will be seen that these cams are made in two parts which are dovetailed together, the purpose being to make them so they will be convenient for use in the assembling department. The cams are exact duplicates of the regular type used on these engines except for the fact that they are made in two parts. They are fastened in place on the shaft of the assembled engines and enable accurate measurements to be made for the locations of the regular cams, thus doing away with any guesswork. After the locations have been determined, the keyways are cut in the crankshaft and the regular cams assembled in place. These special cams also afford a convenient method of trying out cam rollers, push rods, etc., before the regular cams are assembled on the shaft. It will be evident that the dovetailed arrangement enables the cams to be readily put on and taken off the shaft, as often as necessary, without requiring the shaft to be removed from the case. M. W. W.



Slip-on Cams for locating Regular Exhaust and Intake Cams on Heavy Gas Engines

SETTING TOOL WHEN CUTTING MULTIPLE THREADS

The accompanying table gives the distance to move the lathe carriage back when cutting multiple threads in order to locate the tool for cutting the other thread groove or grooves, as the case may be. For example, when cutting a double thread having $1\frac{1}{8}$ thread per inch (that is, $1\frac{1}{8}$ turn per inch of one of the double threads), first complete one of the thread grooves, then stop the lathe, disengage the lock-nuts and move the carriage back four inches (as shown by the table); then close the lock-nuts at this point, and if the tool is not back far enough to begin the cut, reverse the lathe and run the carriage back to the desired position.

The distance to move the carriage back may be determined by the following rule: Multiply the number of threads per inch by a number that will give a whole number as the result. Divide the product by the figures 2, 3 or 4 (depending upon whether the thread is double, triple or quadruple), and multiply the quotient by the lead of the thread; the result will be the distance to move the carriage back for locating it for the next cut. If the final result is not a whole number, the number of threads per inch in the lead-screw must be divisible by the denominator of the fraction in the final result.

To illustrate the application of the rule, suppose a triple thread is to be cut having 2½ threads per inch. 2½ × 2 = 5, and 5 ÷ 3 (this being a triple thread) = 1.66. The lead of the thread = 1 ÷ 2½ = 0.40. Multiplying 1.66 by 0.40 = 0.664, or 2/3 inch; hence, if the tool is moved back 2/3 inch it will be located for taking the next cut, although it may be necessary to reverse the lathe in order to bring the tool back to the starting point at the end of the work.

It was not the intention of the writer to refer to the cutting of worms of coarse pitch, but there is one example of this work which may be of interest to the younger men, although well known to older machinists. A worm having a lead of 3 inches had to be cut on a cast-iron blank 6 inches long. This required two turns of the blank while the lathe carriage or tool traveled 6 inches. The tool was fed in the usual way for the first cut, and after closing the lock-nuts the tool was placed within 1 inch of the end of the blank, after which the lathe was stopped. A chalk mark was then put on the end of the blank at the height of the tool. When taking the following cuts, it was not necessary to stop the lathe at the end of each cut. The lock-nuts were disengaged, the carriage run back to within 1 inch of the end of the blank, and when the chalk mark came around to the top of the tool, the nuts were closed. When using this method, the lock-nuts must be closed promptly when the time arrives, for if they are not engaged with the proper threads on the lead-screw, something will happen before the tool can be moved out.

La Salle, N. Y. C. H. LAKE

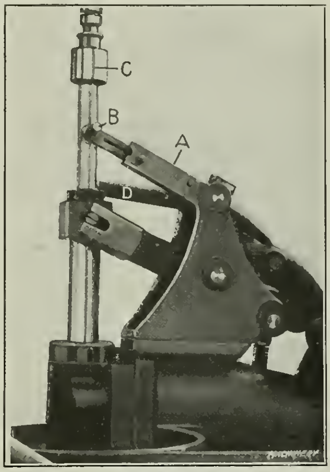
DISTANCE TO MOVE LATHE CARRIAGE FOR SETTING TOOL WHEN CUTTING MULTIPLE THREADS

Threads to be Cut, per Inch	Threads per Inch required on Lead-screw	Distance to Move Carriage, Inches
Double Threads		
1	Even	1/2
1 1/8	Any	4
1 1/4	Any	2
1 3/8	Any	4
1 1/2	Any	1
1 5/8	Any	4
1 3/4	Any	2
1 7/8	Any	4
2	4, 8, 12	1/4
2 1/8	Any	4
2 1/4	Any	2
2 3/8	Any	4
2 1/2	Any	1
2 5/8	Any	4
2 3/4	Any	2
2 7/8	Any	4
3	Even	1/2
3 1/8	Any	4
3 1/4	Any	2
3 3/8	Any	4
3 1/2	Any	1
3 5/8	Any	4
3 3/4	Any	2
3 7/8	Any	4
4	8, 16	1/8
4 1/8	Any	4
4 1/4	Any	2
4 3/8	Any	4
4 1/2	Any	1
4 5/8	Any	4
4 3/4	Any	2
4 7/8	Any	4
5	Even	1/2
5 1/4	Any	2
5 1/2	Any	1
5 3/4	Any	2
6	4, 8, 12, 16	1/4
Triple Threads		
1	3, 6, 12	1/3
1 1/4	3, 6, 12	1 1/3
1 3/4	3, 6, 12	1 1/3
2	6, 12	1/6
2 1/2	3, 6, 12	2/3
2 3/4	3, 6, 12	1 1/3
3	9	1/9
3 1/4	3, 6, 12	1 1/3
3 1/2	3, 6, 12	2/3
4	3, 6, 12	1/3
Quadruple Threads		
1	4	1/4
1 1/4	Any	1
1 1/2	Even	1/2
1 3/4	Any	1
2	8, 16	1/4
2 1/4	Any	1
2 1/2	Even	1/2
2 3/4	Any	1
3	4, 8	1/4
3 1/4	Any	1
3 1/2	Even	1/2
3 3/4	Any	1
4	16	1/16

Machinery

IMPROVED TAPPING MACHINE

The accompanying illustration shows the top of a Garvin automatic tapping machine equipped with an auxiliary tripping lever *A*. I designed this lever to adapt the machine for handling certain classes of work, and found that it greatly increased the rate of production. The auxiliary lever is made to clamp onto the hub of the regular tripping lever on the machine, and may be moved out of the operating position when so desired. The lever carries a roller on the outer end of the slide, the slide being telescoped back into the body *A* when it is desired to throw the auxiliary lever out of action. A handle *B* is provided for adjusting the position of the slide.



Auxiliary Tripping Lever applied to Garvin Tapping Machine

Those who are familiar with this type of tapping machine know that the adjustable stop *C* can be set to come in contact with the tripping lever *D* to reverse the direction of rotation of the tap at the desired point. The reversal is secured by means of a clutch located between pulleys which drive in opposite directions. In performing tapping operations on work which has surfaces at different heights from the work-table or where holes are to be tapped to different depths, it is obviously necessary to reset the position of the stop *C*. To avoid this difficulty, the auxiliary lever *A* was provided. This lever can be set to reverse the machine in tapping holes to a given depth, and after such holes have been finished, the auxiliary lever can be pushed back out of the way to enable the stop *C* to engage with the regular reversing lever *D* for tapping the remainder of the holes.

Buffalo, N. Y. W. W. LAWYER

ALLOWANCES IN PIPE BENDING

I have just been reading the article by William F. Fischer, "Steam Power Plant Piping Details," in the July number of MACHINERY, and am much interested in his methods of calculating the length of straight pipe required for bends. It is, of course, a matter of trigonometry as far as theory goes, but there is a practical point which has escaped him. I spent a number of years in the engineering department of a large corporation which used a great many pipe bends, and their practice was to reduce the theoretical length of the curved portion about five per cent. In other words, their experience showed that the work of bending the pipe caused a slight elongation on the center line; the neutral axis, instead of being on the center line, appeared to be about half way between the center line and the inner side of the bend. This made the length of a 90-degree bend $1.5 \times R$ instead of $1.57 \times R$, and of a 180-degree bend $3 \times R$, which greatly simplifies the figuring.

Their standard radius of bend was six times the nominal diameter of the pipe, so that the above rule would apply, possibly, only to bends of that radius. As they never varied the radius for a given size of pipe, owing to the cost of the dies, I am not prepared to say what the effect would be with bends of shorter or longer radius. While the inaccuracy due to using the theoretical method given by Mr. Fischer might be negligible in the case of small pipes, and could probably be adjusted in the majority of cases, it would evidently be serious in the case, say, of a 90-degree bend of 10-inch pipe, having a radius according to the above standard of 60 inches, which would give a discrepancy between the theoretical and practical methods of 60 × 0.07 = 4.2 inches.

The standard practice described was found to give excellent results with full-weight pipe up to 12 inches in diameter, and a few bends were made during my experience of 16 inches outside diameter pipe with the same results. This company had many miles of lines of 12-, 10-, and 8-inch pipe, and used 180-degree bends or 90-degree bend offsets to take care of expansion, placing them 200 to 250 feet apart.

Cleveland, Ohio R. A. Wright

In reading over the above criticism to my article, "Steam Power Plant Piping Details," which appeared in the July number of Machinery, I was somewhat surprised at Mr. Wright's method of calculating the length of straight pipe necessary for 90- and 180-degree pipe bends. Before proceeding further I wish to say that the method of calculation which I employ and which I recommend in my article has been used by several of the largest pipe bending concerns in this country, and, as far as I know, is still in general use. Several years ago, while employed as chief draftsman by a large manufacturing concern in the East, making a specialty of large steel and wrought iron pipe bends, I was called upon to compute the dimensions of all types of pipe bends, and also to check the dimensions of the bends figured by my assistants before the sketch sheets were sent to the bending shop. I made these computations regularly for a period of between four and one-half and five years and always employed the method of calculation which I describe and recommend in my article, making no allowance for any slight elongation of the pipe which in some cases is apt to occur during the bending process. Without going into actual figures I might safely say with some degree of certainty that I have figured at least nine hundred or one thousand pipe bends ranging in size from the smallest pipe size up to 22 inches in diameter. These bends were made up in the shop from our bending sheets and carefully checked afterwards for possible errors before shipment. The only time, to my knowledge, that any of these bends failed to measure up correctly to dimensions was when one of my assistants or myself made an error in our calculations, that is, an error in calculating the proper length of pipe to be cut and flanged ready for the bender. Furthermore I believe if Mr. Wright will go to the trouble of writing to several pipe manufacturers who make a specialty of bending large pipe that he will learn that they, too, calculate the length of straight pipe as I did.

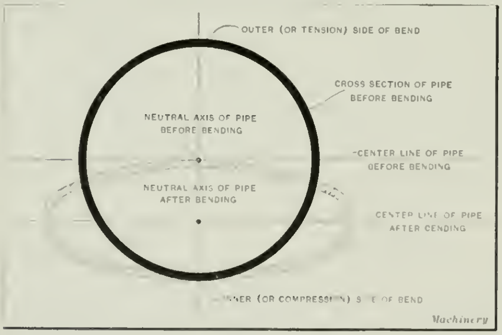

OUTER (OR TENSION) SIDE OF BEND
CROSS SECTION OF PIPE BEFORE BENDING
NEUTRAL AXIS OF PIPE BEFORE BENDING
CENTER LINE OF PIPE BEFORE BENDING
NEUTRAL AXIS OF PIPE AFTER BENDING
CENTER LINE OF PIPE AFTER BENDING
INNER (OR COMPRESSION) SIDE OF BEND
Machinery

Illustration showing Approximate Shape assumed by Pipe if Neutral Axis should change its Location during bending as indicated

Knowing that my method of calculating pipe bends has proved correct in practice as well as in theory, I do not hesitate to recommend what I know to be a correct method of calculation. The fact that the corporation mentioned in Mr. Wright's letter found it necessary to make a five per cent allowance for elongation, together with the statement that "the neutral axis of the finished bend, instead of being on the center line of the pipe, appeared to be half way between the center line and the inner side of the bend" does not convince me that I am in error, but rather that the bends referred to in Mr. Wright's letter, whether of large or small diameter, were greatly distorted during the bending process, and were not curved to a true radius. This would account for the discrepancies in the dimensions of the finished bends. In nearly all cases where large pipes are bent over forms or dies without first being filled with sand and well rammed to pack the sand tight, the pipe will assume a flattened or oval shape in cross-section during the bending process. Judging from Mr. Wright's statements this is exactly what happened to the bends mentioned in his letter, as I will show below.

Returning again to Mr. Wright's statement, "The neutral axis of the pipe, instead of being on the center line of the pipe, appeared to be half way between the center line and the inner side of the bend," tends to prove that the bends, when finished, must have appeared in cross-section, about as shown by the dotted lines in the accompanying illustration. Evidently Mr. Wright is in error regarding this particular point, as the illustration shows what would occur if his statements were correct. The pipe, as shown, would be flattened to about one-half its original diameter in bending. Furthermore, before assuming this shape in cross-section the pipe would buckle so badly on the compression side of the bend as to make the bend worthless when finished. (See also Fig. 68 and description of same in the July number of Machinery.) Filling with sand and ramming well before bending tends to prevent the pipe from flattening, provided, of course, that the bend is not curved to too small a radius. If the bend is curved to a true radius and does not flatten to any great extent in bending, it will not elongate to any great extent on the center line or neutral axis of the pipe, but will act similarly to a loaded beam which deflects under the load, with the upper fibers in compression and the lower in tension. In other words, the upper fibers of the material, on the tension side of the bend, are stretched, and the lower fibers, on the compression side of the bend, are shortened, but the neutral axis remains the same, or very nearly the same length before and after the pipe is bent to shape. Any slight elongation of a pipe bend can readily be taken care of by the bender when truing up the finished bends to dimensions.

Attention may also be called to the Crane Co.'s pocket catalogue No. 40, May, 1912, page 499, giving dimensions of standard pipe bends. Take, for example, the 14-inch U, or 180-degree bend, No. 4. Radius R is 70 inches. Length of straight (X), each end of bend, 16 inches. The lineal feet of pipe in a bend of these dimensions is given as 21 feet. Referring to the July number of Machinery, Fig. 70, we find that the length of straight pipe required to make a 180-degree bend of the above dimensions would be as follows:

Length of straight pipe $= 2 \times F + 3.14R = 2 \times 16 + 3.14 \times 70 = 32 + 219.8 = 251.8$ inches, or 20 feet 11.8 inches, as against 21 feet given in the catalogue.

To conclude, I would therefore say that as far as I know it is not customary to make allowance for elongation of the pipe during the bending process, but as different designers and manufacturers vary considerably in their customs, I am not prepared to say that all manufacturers compute their bends in the same manner as I describe and illustrate. I can say, however, that during my fourteen to fifteen years experience with power plant pipe work I have never heard of one case in which the piping manufacturer made any such allowance for elongation as mentioned in Mr. Wright's letter.

New York City. William F. Fischer

* * *

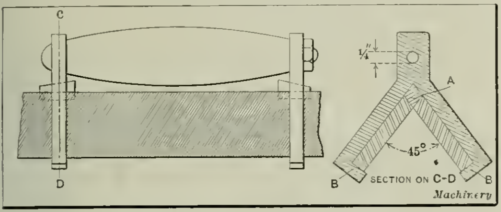
The Calumet and Hecla Mining Co. has developed a new process for treating the waste sands of its dumps. For fifty years, the sands have been dumped into Torch Lake and over 30,000,000 tons containing an average of sixteen pounds to the ton of copper have accumulated. The new regrinding and leaching process applied to these sands will extract over ten pounds of copper to the ton, reducing the copper losses to a little over two pounds to the ton.

SHOP AND DRAFTING-ROOM KINKS

INGENIOUS MEANS AND SHORT CUTS FOR SAVING LABOR AND MATERIALS

A FILING KINK

There are few machinists who have not been cut by the rough edges of pieces of tin or other sheet metal used to form dash plates of machines and for similar purposes. When such pieces are cut with a shear, there are numerous rough burrs which are capable of giving one a nasty cut. The ordinary method of removing such burrs is a tedious operation, and there are probably few jobs that are more likely to be slighted when put in the hands of the average workman. To eliminate the tedious character of this work and also to increase the workman's efficiency, the following will be found a very useful "kink."



Convenient Method of filing down Sharp Edges

Referring to the illustration it will be seen that two files are clamped together by means of two inexpensive forgings. These forgings are drilled to receive a bolt which holds them in position at each end of a wooden handle. The files are held in place by means of the wedges *A* and the shoulders *B* at the bottom of the forgings. The feet *B* are made slightly wider than the thickness of the files, as this makes the binding action of the bolt more effective. Using this tool, both sides of a piece of sheet metal are filed simultaneously and a few strokes—changing the angle of the tool at each stroke—produce a very smooth round edge. Since the greater part of the files is brought into use when thus applied, the method is also the means of effecting a saving in the number of files used.

Stillwater, Minn. R. C. MacLachlan

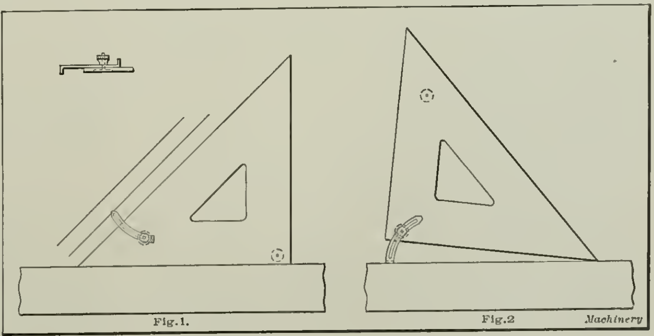
ATTACHMENT FOR 45-DEGREE TRIANGLE

The accompanying illustration shows an inexpensive, yet useful, attachment for any forty-five degree triangle, to facilitate the drawing of equidistant parallel lines for representing a section or the drawing of numerous small angles. The attachment consists of a slotted curved arm, with one end pointed and bent down, and the other end flat and bent in the opposite direction. This arm is held to the triangle by a screw with a large thin flat head and a knurled nut.

By setting the arm at a given distance a series of equidistant parallel lines may be drawn by moving the triangle along the edge of the T-square or ruler until the pointed end is over the last line drawn, thereby bringing the edge of the triangle into position to draw another line. (See Fig. 1.)

By changing the attachment from the position in Fig. 1 to another hole in the triangle located as shown in Fig. 2, and reversing the arm so that the flat end is down and against the guiding edge, either side of the triangle can be set at any desired small angle.

Hartford, Conn. Henry E. Gerrish



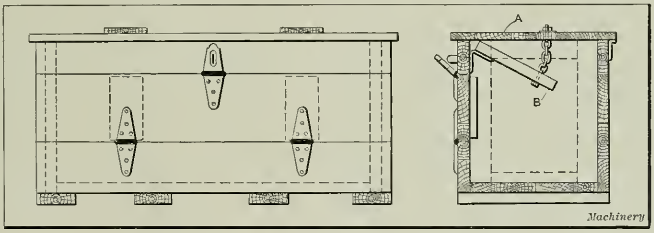
45-degree Triangle with Attachment for drawing Equidistant Parallel Lines and Small Angles

SCRAP BRASS BOX

The accompanying illustration shows the design of a box used for scrap brass or other valuable material. In the shop where the writer is employed, considerable trouble was experienced in keeping such material in ordinary boxes secured with padlocks. It was necessary for several people around the shop to have a key to the box and this made it very difficult to fix the responsibility when material was stolen. After several attempts had been made to overcome this difficulty, we designed the box which forms the subject of this article. It will be evident from the illustration that the material kept in it is absolutely safe and still the box can be opened to allow anyone in the shop to place material in it without requiring the use of a key.

It will be seen that the box has two doors. The door at the side is kept locked at all times, except when it is required to remove material from the box. The door at the top is used for dumping scrap into the box. The top door is double, and when the upper door *A* is lifted, a chain connected to it pulls up an auxiliary door *B* which is hinged to the inside of the box. The arrangement is such that the top door can be raised only about eight inches before the lower door has reached the highest point of its travel. When the upper door has been raised eight inches, the lower one is in a horizontal position and closes the box. The material which is to be put into the box is dropped in onto the top of the lower door, and when both doors are dropped, the lower one is inclined at an angle of about 45 degrees, allowing the material to roll off it into the box. It will be evident that it is impossible for material to be taken out except through the side door, and as only one man has a key to this door he is held strictly responsible for the contents of the box which are entrusted to his care.

Poughkeepsie, N. Y. R. F. Calvert



Scrap Brass Box which prevents Material from being stolen

* * *

The Geological Survey reports that the value of metal recovered from waste and scrap during 1913 was $73,000,000.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

INSPECTING LARGE WORM-WHEELS

T. E. M.—I would be interested in seeing an article dealing with the best method of inspecting or checking large worm-wheels. It is our practice to cut wormwheels on a machine which feeds the hob radially into the gear. Some of the hobs have inserted teeth which do not cut the throat and consequently in some sizes the throat is uncut with relation to the teeth and the ordinary method of measurement by calipers is not feasible. It is possible to provide a vernier measuring the distance between two cones having profile dimensions equivalent to a meshing rack tooth, but this method is expensive and because of the weight of the vernier, which would have to be about three feet long, it is not very accurate. Probably this problem has been solved by others and information may be available on the subject although it has never been published.

This inquiry is referred to our readers for discussion.

CUTTING ASBESTOS BOARD

C. F. J.—Can you tell me how to cut asbestos board one-half inch thick economically? We have been using a saw, but the saw dulls very quickly.

A.—The H. W. Johns-Manville Co., New York City, advises the use of an ordinary wood-working saw table with circular saw sixteen inches diameter, ten gage, five teeth to the inch. It is true that the asbestos board dulls the saw quickly, but the company overcomes this difficulty by using automatic saw setting and filing devices, the plant being equipped with these devices to put the saws in good order quickly. The saving of time effected by the use of the circular saw much more than compensates for the loss of time and labor caused by frequent sharpenings.

DIMENSIONS OF FOUNDATION BOLTS

G. C. H.—A 3-inch foundation bolt is to have an enlarged lower end to receive a steel cotter pin. It is required to compute the necessary dimensions so that the lower end of the bolt and the cotter pin will have the same strength as the smaller section of the bolt in which the thread is cut. The bolt is made of wrought iron which has a tensile strength of 50,000 pounds per square inch, a shearing strength of 45,000 pounds per square inch and a crushing strength of 50,000 pounds per square inch. The cotter pin is made of steel which has a shearing strength of 68,000 pounds per square inch and a crushing strength of 75,000 pounds per square inch.

Answered by William L. Cathcart

The bolt is to be of wrought iron and the key of forged steel. Taking the working stresses as given, we have:

S_t = tensile strength of wrought iron = 50,000 pounds per square inch;

S_c = crushing strength of wrought iron = 50,000 pounds per square inch;

S_s = shearing strength of wrought iron = 45,000 pounds per square inch;

S_c' = crushing strength of steel = 75,000 pounds per square inch;

S_s' = shearing strength of steel = 68,000 pounds per square inch.

Let:

d = diameter of bolt at root of thread = 2.629 inches;

a = area of cross-section of bolt at root of thread = 5.429 square inches;

D = diameter of enlarged section of bolt;

A = area of enlarged section of bolt;

t = thickness of key;

b = width of key at middle of keyway;

h = depth of bolt below key at middle of keyway;

W = total axial load which bolt can sustain = $S_t \times a$ = 271,450 pounds.

For maximum economy of metal, all sections of both the bolt and key which are under strain should be equally strong, i. e., each such section should have the same strength as that of the bolt at the root of the thread. Failure may occur by:

(1) Rupture of bolt at root of thread, as shown at *B*, Fig. 2. The total stress resisting rupture is equal to the product of the area *a* of the bolt and the tensile strength:

$$W = S_t \times a = S_t \times 0.7854\ d^2 = 39{,}270\ d^2 \qquad (1)$$

(2) By rupture of the slotted section of the bolt, as shown at *C*. The resisting stress is equal to the product of the area of the cross-section of the bolt and the tensile strength:

$$W = S_t\ (A - Dt) = S_t\ (0.7854\ D^2 - Dt) = 39{,}270\ D^2 - 50{,}000\ Dt \qquad (2)$$

(3) By the crushing of the metal at the bottom of the keyway, as shown at *E*. The resistance to this crushing is equal to the area of the base of the keyway times the crushing strength:

$$W = S_c \times D \times t = 50{,}000\ Dt \qquad (3)$$

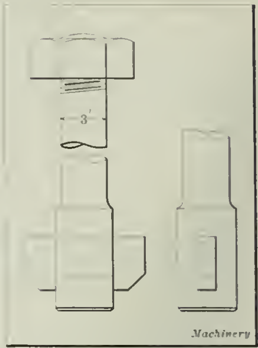


Fig. 1. Type of Foundation Bolt for which Dimensions are to be determined

(4) By the shearing of a vertical section of the bolt below the keyway and equal in width to the key, as shown at *F*. Since both side of this section must be sheared simultaneously, the resistance to shearing is equal to the product of the shearing strength and twice the area of one side:

$$W = S_s \times 2(D \times h) = 90{,}000\ Dh \qquad (4)$$

(5) By crushing the key at the contact-surface between it and the keyway, as shown at *E*. The total resisting stress is equal to the product of the crushing strength of the metal of the key and the area of the keyway, or

$$W = S_c'\ (D \times t) = 75{,}000\ Dt \qquad (5)$$

The same action occurs at the bearing of the key on the foundation plate. The area of bearing surface at these points should be at least equal to that of the keyway.

(6) By shearing the key where it enters and leaves the bolt, as shown at *H* and H_1. Since there are two sections of the key to be sheared simultaneously, the total stress resisting shearing is equal to the product of the shearing strength

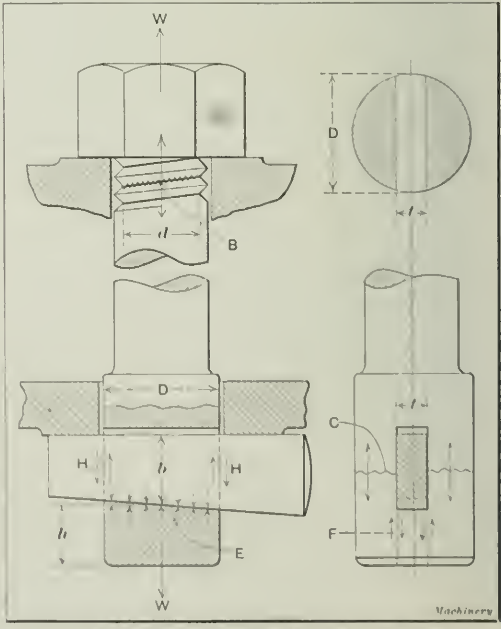


Fig. 2. Condition of Foundation Bolt when under Stress

of the metal by twice the mean cross-sectional area of the key:

$$W = S_s' \times 2\,(b \times t) = 136{,}000\ bt \qquad (6)$$

To obtain a strength at each of these various sections under strain, which shall be equal to that of the bolt at the root of the thread, it is evident that the equation giving the resisting stress in each case must be equated with Equation (1), and then the unknown values D, t, b, and h can be found by successive substitutions. Thus, to find the diameter D, equating Equations (5) and (1) we have:

$$75{,}000\,Dt = 39{,}270\,d^2$$
$$Dt = 0.524\,d^2 \qquad (7)$$

Equating Equations (2) and (1), we have:

$$39{,}270\,D^2 - 50{,}000\,Dt = 39{,}270\,d^2$$

Substituting and transposing in the preceding expression and in Equation (7) we have:

$$39{,}270\,D^2 = 65{,}470\,d^2$$
$$D^2 = 1.66\,d^2$$
$$D = 1.29\,d = 3.39 \text{ inches} = 3\ 7/16 \text{ inches} \qquad (8)$$

To find the thickness t, we proceed by equating Equations (5) and (1):

$$75{,}000\,Dt = 39{,}270\,d^2$$

Since $D = 1.29\,d$, we have by substituting and transposing:

$$96{,}750\,dt = 39{,}270\,d^2$$
$$t = 0.406\,d = 0.406 \times 2.629 = 1.067 \text{ inch} = 1\tfrac{1}{8} \text{ inch} \qquad (9)$$

To find the width b, we proceed by equating Equations (6) and (1):

$$136{,}000\,bt = 39{,}270\,d^2$$

Since $t = 0.406d$, we have by substituting and dividing by d:

$$55{,}216\,b = 39{,}270\,d$$
$$b = 0.711\,d = 0.711 \times 2.629 = 1.869 \text{ inch} = 1\tfrac{7}{8} \text{ inch} \qquad (10)$$

To find the depth h, we equate Equations (4) and (1):

$$90{,}000\,Dh = 39{,}270\,d^2$$

Since $D = 1.29d$, we have by substituting and dividing by d:

$$116{,}100\,h = 39{,}270\,d$$
$$h = 0.338\,d = 0.889 \text{ inch} = 15/16 \text{ inch.}$$

It will be observed that the values of the various dimensions deduced as above depend wholly on the working stresses assumed. Any change in these stresses will make a corresponding change in these dimensions. In any event, the latter are subject to some alteration, owing to the conditions of practice.

* * *

PRINCIPLES OF MOLDING

BY J. A. SHELLY*

The subject of molding has been fully covered in technical books and magazines by men who are recognized experts in that particular line, but these writers have usually written for the benefit of the foundryman, and their works have conveyed but little information to those not directly engaged in the trade. It is not the writer's intention to present a treatise on molding, but so many questions are asked in the shop by draftsmen and others whose work is closely related to the molder's that a brief explanation of the various methods pursued in the foundry on different classes of work may be of interest to many readers of MACHINERY.

All sands suitable for molding purposes must be open and porous to allow the steam and gases to escape freely, and must be able to hold a given form under the pressure and wash of the flowing molten metal. Such a sand must contain a sufficient quantity of clay or other binding material in order to comply with this latter condition. This binding material is either present in the sand naturally, or, if not, it must be added to it before it is fit for use; otherwise the body of sand will not hold together when dampened and compressed by ramming.

Roughly speaking, there are four branches to the molder's trade. These are, green sand and dry sand work; loam molding and core-making. Properly speaking, core-making is not part of the molder's trade as it is practiced today. It is a branch of the business that has become highly specialized of late years, and is now regarded as a trade in itself. It is, however, a very important part of the business, and one that every molder should thoroughly understand. The difference between molding and core-making is that the molder makes the mold that forms the exterior of the casting, while the core-maker makes those bodies of sand that form the interior openings or holes in the casting.

Small and medium-sized castings are generally made in molding boxes called flasks. These are made in various sizes to suit the different jobs and may be of wood or iron. The type known as snap-flasks is used for very light work. These flasks have three hinged corners and some form of snap fastener at the fourth corner to hold the box together, so that the flask may be removed after the job is molded and set in place for pouring. The men who handle snap-flask or other small work that can be done on benches are known as bench-molders, while those who take care of the heavier work that must be accomplished on the floor of the foundry are called floor-molders.

The green sand method is used to a greater extent than the others, because it is the cheapest for producing small and medium-sized castings. The term "green sand" means that molds so made are to be used at once, or while in a green or moist condition. Dry sand molding differs from the green sand method in that the molds are dried in an oven built for the purpose. It takes its name from this drying process, and for the same reason the molding should always be done in iron flasks to withstand the heat of the oven. The sand used must possess all the properties of green sand with the additional one of continuing to adhere in a compact mass during the process of drying. Molds so made will stand great pressure without distortion, and on account of their dry condition are free from steam and provide a ready escape for troublesome gases. Another advantage of this method is that the molds may be divided into a number of parts and these parts lifted away to relieve undercuts and similar places on the pattern. This is what is known in foundry parlance as "cheeking" or using "drawbacks."

Loam molding is used for large and heavy castings, or, in some cases, where the cost of a pattern would be prohibitive, because many jobs may be accomplished with a very small amount of pattern work. It is the most expensive form of molding, but it is safe and therefore is frequently the cheapest in the end. Flasks are not used in loam work. The mold is built of brick-work reinforced by iron plates and rods and clamped and bolted together where it is deemed necessary. The molding material is either natural loam or a mixture of sand and clay in the proper proportions and mixed with water to about the consistency of mortar. The loam is either worked into the mold between the pattern and the brick-work, when a pattern is used, or plastered on the bricks and worked to the desired forms by sweeps swinging from a central spindle in cylindrical work, or by strickles worked back and forth over frames when irregular forms are desired. Loam molds are made in any number of necessary sections and disjointed to relieve the pattern, thus allowing its withdrawal. When the sections are assembled in a pit with sand firmly rammed between the mold and the sides of the pit, it is ready for pouring. Loam molds are always dried, either in an oven or over an open fire, if an oven large enough to accommodate the different sections is not at hand.

Cores are either formed in boxes or by the use of frames, sweeps or strickles; and may be made in green sand, dry sand or loam. The core-maker's efforts, however, are generally confined to dry sand work, as the molder usually makes his own cores when the job is green sand or loam. When made in boxes the sand is rammed in and reinforced with iron rods to add strength and stiffness to the core. The box is really a mold to give shape to the core sand.

* * *

The new Zeppelin airship—the *Zeppelin V*—is claimed to be remarkable on account of the absence of noise from the engines. It is said to have cruised over Berlin without any noise whatever having been heard at a distance. One of the Zeppelin airships recently flew over a range of the Swiss mountains, reaching the high record for dirigibles of over 10,000 feet.

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CLEVELAND TURNING, BORING AND RECESSING ATTACHMENT

A Cleveland automatic machine fitted with a turning attachment having roughing and finishing cutters and a special boring and recessing attachment, is shown in Figs. 1 and 2, and the operation for which this tool equipment is used is illustrated in Fig. 3. By using two tools in the turning attachment, the two principal diameters can be finished concentric and to size to better advantage than with a forming tool. The important feature of the new design of recessing tool is that it will recess a long hole in two or three places or positions if desired; that is, the tool can be arranged to drop down and out of the cut as often as may be required and it will produce almost any shape of hole; moreover, one tool finishes the hole parallel.

Fig. 1 shows the turning attachment secured to the face of the turret by three of the tool shanks. The stem or bar carried in the center of the spider is fitted with two roughing and two finishing cutters. Cutter *A* rough-turns the larger diameter *J*, see Fig. 3, whereas cutter *B* reduces the bar from 3 1/2 inches to 2 3/16 inches at *K*. The two finishing cutters *C* are shown in the working position; the first one finishes the large diameter while the second finishes the diameter previously rough-turned to 2 3/16 inches. The bar which carries the cutters is secured in the bore of the spider by means of a key and set-screw and it can easily be removed and a bar with any combination of cutters substituted. This attachment is very rigid and is intended for heavy work when it is not practicable to use a box-tool.

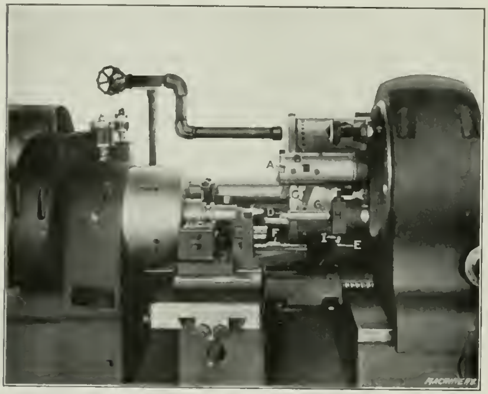

Fig. 1. Cleveland Automatic equipped with Turning, Boring and Recessing Attachment

Fig. 1 also shows the special recessing tool in the turret. The cutter *D* of the recessing tool is supported by sleeve *G*, the cutter shank passing through a hole which is eccentric with the shank in the turret hole. Cutter *D* is fastened to the hub of a gear by means of a hollow set-screw inside of housing *H*, and it can easily be removed for grinding or replacement. Plunger *I* has a rack cut on the side which engages the gear inside of housing *H*. The ball-pointed screw *E* passes through plunger *I* and it is squared at the upper end and fitted with a lock-nut. This gives a fine adjustment to the rise of plunger *I* as it travels over cam *F* which is attached to the cross-slide. The working end of cutter *D* when at rest is parallel to the extreme throw of the eccentric hole in sleeve *G*. When turning the part illustrated in Fig. 3, the turret travels to the full stroke, bringing cutter *D* to the bottom of the hole; the cross-slide then moves forward until cam *F* is in the path of ball-pointed screw *E*, when the turret is on the return stroke. The screw *E* and plunger *I* are lifted up as indicated in Fig. 2, thus causing the pinion in housing *H* and the cutter in sleeve *G* to rotate. This sinks the tool into the side of the hole and as the turret continues to travel backward, the recessing tool is in operation as long as screw *E* is held up by cam *F*. A strong spring, which is compressed by plunger *I*, brings the cutter *D* back to rest after screw *E* passes the end of cam *F*.

A combination boring and recessing operation can be effected by sinking the cutter *D* in to the depth left for a boring cut at the bottom of the hole. A rise in the cam *F* at the proper height to suit the amount of recess required can be employed. With this arrangement, the hole can be bored and recessed in one operation. Cam *F* can also be made to any desired shape for producing an irregular form or shape. This tool may be used for an operation which usually requires two tools, that is a boring tool independent of the one used for recessing. Thus, the time for forming the recess is eliminated, which may reduce the total time one-half.

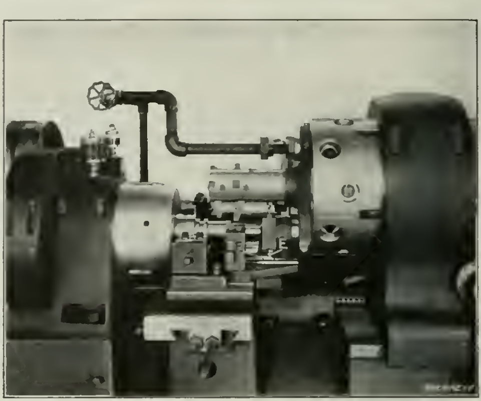

Fig. 2. Recessing Attachment in Operation on Cleveland Automatic Machine

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STRENGTH OF WIRE ROPE

An investigation into the strength and durability of wire ropes has been made by Prof. Eenoit of the Technical Institute at Karlsruhe. The results of this investigation are of considerable interest. The experiments were made with plow-steel wire 1 millimeter (0.03937 inch) which showed a strength of from 247,000 to 255,000 pounds per square inch, 225,000 pounds per square inch having been guaranteed. The wire was bent over a pulley of 6⅞ inches diameter, through an angle of about 90 degrees, at the rate of 1000 complete bends per hour, a complete bend being the bending of the wire from the straight and then back to the straight again. During the bending, the wire was subjected to a stress of 11,200 pounds per square inch and stood 198,710 bends. Seven wires were twisted together into a strand and bending tests were undertaken with this strand. One or two wires were broken in the strand after from 44,800 to 47,200 bends. Three of these strands were then combined into a rope; one wire in this case broke after 22,860 bends, and the twisted strands were practically entirely broken up after 36,440 bends. The conclusions seem to indicate that twisting the strands causes considerable stress in wire rope, especially when bending over sheaves.

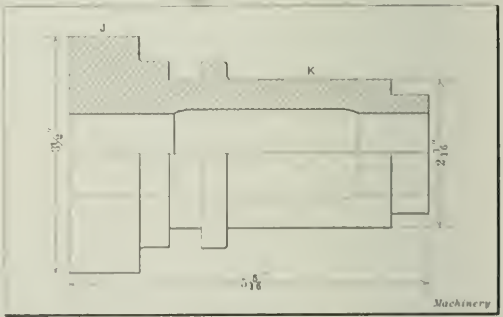


Fig. 3. Part turned, bored and recessed by Tool Equipment shown in Figs. 1 and 2

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

BEMENT BORING, DRILLING AND MILLING MACHINE

Prior to 1850, the boring of small holes was done under the drill press, or in the lathe when great accuracy was required. For work that could not be handled on either of these machines, the usual method was to employ the portable boring-bar with a traveling head and star feed. All of these methods were more or less slow and cumbersome. In 1854 Bement brought out a horizontal borer with the spindle at a fixed height and a vertically adjustable work-table. On account of great adaptability, together with the convenience of being able to operate it from either side, this machine has continued in popularity to the present day. In 1875, the Bement Co. made another advance in boring machine design by building a new type of horizontal boring machine. This machine had a stationary post with a vertically adjustable saddle, the table being at a fixed height and provided with cross and longitudinal traverse. An adjustable outer bearing was furnished for support of the boring-bar. Since that time a large number of machines of this type and similar design have been placed on the market.

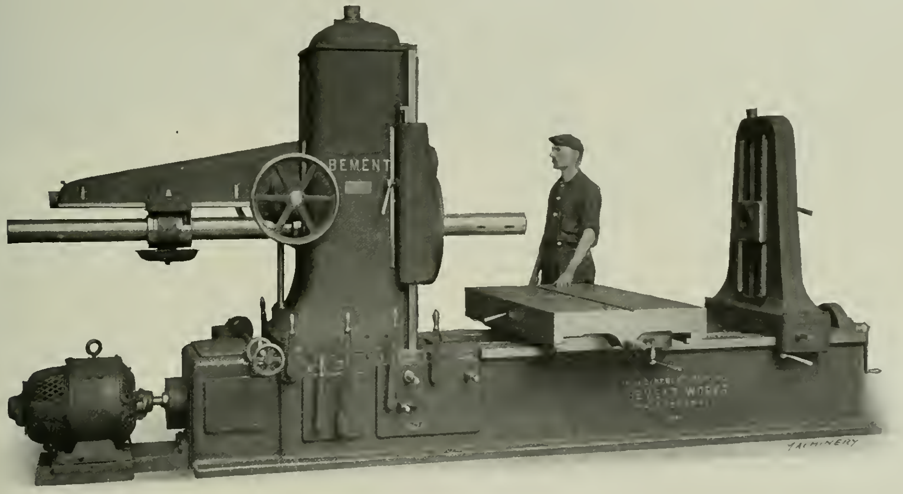


Fig. 1. Niles-Bement-Pond Duplex Control Boring, Drilling and Milling Machine

Realizing the importance of duplex control on machines of this class, the Niles-Bement-Pond Co., 111 Broadway, New York City, is now manufacturing the improved horizontal boring, drilling and milling machine illustrated herewith. This machine is of the elevating spindle type, but is symmetrical throughout with respect to the spindle axis, permitting the operator to stand on either side and have all the controlling levers within convenient reach. It is adapted for work requiring great accuracy and at the same time is designed for heavy boring. Service and durability are prominent features, the entire design being free from delicate parts. Perhaps the most striking feature is the location of the spindle saddle within the post. This makes possible the symmetrical construction about the spindle axis which has been carried throughout the design of the spindle post, bed, tables and control—an arrangement very essential on a large part of boring work. This design also affords most rigid support for the spindle. The thrust is taken on two V-tracks, one on each side of the spindle, entirely eliminating the distorting strains which are inevitable in machines where the spindles and saddles are on the front side of the post.

The Spindle, Saddle and Column

The spindle is of high carbon hammered steel and is lap-ground with great care. It slides in a long sleeve which revolves in removable bearings, the main bearing being tapered so that adjustment can be made for wear. The spindle is driven through two large spline keys set into the sleeve and engaging with keyways in the spindle. It is fed and rapidly traversed by means of a screw in the saddle horn. The front portion of the spindle saddle has long bearings on V-tracks planed on the faces of the column. The V-bearings form the best possible method of preserving the spindle alignment when the saddle is clamped for boring, or sliding vertically for milling. Furthermore, with this construction, the hard back pressure due to boring adds to the truth of the alignment. The saddle has vertical power feeds for milling and also rapid power traverse. This motion is transmitted through a vertical screw which is connected by gearing to a similar screw in the outboard post, so that the spindle saddle and outer bearing always move in unison with each other. The spindle driving gear is enclosed within the saddle, with a portion extending outward and exposed for use as a faceplate.

The spindle column is of box form, open through the center but connected at the bottom in one continuous casting. The column is held at the top by a cap tongued and grooved to it, the whole design making a very rigid structure. It is strengthened inside by ribs located in the best possible manner for resisting backward and torsional strains. V-tracks for the saddle traverse are planed on the front of the column. The tracks have unequal sides; the faces toward the outside of the column are broad for presenting a liberal bearing surface for the saddle; the faces toward the inside are approximately at right angles to the others for resisting side thrusts. The outboard column is made in two parts; the lower portion is adjustable along the bed to which it is gibbed; and the upper part is bolted and doweled to the lower, so that it may be removed for long pieces of work and easily replaced in correct alignment. Provision is made for disconnecting the vertical lifting screw from the rest of the mechanism in order to avoid the necessity of dismantling any of the gearing when it is desired to remove the post.

The Table

The table has a very large working surface with T-slots for holding the work. It is gibbed to a saddle with square locks having adjustment for wear. The table is provided with power cross-feeds for milling and rapid power traverse for quick adjustment. The table slides on a broad saddle long enough to support it at the extreme position of its travel. The table saddle is adjustable along the bed by hand or by power through a screw running through the center between the tracks of the bed. It is gibbed to the bed with square locks having adjustment for wear. Power feeds are provided as follows: horizontal feed of the spindle, suitable for boring and drilling; vertical feed of the spindle saddle and cross-feed of the table for milling. In addition, automatic feed may be provided for the circular motion of the standard table, or in connection with a round table, if ordered. The feed-screws are accurately cut and of large diameter. All feeds are reversible and can be varied through the entire range for each spindle speed. The feeds are not affected in amount per revolution as the spindle speed is changed.

The Bed

The bed is a cored-out box casting, unusually wide at the top and presenting a liberal surface for the table saddle bearing. It has broad flanges at the bottom for support and is braced inside with frequent cross ribs. It is entirely closed at the top to prevent chips from falling inside. Within are the driving, feed and traverse gears. The driving gears run in an oil bath and the feed and traverse gears are lubricated by the splash system. The gearing is readily accessible for examination by removal of large cover plates on both sides of the bed. The bed has been designed to give maximum strength and rigidity so that the machine can be placed where no special foundation is available.

The Facing Head

A facing head can be furnished, which may either be attached to the faceplate gear or fastened on the boring-bar. It is provided with automatic radial feeds by adjustable fingers and star. If required, an additional work support can be supplied, consisting of a comparatively narrow casting which extends across the bed and has adjustment on it. It is of the same height as the regular work-table and has a T-slot in the top surface for clamping. The preferable drive is by a direct-current variable-speed motor of three to one range, but the machine may also be furnished with the following drives: cone pulley and countershaft, single pulley through a speed-box, multi-speed alternating-current motor, or constant-speed alternating-current motor through a speed-box. Inasmuch as the single-pulley and constant-speed alternating-current motor drives require additional gearing, one of the other methods is recommended.

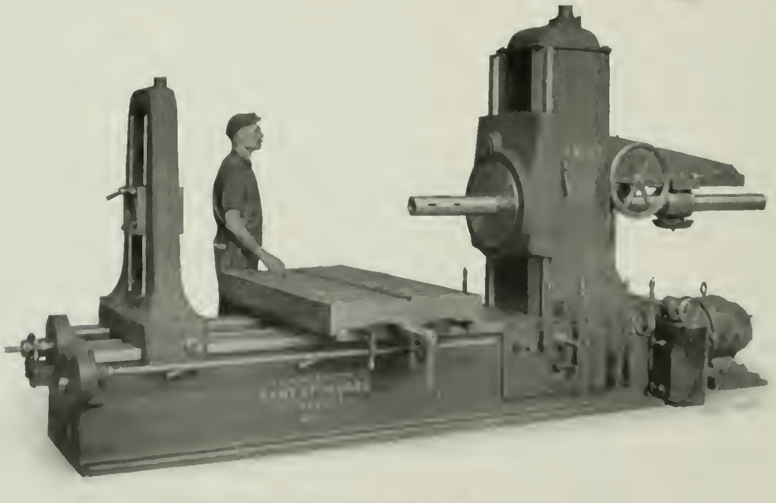


Fig. 2 Opposite Side of Niles-Bement-Pond Machine shown in Fig. 1

GREAVES-KLUSMAN 24-INCH LATHE

The Greaves-Klusman Tool Co., Cincinnati, Ohio, is now building the 24-inch lathe which is illustrated in Fig. 1. The design of this machine has been carefully worked out to meet the requirements of heavy lathe work and several new features have been applied in its construction. Notable among these, is the quick-change gear-box which is a separate unit bolted to the bed of the machine. The cone of nine gears contained in this box gives the fine changes and these are compounded by a cone of six gears to the left. Threads from ½ to 28 per inch can be cut without requiring the gears to be changed. All gears in the quick-change gear-box are of steel and the cone gears and tumbler gears are cut with a 20-degree pressure angle cutter. The teeth are brought to a sharp point so that they can be readily engaged even when the machine is standing idle. By substituting different change gears on the studs at the head end of the machine, metric and special threads can be cut. The gears in the quick-change gear-box run in a bath of oil.

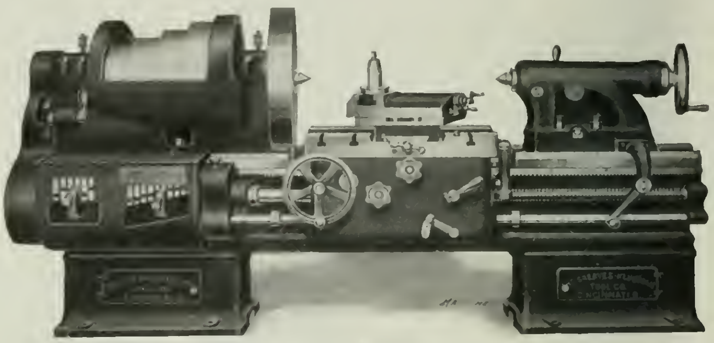


Fig. 1. Greaves-Klusman 24-inch Heavy-duty Lathe

The headstock is of massive construction and heavily webbed for its entire length. The spindle is set back of the center line of the bed. It has hardened bearings at both the front and rear and runs in bronze-bushed boxes which are oiled by sight-feed lubricators. The lower half of the back-gear guard is cast integral with the headstock and the headstock cone pulley is of unusual size, with a wide belt.

The bed is of improved design and heavily reinforced between the vees, these reinforcements extending down below the top of the girths. A heavy wall is cast through the center of the bed and there is a rack on the upper surface of this wall which engages a pawl attached to the tailstock. This rack and pawl mechanism provides for taking the end thrust on the tailstock when the machine is under heavy cut. The cross-section of the lathe bed is shown in Fig. 2, from which the departure from standard design will be apparent. The ordinary practice has been to make the front and rear vees of equal height so that in leveling up the lathe, the level would be placed on top of the two outer vees. As it is important to have the spindle as close to the bed as the required swing of the lathe will permit, the outer vee at the rear of the machine has been brought to the level of the flat inner bearing at the front. In leveling up the machine, the level is placed on top of this flat surface with its other end resting on the outer vee at the rear of the machine. This design permits the spindle to be lowered ⅞ inch without diminishing the swing over either the shears or carriage.

Another feature of the design is the form of the vee at the front of the machine. Referring to Fig. 2, it will be seen that this is machined with two surfaces on the inside. The lower surface makes an angle of 15 degrees with the perpendicular, while the upper surface is inclined at 45 degrees, thus providing a larger wearing surface for the carriage. With the spindle set back of the center line of the bed, and also lowered by reason of the design of the machine, the line of action of the tool pressure is carried further toward the center of the machine. Assuming that the tool is ground to a standard angle, the tool pressure on the 24-inch lathe falls within the front vee when turning all diameters up to 17 inches. The advantage of this is obvious, as 90 per cent of all work done on a lathe of this size is well under 17 inches in diameter. When the angle of tool pressure falls outside the front vee, the strain is thrown on the carriage and the carriage has a tendency to creep up on the vees, making it necessary to have the gibs snug.

The compound rest is of improved construction. Instead of being rounded at the end, the lower slide is square and is graduated through an arc of 180 degrees on its upper surface. The middle casting is also square. The design gives a very rigid support to the toolpost, and the compound rest can be locked in any position by four locking bolts. The carriage is locked to the bed by a screw and gib which are located as near the center as the compound rest will permit. The apron is designed with a removable front plate so that in case it is desired to examine the mechanism, it is not necessary to remove the apron from the machine. All that is required is to remove the levers and wheels, and then remove the cap-screws and lift off the front plate. To insure alignment, the plate is doweled to the main apron casting. The feed-rod is supported at both ends of the apron so that there can be no unusual wear on the double bevel pinion by reason of sag in the feed-rod. The lead-screw is also supported in the main apron casting by two bearings—one on each side of the lead-screw nut. The lead-screw is 2 inches in diameter and has a two-pitch right-hand single thread. The indicator dial swings free of the lead-screw when not in use for thread cutting, and the usual safety device is provided so that the feed-rod and lead-screw cannot both be engaged at the same time.

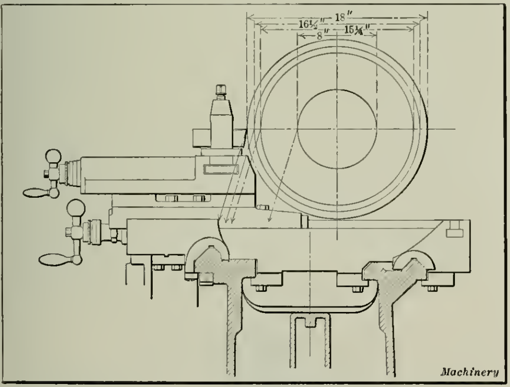
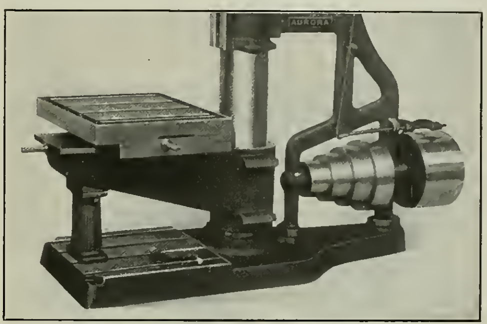


Fig. 2. Cross-sectional View of Greaves-Klusman Lathe Bed

The tailstock is of exceptionally heavy construction. It is locked in position by four bolts, all of which are accessible from the front. This lathe is built with either a four-step cone pulley and double back-gears or with a single pulley drive and geared head. The principal dimensions are as follows: Swing over bed, 27½ inches; swing over carriage, 18 inches; maximum distance between centers, 5 feet 6¼ inches; ratio of back-gearing, 12.7 to 1; travel of compound rest, 8½ inches; net weight of machine, 8500 pounds.

AURORA COMPOUND TABLE

The 24-, 26-, 28-, 32- and 36-inch drill presses built by the Aurora Tool Works, Aurora, Ind., can now be provided with the compound table which forms the subject of this article. The design of this table is of unusually heavy construction and the table and saddle slide on bearings of ample width. The working surface of the table built for use on the 24- and 26-inch machines is 18 by 24 inches, and the table has transverse and longitudinal movements of 15 inches. The compound table for use on the 28- and 32-inch machines has a working surface of 22 by 28 inches, and longitudinal and transverse movements of 17 inches. The table for the 36-inch machine has a working surface of 24 by 30 inches, and longitudinal and transverse movements of 17 inches. The height from the top of the base to the top of the table is 20 inches for all sizes in which this table is built.

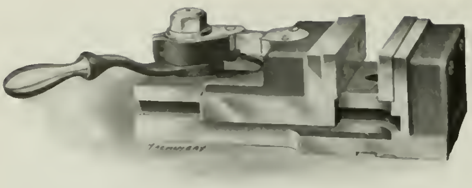


Compound Table built for Use on Aurora Drill Presses

In the May, 1913, number of MACHINERY, a 24-inch Aurora upright drill provided with positive geared feed was illustrated and described. This company is now building a machine of similar design in a 22-inch size. The principal dimensions of the new 22-inch machine are as follows: Maximum distance between spindle and table, 30 inches; hole in spindle, No. 4 Morse taper; traverse of spindle, 11 inches; back-gear ratio, 6 to 1; width of belt, 2½ inches; and net weight of machine, 1350 pounds.

CARTER & HAKES QUICK-OPERATING VISE

To meet the demand for a quick-operating vise with a wide opening of the jaws, the Carter & Hakes Co., Sterling Place, Winsted, Conn., has brought out the tool which forms the subject of the present article. For some time, this company has been manufacturing a No. 2 lever vise, and the new product follows very closely along the line of the preceding type as regards dimensions and method of operation. The difference lies in the fact that the new vise is provided with a friction clamp on the operating lever which makes it possible to increase the quick operating movement of the jaw from ⅛ to ¾ inch. This is found particularly useful where the nature of the work requires the use of a vise with a wider opening or where the pieces to be machined have to be located from holes which necessitates the use of pins in the vise jaws. The construction of the vise is such that the friction clamp does the quick operating of the mov-

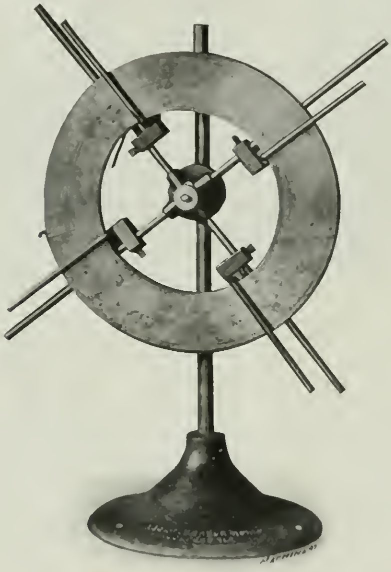


Carter & Hakes Quick-operating Vise provided with a Friction Clamp

able jaw, while the final and actual holding is accomplished by an eccentric and link mechanism, the same as on the regular Carter & Hakes No. 2 vise.

ROCKFORD PUNCH PRESS STOCK REEL

For handling flat stock for punch presses, the Rockford Iron Works, Rockford, Ill., has recently placed on the market the reel which is shown in the accompanying illustration. This reel is arranged to hold stock up to 4 inches in width and rolls up to 36 inches in diameter. Reference to the illustration will show that the reel is adjustable up and down, and the proper tension is obtained by means of a friction disk, so that no difficulty is experienced from having the stock run off the reel faster than it is used up by the press. The illustration makes the construction of this equipment so clear that further description is unnecessary.



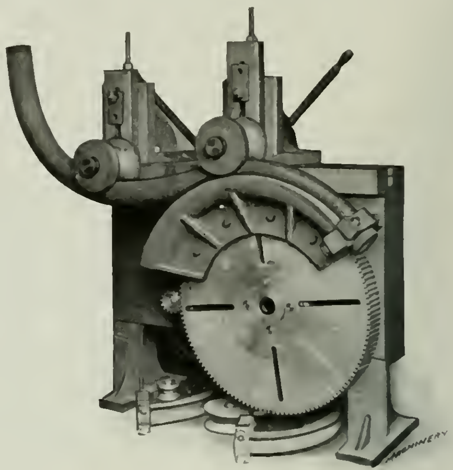
Rockford Reel for holding Flat Stock to be fed to Punch Presses

PEDRICK PIPE BENDING MACHINE

The demand for a machine to bend large pipe has led the Pedrick Tool & Machine Co., 3639 Lawrence St., Philadelphia, Pa., to develop a machine adapted for this class of work. Fundamentally, there is not a wide divergence between the construction of the present machine and the smaller sizes of pipe-bending machines built by this company. The same principles are employed, but have been modified to suit the conditions met with in bending heavy pipe.

The main frame of the machine is a rectangular casting ribbed on one side and having large bosses to provide the bearings for the gear shafts. An ample gearing ratio permits hand power to be utilized to operate the machine. The pipe to be bent rests in a quadrant which is attached to the faceplate gear. There are two resistance rollers which are adjustable laterally on the bed and also vertically so that they may be brought to bear on the pipe at any desired points.

On this machine it is an easy matter for two men to make a right-angle bend in a 4-inch pipe, the pipe being bent cold and without requiring it to be packed with sand or other filling material. The illustration shows a 4-inch pipe in the machine, bent on an 18½-inch radius, which is somewhat smaller than that usually called for by standard practice. The bends made by the machine are smooth and the section of the pipe remains round, the work being so perfect that it will easily pass the most critical inspection.

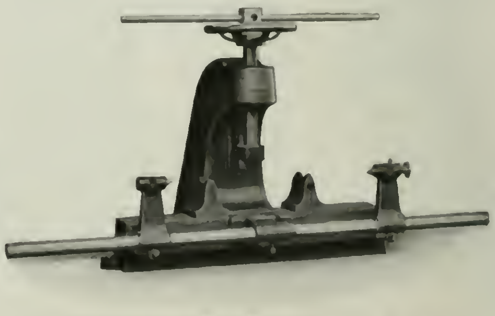


Large Size Pedrick Pipe Bending Machine

SPRINGFIELD BENCH-STRAIGHTENING PRESS

For some years, the Springfield Machine Tool Co., 631 Southern Ave., Springfield, Ohio, has been manufacturing two sizes of bench-straightening presses and centers, known as the Nos. 00 and 0. To meet the demand for a machine adapted for handling heavier work, a No. 1 straightening press of similar design has recently been placed on the market. Reference to the illustration of this machine, which is presented herewith, will show any mechanic the work for which it is adapted without requiring a detailed description to be published. It will be seen that the blocks upon which the work rests while being straightened, are movable to or from the screw and are kept in line by tongues which fit in a groove in the bed of the machine.

The shaft which supports the centers is movable through the arm which carries it, and is held in position by means of a set-screw. This screw has a brass cap over its point to



Springfield Combination Bench Straightening Press and Centers prevent damaging the shaft. It will also be noted that the positions of the centers can be adjusted along the shaft and that the centers are held in any required position by means of binding screws. The right-hand center is pressed forward against the work by means of a spring and has a knurled knob at its end for pulling the center back when it is desired to put work in place or to remove it. The convenience of this combination straightening press and centers will be readily appreciated by those who have had experience in carrying work back and forth between a straightening press and lathe, in shops where a combination machine is not available. The dimensions of the new No. 1 machine are as follows: Diameter of screw, 2 inches; diameter of centering shaft, 1¾ inch; length of centering shaft, 65 inches; maximum distance between sliding blocks, 13½ inches; maximum distance between centers, 55 inches; maximum diameter of stock which can be straightened, 3½ inches; and net weight of machine, 750 pounds.

NEIL & SMITH PORTABLE ELECTRIC CENTER GRINDER

The accompanying illustrations show a portable electric grinder which has been developed by the Neil & Smith Electric Tool Co., 120-122 East Sixth St., Cincinnati, Ohio, for use in grinding lathe centers. It will be seen that the grinder is provided with a taper shank which fits into the spindle of the tailstock on the lathe, and when so set up the grinder is in position for grinding the live center to the required angle of 60 degrees. The operator is not called upon to adjust the grinder to secure this angle, and the use of this tool is the means of having all centers in the shop brought to a uniform and accurate standard.

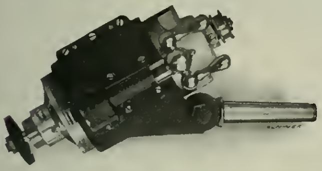


Fig. 1. Neil & Smith Portable Electric Center Grinder

The center of the grinder spindle and the center of the taper shank are exactly in line with each other, and the only condition governing the accuracy to which the center is ground is the alignment of the tailstock with the headstock. For example, consider the case of a lathe that is accurate within the limits of commercial requirements; the live center will be ground accurate within the same limits, which is all that is necessary to secure the degree of accuracy that is required of the work done on the lathe. Means have been provided to make the grinder interchangeable between different sizes of lathes that may be used in a shop. For this purpose, the grinder is provided with a standard size hole and the taper shank that fits in the tailstock spindle has a standard size shank that fits into this hole. As a result, it is merely necessary to order shanks of the proper size to fit the different tailstock spindles of the lathes which are in use in the factory, and all of the centers can then be accurately ground to a uniform angle of 60 degrees.

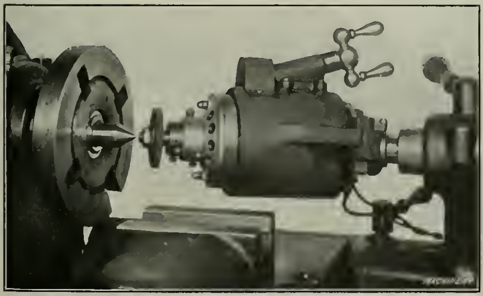
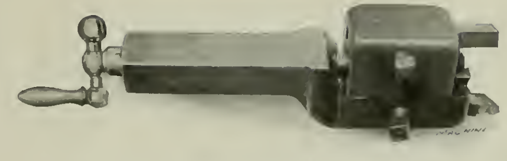


Fig. 2. Neil & Smith Center Grinder set up on a Lathe

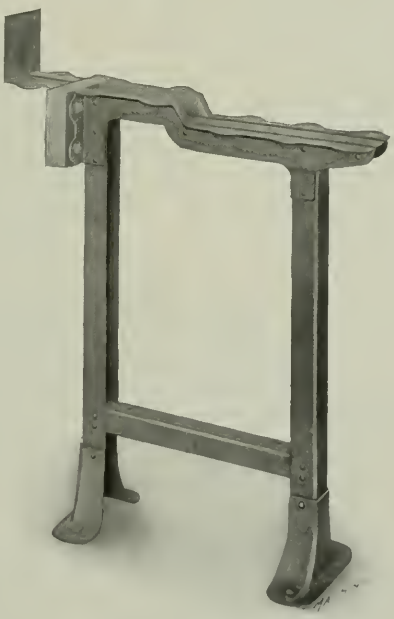

Hall Tool-holder for taking a Roughing and Finishing Cut simultaneously

HALL TOOL-HOLDER

The accompanying illustration shows a tool-holder which provides for holding two tools, one of which takes the roughing cut while the other is used for the finishing operation. Referring to the illustration, it will be seen that one of the tools is carried in a head which is integral with the shank, while the second tool is mounted in a head, the position of which is adjustable. The two heads are held together by a dovetailed slide, and the position of the adjustable head is regulated by means of a screw and ball-crank as shown in the illustration. The screw is fitted with a micrometer collar to facilitate making accurate settings. In this way, the relation between the roughing and finishing tools can be adjusted so that the roughing tool leaves just the required amount of stock to be removed by the finishing operation. This new tool-holder is made by Frederick M. Hall of Waterbury, Conn.

NEW BRITAIN BENCH LEG

In order to meet all requirements of a modern manufacturing plant, a bench leg must provide a stiff and rigid construction, without requiring the bench to be dependent upon support from a wall. It must be possible to plank the bench in a variety of ways; the leg must provide support for an underneath shelf or bin, where such a construction is required; it must be possible to sweep around the bench; and the bench must not interfere with steam pipes that are required to be carried at the back of it. It must also be possible to change the bench from one location to another without damage, should such a change of location become necessary.


New Britain Pressed Steel Bench Leg

Bearing these requirements in mind, the New Britain Machine Co., 64 Bigelow St., New Britain, Conn., has brought out a pressed steel bench leg which is shown in the accompanying illustration. This company's experience in making gray iron bench legs has shown the value of providing a longitudinal stringer. This construction enables the legs to be placed as far as 8 feet apart and results in a reduction of labor and lumber costs. The stringer affords great rigidity to the back portion of the bench, and prevents deflection and end sway. Additional stiffness is afforded by the back board which is screwed to the face of the upright and forms a screen to prevent work from being pushed off the bench.

The U-shaped section of the legs with the U's facing each other, enables the lower shelf or bin supports to be put in between the flanges of the legs and securely retained in place. Reasonable variation in the height of the leg can be made to meet special conditions, but the stock pattern covers the average requirements of all machine shops.

"NATCO" NO. 30 MULTIPLE SPINDLE DRILL

The National Automatic Tool Co., Richmond, Ind., has just added to its line of multiple spindle drills the No. 30 machine illustrated herewith. This is a large, heavy machine built to meet the demand for a multiple drill capable of carrying a large number of adjustable spindles over a large drilling area. A machine of this type is particularly adapted for such drilling as automobile crank-cases and work of similar nature. The machine illustrated is capable of carrying from two to forty-four adjustable spindles or it may be equipped with cluster boxes carrying from two to ninety spindles. The sizes of heads furnished on this machine are 16 by 30 inches and 16 by 44 inches. The drill shown in the illustration is equipped with a head 16 by 42 inches in size; this machine was furnished to a motor manufacturer for drilling six-cylinder crank-cases in one operation. It is built along simple and sturdy lines, and has ample power to drive high-speed drills at their maximum efficiency, regardless of speed.

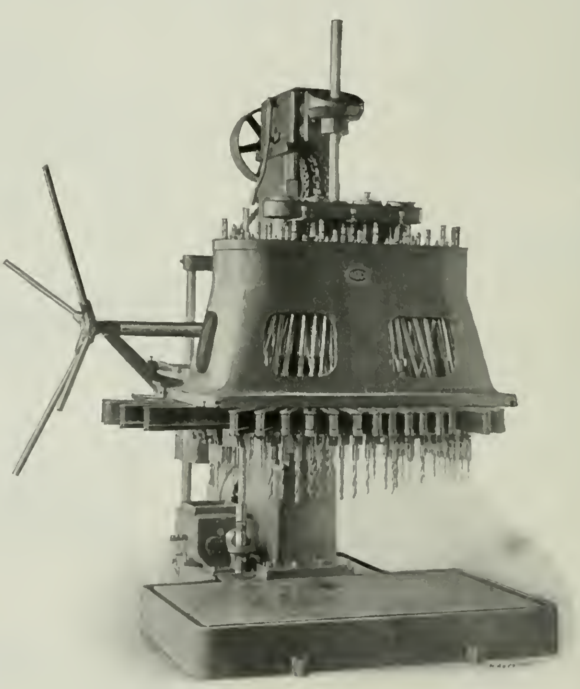


Fig. 1. Front View of "Natco" No. 30 Multiple Spindle Drill

A single-pulley drive is employed so that the machine may be belted to the lineshaft, if so desired, or if individual motor drive is wanted it is easily applied. The driving pulleys are of large diameter and wide face, and are mounted on Hyatt roller bearings. The speed-box is located at the top of the column and three changes of speeds are provided by the sliding gear transmission. The gears are of coarse pitch and wide face, and are hardened and ground. Any one of the three available speeds is obtained by shifting the hand lever to one of the positions marked *A*, *B* and *C*. For each speed obtained from the speed-box there are two independent changes of speeds in the head, made by means of the sliding gearing in the head. These changes are made while the machine is running. The bearings in the speed-box are also provided with Hyatt high-duty roller bearings which insure a high transmission efficiency. The speed-box and feed-box gears are provided with the cascade system of lubrication. There are three independent drill feeds which permit the use of any feed with either of the three double drill speeds that are available in the head. All of the feed changes can be made while the machine is running. The feed-box is located at the base of the column, the feed gears being cut from the solid, hardened and ground. They are of large diameter and run at moderate speeds.

The machine is mounted on a heavy base which is provided with an oil channel for catching the overflow. This channel has a screen pocket through which the cutting lubricant must flow to enter the tank from which it is pumped back to the tools. The pumps employed for oiling the machine and delivering cutting lubricant to the drills are independent of each other. When so desired the base of the machine may be provided with T-slots. Any head which may be furnished on this machine may be equipped with various combinations of adjustable spindles and cluster boxes for drills ranging in size from ⅛ to 1 inch in diameter. The head is provided with power feed and with a pilot arm to facilitate advancing and returning it easily and rapidly. The power feed may be tripped either automatically or by hand. The head is counterbalanced by means of three chains which support a counterweight within the column and also additional sectional counterweighting in the rear of the machine to compensate for the variations in the number of arms used.

The column is heavy and rigid, and is of box section. The spindles are made of special steel, hardened and ground, and are provided with ball thrust bearings at the lower end and lock-nuts at the upper end to take up any end wear that may develop. The spindles are made to carry either straight shank or Morse taper shank drills, as required. Individual flexible oil tubes deliver the cutting lubricant to each drill when the machine is working on steel or aluminum. The bronze bearings which carry the drill spindles are provided with a vertical adjustment to compensate for variation in drill lengths. This adjustment is secured by simply loosening one nut which is so located as to be always accessible. When vertical adjustment is needed it is not necessary to move any arm from its set position. This spindle adjustment is a patented construction and holds the bearing rigidly to the end of the arm; and the arm may be moved to cover any layout within the range of the head. The universal joints used on all "Natco" drills are milled from the solid and carefully hardened. They are composed of only five pieces. These universal joints are guaranteed for two years.

One of the most important features of this machine, which is used exclusively on "Natco" drills, is the independent drill speeds in the head which give two independent changes of speed to each spindle for each of the three changes of speeds obtained in the gear-box. This enables large and small holes to be drilled simultaneously at correct cutting speeds. It is a recognized fact that it is impractical to drive drills of different sizes at the same speed or feed per revolution. The "Natco" independent drill speed feature gives approximately the correct speed and feed for each size drill that comes within the range of the machine. For example, using ½- and 1-inch

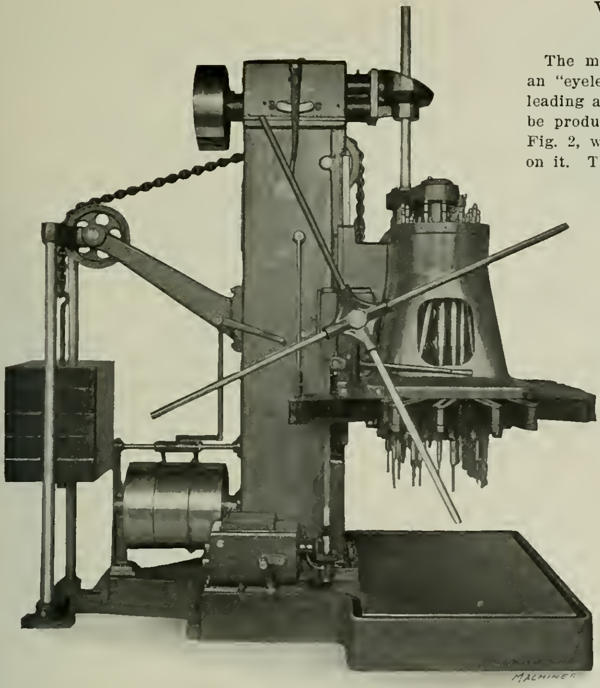


Fig. 2. Side View of "Natco" Drill shown in Fig. 1

drills in cast iron, it is possible to secure a feed of 4.72 inches per minute. For this purpose the speed-box lever is shifted to *B* which gives 547 revolutions per minute, or 71.5 feet per minute as the peripheral feed of the ½-inch drills which are fed at 0.0086 inch per revolution. By shifting the driving pinion in the head which drives the 1-inch drills, these drills can be driven at 271 revolutions per minute, or 71 feet per minute at a feed per revolution of 0.0174 inch. The peripheral velocity of the drills in feed per revolution is practically the same, while the feed of the ½-inch drills is only one-half as great as that of the 1-inch drills.

LUFKIN TAPE THREADER

Those who have had experience in the use of woven or steel measuring tapes, know that the case in which the tape is rolled up when not in use lasts much longer than the tape itself. This is due to the fact that metal tapes are quite easily broken and the woven tapes become frayed at the edges while the case is still quite good. As the case represents approximately half the cost of the complete outfit, it is obviously a desirable feature to be able to put a new tape in an old case. For this purpose, the Lufkin Rule Co., Saginaw, Mich., has developed a device styled a "tape threader" which enables a new tape to be inserted in a case in this way. It consists of a loop and stud arrangement by means of which the old tape may be readily detached from the winding drum in the case and a new tape secured to the winding drum in its place. One of these threaders will now be furnished with all measuring tapes sold by the Lufkin Rule Co., thus effecting a marked economy through the possibility of fitting new tapes into old cases when necessary.

WATERBURY-FARREL EYELET MACHINES

The multiple-plunger press illustrated in Fig. 1 is styled an "eyelet machine," but this name is really somewhat misleading as a great variety of products other than eyelets can be produced. This fact will be emphasized by reference to Fig. 2, which shows some products that are regularly made on it. The illustration is about one-fourth size, and bearing this fact in mind manufacturers who produce articles of the character for which this machine is adapted will be able to gain an idea of its capacity. The following description will make it clear that work which involves cutting a blank from sheet metal and then performing subsequent drawing, forming, piercing, clipping and similar operations on it, can be handled in an efficient manner.

Referring again to Fig. 1, it will be seen that the machine is essentially a multiple-plunger press. Different numbers of plungers are built into a single frame, each plunger performing a special operation; a carrier is provided to transfer the work from plunger to plunger. As all operations are performed in rapid succession, the expense of handling is reduced, and annealing the work—which is frequently required where individual presses are used—is avoided. Experience has shown that four plungers is about the smallest number that can be used to advantage, although three plungers are successfully employed in certain cases. The standard machines are built with from four to eight plungers, and manufacturers are advised to purchase machines with at least six plungers. Where this number of plungers is not required, the work can still be handled with exactly the same efficiency, as the plungers not in use remain idle. To meet special requirements, machines can be built with nine or ten plungers.

The operation of the machine is as follows: The stock in the form of a strip of uniform width is carried on a reel at the front of the machine. Before entering the machine the stock passes over a lubricating sponge box and then through a guide to a pair of intermittent ratchet feed rolls. While the feed is at rest, the first blanking plunger cuts out the

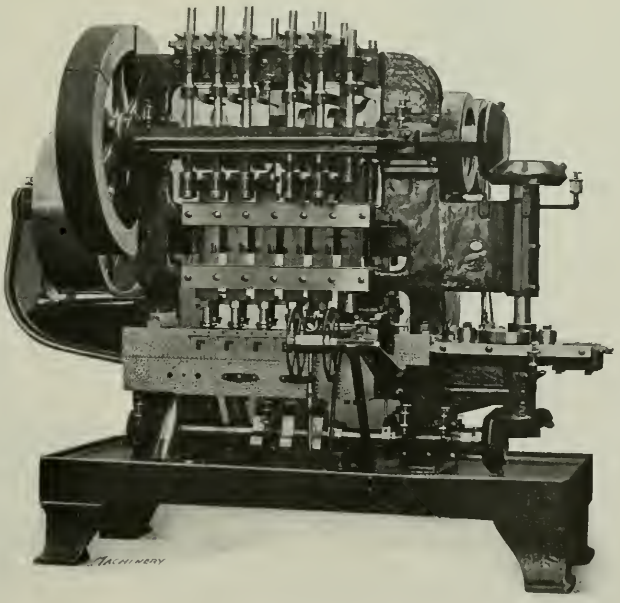


Fig. 1. Standard Waterbury-Farrel Six Plunger Eyelet Machine

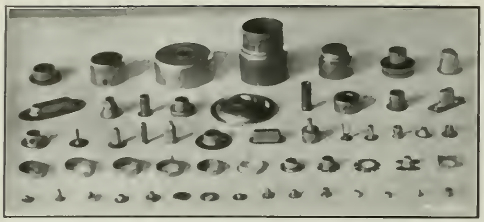


Fig. 2. Examples of Work done by Waterbury-Farrel Eyelet Machine

blank on its downward stroke and carries it through the die into a socket in the transfer slide. The scrap metal goes on through the machine and is rolled up on a second reel. The transfer slide is then moved to the left by the action of the side camshaft and carries the blank to the second plunger. At this point the second plunger with its forming punch comes down and draws the blank through the transfer slide into the first cupping die. The transfer slide now recedes and on the up-stroke of the second plunger a knockout, which is actuated by a cam motion on the lower shaft, pushes the shell out of the die into a pair of fingers held on the transfer slide. The next advance of the transfer slide carries the work on to the third plunger and at the same time brings a second blank forward to the second plunger. This sequence of operations continues until the work is completed, when it drops out through a delivery tube located at the left-hand side of the machine. Similar tubes are provided at each station where piercing or clipping operations are performed, which deliver the scrap metal into retainers placed in a convenient position to receive it.

It is not within the scope of this article to enter into detail in regard to the design and construction of the machine. Let it suffice to say that the noteworthy improvements consist of the substitution of a cam-actuated transfer slide in place of the old crank-operated slide. This change was made to eliminate trouble resulting from the use of a crank for this purpose, which was found to be noisy, unmechanical and to give trouble on account of the liability of the side stud to break, thus resulting in a loss of time and frequent damage to the tools. An improved form of adjustable stripper is also used and improved fingers on the transfer slide provide for moving the work from plunger to plunger for the various operations.

Machines of this type are made in seven different sizes. This does not refer to the number of plungers on the press but to the distance from center to center of the plungers and the stroke of the cams. Machines of each size are made with the different numbers of plungers referred to in a previous article. The smallest machine of the series has a distance of 1¾ inch from center to center of the plungers and a standard stroke of the cams of 1¼ inch; the largest machine has a distance of 5 inches from center to center of the plungers and the stroke of the cams is 4½ inches. These machines are built by the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.

CIRCULAR ATTACHMENT FOR CLEVELAND PLANERS

Cleveland Planer Works, 3150-3152 Superior Ave., Cleveland, Ohio, recently built a circular planing attachment for use on a Cleveland planer used in the works of a bridge and iron company. The planer equipped with this circular attachment is illustrated in Fig. 1, and Fig. 2 shows a closer view of the circular table. Curved work with radii ranging from 5 to 15 feet can be planed on this attachment by adjusting the position of the center about which the circular table swings to different points on the truss which supports the center. In order to provide for planing a surface at an angle, as would be necessary on curved tracks and similar work, a special planing head is provided which can be set to different angles. This head is clearly shown in the illustration.

There is a stud set in the regular planer table and a second stud in the circular table, these two studs being connected by a link. In this way the circular table is drawn back and forth by the planer table. The circular table is held down on the planer table by means of extension plates. Thus, the circular table is free to swing on the required arc when the center about which it swings is adjusted to different positions on the horizontal truss. The work to be planed is fastened to the circular table in the usual way, by means of T-slots and bolts.

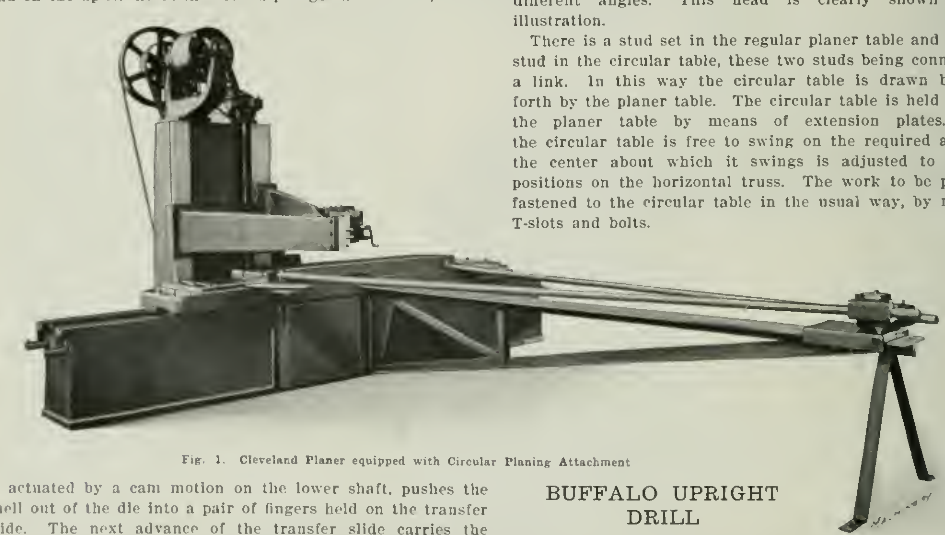


Fig. 1. Cleveland Planer equipped with Circular Planing Attachment

BUFFALO UPRIGHT DRILL

One of the latest products brought out by the Buffalo Forge Co., Buffalo, N. Y., consists of a 20-inch upright drill which is shown in the accompanying illustration. It will be seen by referring to the engraving, that the table of this machine is raised or lowered by means of a screw and handwheel; this screw is provided with a ball-thrust bearing at its lower end so as to make the movement of the table as smooth and easy as possible. In order to provide

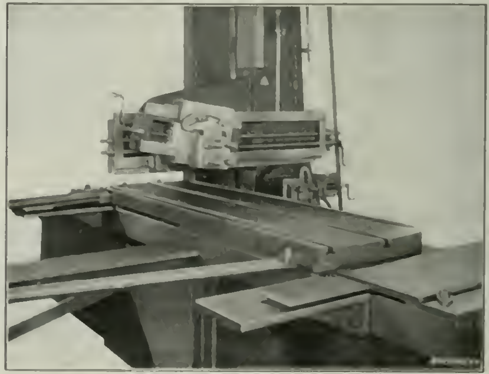
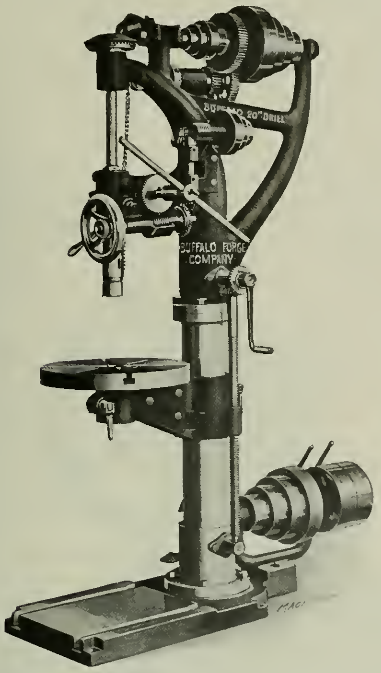


Fig. 2. Close View of Cleveland Circular Planing Table

for handling large work, the design is such that the table can be swung out of the way; T-slots are machined in the base of the drill and large work can be secured in place on the base.

This drill press is equipped with either lever, wheel or power feed. In order to provide suitable leverages for various drilling operations, the position of the hand lever in the hub is made adjustable. A spring is located in a socket in this hub and the pressure provided in this way is sufficient to hold the lever in any required position. Suppose the operator is changing the drill press over for a heavier operation. It is merely necessary for him to pull the lever out to a position which will give the required leverage and the spring will then hold it in this position. Where one class of work is to be handled for a considerable length of time, the lever can be permanently clamped in place by tightening up a wing nut.



Buffalo 20-inch Drill equipped with Wheel, Lever or Power Feed

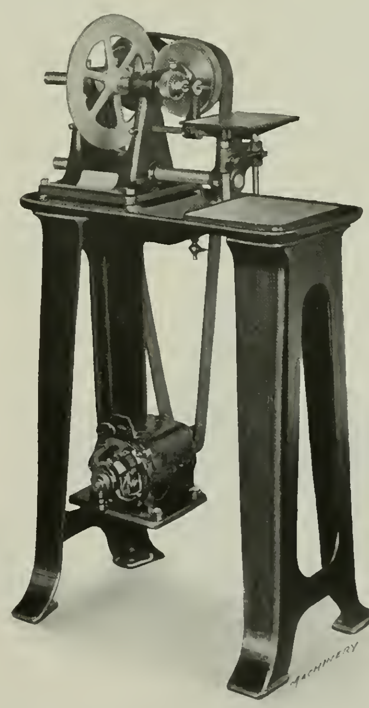
For using either the wheel or power feed, the worm is brought into engagement with the worm-wheel and held in place by means of a latch located at the left-hand side of the machine. The arrangement of the drive will be readily understood from the illustration without requiring further description. It will, of course, be evident that when the wheel feed is used the worm is rotated by turning the handwheel. When it is desired to use the power feed, it is necessary to tighten up a screw at the front of the handwheel hub. This draws up a friction in the bevel gear which transmits power to the worm, and in this way the power feed is secured, doing away with the necessity of rotating the worm by means of the handwheel.

Another feature of this machine is the ease with which the back-gears may be engaged or disengaged. To throw the gears into engagement, it is merely necessary to operate a small lever located near the top of the machine on the left-hand side. This brings the gears into mesh. When it is required to drive direct, the back-gears are disengaged. Located on the end of the pulley shaft, there is a disk which has a hole in it to receive a tapered pin. This pin is carried in the gear at the end of the horizontal shaft at the top of the drill press, and by entering the pin in the hole in the disk, the direct drive is secured.

The spindle is mounted in ball bearings and is counterweighted inside the column of the machine. It will be seen that the column is made in two sections which are bolted together. Ample strength is secured in this way and a considerable advantage in machining the drill press columns is secured by having smaller castings to work with. The machine can be arranged for belt drive, for direct-connected motor drive or for individual motor drive with the power transmitted from the motor to the pulley of the machine by belt. The principal dimensions are as follows: Maximum distance between spindle and base, 41½ inches; maximum distance between spindle and table, 25½ inches; drills to the center of a 20-inch circle; available feeds, 0.004, 0.007 and 0.012 inch per revolution; maximum movement of spindle, 8¼ inches; spindle bored for No. 3 Morse taper; and weight of machine, 725 pounds.

RICKERT-SHAFER TAPPING MACHINE

The Rickert-Shafer Co., Erie, Pa., has recently added to its line a tapping machine the design of which marks a departure from that of other tapping machines. The drive is of the friction type, the mechanism consisting of a metallic disk mounted between two friction driving wheels. The metal disk is of aluminum and the driving wheels of friction board. By moving the work forward, the disk is thrown against the rear or tapping friction, while pulling the work backward brings the disk into contact with the forward or reverse friction wheel. The friction wheels are mounted at right angles to the disk, as shown in the illustration, and are beveled at such an angle that the maximum pulling power is secured.



Rickert-Shafer Horizontal Tapping Machine with Friction Drive

Another interesting feature of the machine is that it is driven by a single belt which comes down around the rear or tapping friction wheel and then up around the front or reverse friction wheel. It will be evident from this description that both of the friction wheels rotate in the same direction and the reversal of the tap is due to the fact that the disk engages the friction wheels on opposite sides. The standard equipment consists of a small work-table provided with a stop which can be swung out of the way when not wanted, and with an auxiliary work-slide of the vertical type against which flat work can be held. This slide is provided with a small stop collar. The machine has a capacity of 5/16 inch and of ½ inch for re-tapping. It is built with a base as shown in the illustration or as a bench type machine.

SELLEW AUXILIARY DRILL HEAD

The auxiliary drill head shown in the accompanying illustrations is the latest product of the Sellew Machine Tool Co., Pawtucket, R. I. This is known as the Sellew "straight line," adjustable drill head because the spindles are placed in a straight line. Experience has shown that there is almost as much drilling done in a straight line as in circular formations but up to the present, no auxiliary drill head has been made with the drills located in this way. The head consists of a main casting or rail, upon which the spindle boxes are bolted and means are provided for adjusting the positions of the spindles along the rail. The rail is bolted to a sleeve which connects it to the drill press, the sleeve being split at its upper end for clamping to the quill of the drill press spindle. This sleeve is interchangeable with other types of adjustable drill heads made by this company. This is a feature of particular advantage, where different heads are to be used on the same machine.

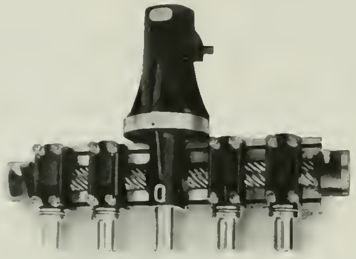


Fig. 1. Sellew "Straight Line" Auxiliary Drill Head

It will be seen that the drill spindle intermediate gear is mounted in a horizontal position on the rail; this gear is mounted in double annular ball bearings at the center, while annular and thrust ball bearings are used at each end. It is driven by the center spindle which fits into the taper hole of the spindle of the drill press. The spindles on the head are provided with Morse taper holes and they are mounted in bronze bushed bearings. The thrust is taken by ball bearings. The spiral gears on the spindles are enclosed. This head is made in three sizes, known as Nos. 1, 2 and 3, the smallest of which is suitable for use on sensitive drilling machines fitted with small drill chucks. The medium size is arranged for use with either drill chucks or No. 1 Morse taper sockets, while the largest head is suitable for use with No. 2 Morse taper sockets. The range of center distances of these heads is from 1 inch up to 18 inches and is dependent upon the length of the rail. The head is so arranged that it can be used for tapping as well as drilling operations.

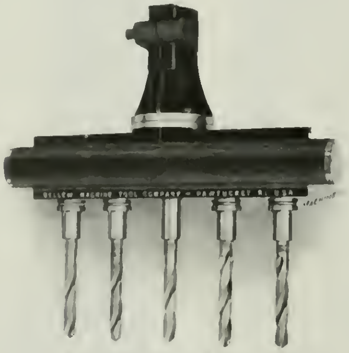
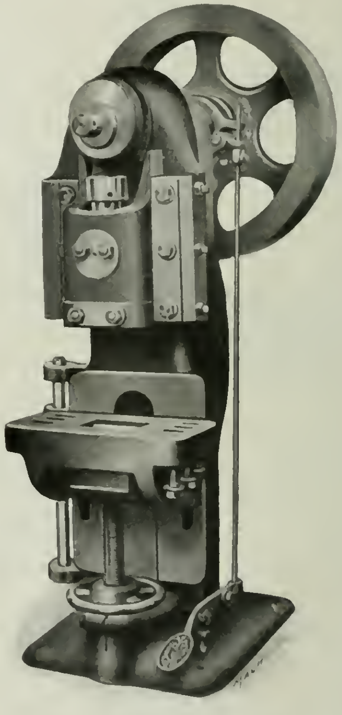


Fig. 2. Opposite Side of Sellew Drill Head

FERRACUTE ADJUSTABLE BED PRESS

The Ferracute Machine Co., Bridgeton, N. J., is now building a series of punch presses provided with adjustable beds. The illustration shows the style PA3 press which is the third size; there are six presses in the series. Above the throat, the design of these presses is the same as that of preceding machines built by this company. They have heavy flywheels mounted on shafts which run in phosphor-bronze bearings, pin-clutches and 50-point carbon steel shafts.

The bed of the style PA3 press is supported by a 3-inch steel stud and bolted to the frame by four 1⅜-inch steel bolts. An adjustment of 11 inches from the standard height is provided which, added to the 3-inch ram adjustment, gives a total adjustment of 14 inches. This makes the press particularly suitable for use in connection with a variety of high dies.

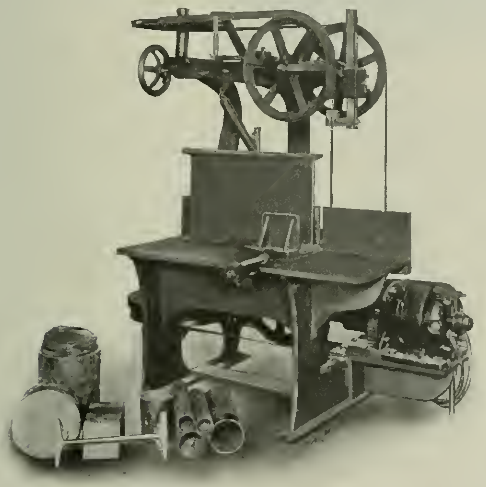

Ferracute Adjustable Bed Punch Press

A hinge at the side of the press enables the bed to be swung out of the way when the machine is to be used as a horning press. The principal dimensions of the machine are as follows: Diameter of horn-hole, 6 inches; height from the top of the horn-hole to the bottom of the ram at the top stroke and adjustment, 7 inches; size of hole in bed, 7 by 4 inches; pressure exerted by style PA3 press, 35 tons; and weight of machine, including bolster plate, 4900 pounds.

WILLIAMSON METAL-CUTTING BAND SAW

The Williamson metal-cutting band saw which is illustrated herewith is built by H. C. Williamson, 1840 West Lake St., Chicago, Ill. The construction of this machine is such that any length of stock can be cut off, the wheels being so arranged that the "idle side" of the saw is carried back over a wheel located directly behind the wheel over which the "cutting side" of the saw runs. The table is provided with holes for strapping work in place and the swivel back and vise provide for cutting at any desired angle. When so desired, the vise and back can be removed from the table to leave a perfectly flat surface on which special work can be held. The operation of the machine is said to be so simple that an apprentice can run it, as the feed is automatic and the machine practically takes care of itself after it has been started. An automatic stop shuts off the power when the cut is finished. When idle, the frame which supports the wheels over which the saw runs stands upright. In starting a cut, the operator takes hold of a handle at the front of the frame and draws it forward to bring the saw into contact with the work. The machine then feeds itself by the action of gravity without requiring further attention from the operator.

As previously stated, an automatic stop shuts off the power when the cut is finished, and a spring retards the forward movement of the frame so that an even feed pressure is secured at all times. The pulleys are flanged so that the saw never runs off, and a handwheel provides for tightening the saw to the required tension. Ample adjustment is provided, and in the event of the saw breaking, it can be brazed together and continue to give good service. It is said that a tooth is very seldom broken from a blade used on this machine and that a ½-inch round bar can be cut off just as satisfactorily as a bar 10 inches in diameter. Tool steel can be cut as well as soft steel and the capacity of the machine is for structural steel up to the size of a 12-inch I-beam or round bars up to 10 inches in diameter. An idea of the rate at which cutting is done may be gathered from the fact that the machine will cut a 3-inch round bar in 7 minutes. A convenient feature of this machine is that the table is only 20 inches above the floor level, so that it is an easy matter to handle heavy bars, axles, etc., which are to be cut. The power requirements of the machine are exceptionally low, only one-half horsepower being required to drive the saw. The principal dimensions are as follows: Size of blade, 20 feet 9 inches long by ⅝ inch wide; floor space occupied by machine, 36 by 50 inches; weight, approximately 900 pounds.



H. C. Williamson Metal-cutting Band Saw

WESTERN ELEVATING PLATFORM TRUCK

The Western Tool & Mfg. Co., Springfield, Ohio, has added to its line of shop furniture the elevating platform truck which is illustrated in Figs. 1 and 2. Referring to these illustrations, it will be noted that the usual form of auxiliary loading platform is used in connection with this truck. Fig. 1 shows a truck under the platform with the handle pulled down into the "running position." With the handle in this position, the auxiliary platform is raised so that the skids are clear of the floor and the load on the platform can be pulled along by the truck.

In Fig. 2, the handle has been raised to the vertical position. This allows the truck to drop, causing the skids under the auxiliary platform to rest on the floor. The truck can then be drawn out from under the platform and taken to some other location, where it may be required. It will be evident that this form of truck enables cheap loading platforms to be used for storage purposes and only a sufficient number of trucks for transferring material about the plant need be purchased. The top of the Western truck is 17 by 23 inches in size and it elevates 1½ inch. The wheels run on roller bearings and the swivel joint is also provided with a roller bearing. The truck is built along exceptionally strong lines so that it will wear almost indefinitely.

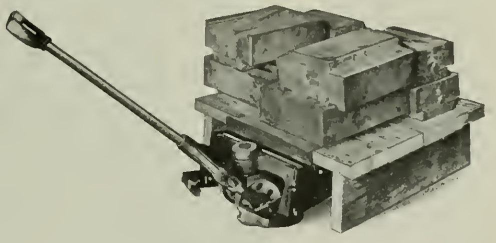


Fig. 1. Western Elevating Truck with Handle in "Running Position"

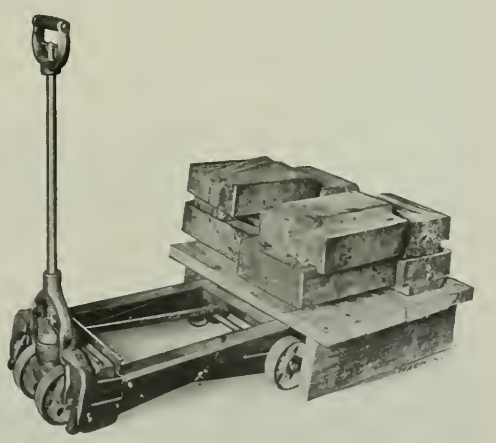
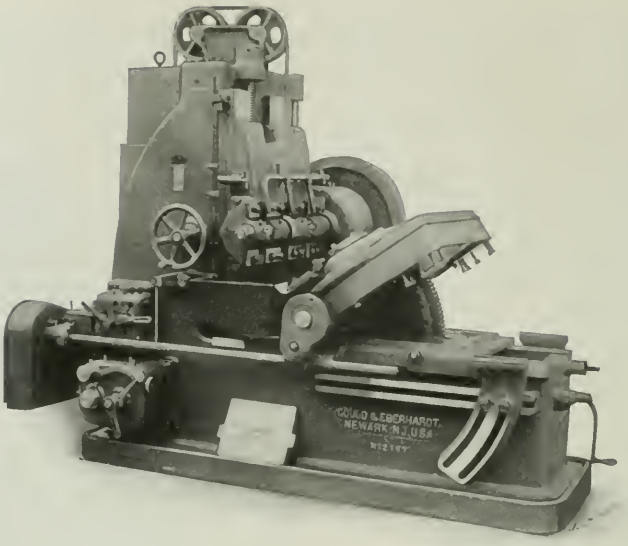


Fig. 2. Truck shown in Fig. 1 with Handle raised to lower Load to Floor

EPICASSIT—A PROTECTIVE METAL COATING

Epicassit is a German material which serves to protect metals against corrosion. It consists of pure tin, pure lead or an alloy of these two metals in various proportions. An alloy of lead, tin and zinc can also be used satisfactorily. The metal is reduced to a powdered condition and this powder is mixed with "Epicassit fluid" to the consistency of a thick, creamy paint. This is applied with a stiff bristle brush and then melted onto the surface to be coated by heating the article. Any clean source of heat may be employed, such as a blow-torch, a clean fire or an oven. The coating will not run any more than paint, thus making it possible to cover vertical or inverted surfaces with a protective coating of tin, lead or zinc.

Epicassit does not compete with dip-coating methods, where such methods are available, but it covers a peculiar field of



Gould & Eberhardt Vertical Cutting Multiple-spindle Gear-cutting Machine

its own. Structural iron work, water tanks and towers, bridges and many other classes of metal work may be galvanized after erection, thus giving them a high resistance against damage from water, acid, ammoniacal fumes or salt water. The damage done in the erecting field to stock which has been galvanized at the mill may also be repaired with Epicassit. No subsequent painting is necessary, but when painting is desirable, the Epicassit sub-surface will prevent blistering or flaking off of the paint, which is usually caused from rusting of the metal under the paint. As Epicassit takes paint well, it effects an economy in both paint and labor.

In making local repairs of vats, tanks, etc., or in entirely recoating worn surfaces, Epicassit is particularly useful, as it avoids the necessity of dismantling the equipment, shipping it to the dipping plant, and then remounting it. Aside from the cost of freight and labor incident to such a method of procedure, the saving of time which results is a very important factor. It has also been found that babbitt adheres more securely to cast-iron bearing boxes which have been given a preliminary coating of this material. Soldering of cast iron is also greatly facilitated where a sub-surface of Epicassit is used. Hess & Son, 1031 Chestnut St., Philadelphia, Pa., are American agents for this product which has been in successful use in Germany for a number of years.

BARNES SCREW-CUTTING ENGINE LATHE

The screw-cutting engine lathe, front and end views of which are shown in Figs. 1 and 2, is the latest product of the W. F. & John Barnes Co., 231 Ruby St., Rockford, Ill. In designing this machine, the requirements of the garage and repair shop were borne in mind, in addition to the work done by a lathe of this type in manufacturing plants. Ample strength and convenience of operation are provided. The machine is known as the 16–18-inch lathe, not because it is a gap lathe but with the idea of giving the exact swing. Most 16-inch lathes swing from 16½ to 18 inches, and as a result the purchaser does not know what swing his machine has until he has had an opportunity of going over its dimensions.

The head is back-geared in the ratio of 9¼ to 1. The spindle runs in bronze-bushed bearings, and the hole through the spindle is 1⅝ inch in diameter. The taper hole is bored No. 3 Morse taper. The machine has a capacity for cutting from 1 to 56 threads per inch. The lead-screw is 1 7/16 inch in diameter. Shifting a lever to the right or left provides four changes of feed without the necessity of changing gears. With this lever the feed can be instantly reversed; the cross-feed of the tool carriage is governed in the same way. The regular equipment of the machine consists of one large and one small faceplate, one center-rest, two tool-steel centers, a set of eighteen gears which provide for cutting the range of threads previously mentioned, a countershaft and the necessary wrenches. A taper attachment and follow-rest can also be provided for use on this machine. The principal dimensions are as follows: Swing over bed, 18 inches; and swing over carriage, 12 inches. When made with a 6-foot bed, the machine has a maximum capacity of 2 feet 8 inches between centers, and a net weight of 1815 pounds. Built with an 8-foot bed, the lathe has a capacity of 4 feet 8 inches between centers and a net weight of 2025 pounds.

GOULD & EBERHARDT MULTIPLE-SPINDLE GEAR-CUTTING MACHINE

In the February, 1911, number of MACHINERY, a 24 by 8 inch vertical cutting multiple-spindle gear-cutting machine built by Gould & Eberhardt, Newark, N. J., was illustrated and described. This company has recently added to its line a

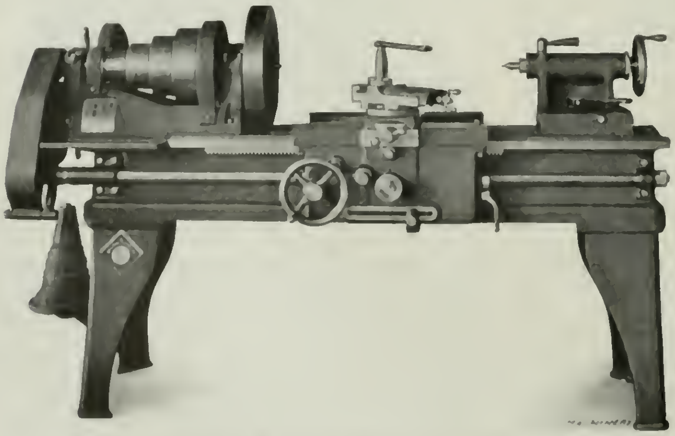


Fig. 1. Front View of W. F. & John Barnes Screw-cutting Engine Lathe

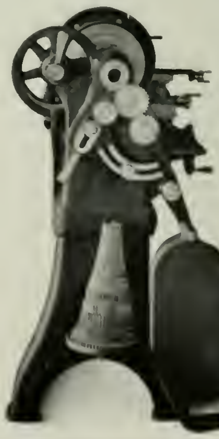


Fig. 2. End View of Lathe shown in Fig. 1

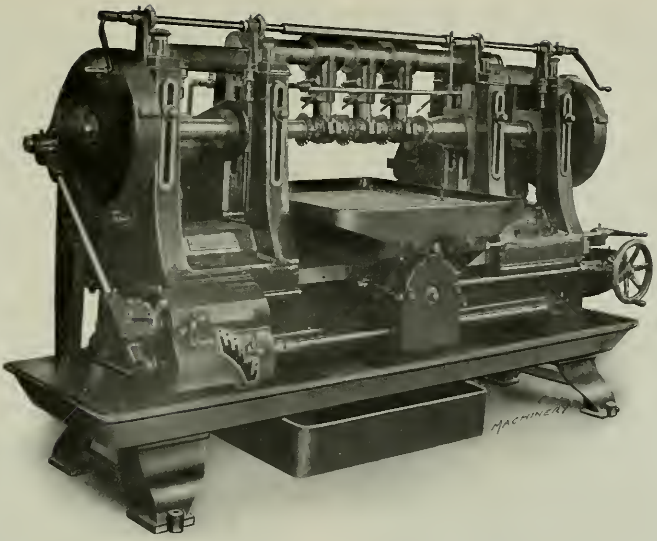


Fig. 1. Front View of Hendey No. 16 Duplex Lincoln Miller

machine of similar design. The new machine is much larger, however, as it is rated at 60 by 16 inches when furnished for cutting spur gears, and at 48 by 12 inches when built for cutting both spur and bevel gears. The capacity of this machine is for cutting up to 1½ diametral pitch in cast iron and 2 diametral pitch in steel. The illustration shows the 48 by 12 inch combination spur and bevel gear machine equipped with a multiple-spindle head attachment for roughing out two large bevel gears at a time. The machine is built for use in roughing out bevel gears for automobile trucks, and meets the requirements of work that is too heavy for the smaller machine which was described in the article previously referred to. The design has been improved in certain respects so that the new machine not only has a greater capacity but is a more efficient producer.

The design of the base and stanchion is the same as in the smaller machine, that is, they are cast in one piece. This provides a rigid structure on which to mount the cutter-slide. The base is designed to give ample support to the work-table and when furnished for cutting bevel gears, the table is provided with rigid supports on each side of the base, which may be adjusted to suit the various angles of the table. The machine shown in the illustration was photographed with these supports disconnected from the table, but the idea will be apparent from the illustration. The supports, acting in conjunction with the worm, worm sector and the clamping screw, assure a rigid support for the work. The cutter-slide is exceptionally long, giving a long narrow guide to the cutter; this tends to maintain a more permanent alignment of the cutter-slide than would otherwise be possible.

The large flywheel at one end of the cutter-spindle serves to equalize the action of the cutter and increase the efficiency of the machine. The vertical cutting or anvil principle works out particularly well on this large machine, the heavy gear blanks when resting in a horizontal position being very securely held for cutting. The weight of the blank is evenly distributed over the table and the entire rim is adequately supported. In the case of two bevel gears which are to be roughed out at one time—for which purpose the machine shown in the illustration is intended—the blanks are mounted on the tilted table and the entire rim or face of the blank is backed up by means of special hardened plates. The vertical cutting principle necessitates tilting the work-slide less than if the cutter-slide tilted with the work held on a horizontal mandrel.

As already stated, the machine is designed along the same lines as the smaller size of vertical-cutting gear-cutting machines built by Gould & Eberhardt. It is provided with a positive indexing mechanism; a quick-change feed gear-box, which gives sixteen changes of feed arranged in geometrical progression; a safety lever mechanism whereby the movements of the cutter-slide and indexing of the work-table are interlocked, so that one cannot operate while the other is in action. All gears are of hardened steel; all bearings receiving thrust loads are equipped with ball thrust bearings; the drive is through a single pulley; and all exposed parts of the mechanism are adequately protected to provide for the safety of the operator.

HENDEY NO. 16 DUPLEX LINCOLN MILLER

The No. 16 duplex Lincoln miller, front and rear views of which are shown in Figs. 1 and 2, is a recent product of the Hendey Machine Co., Torrington, Conn. This machine is of exceptionally heavy design to adapt it for the most exacting requirements of high-speed production. The bed has an extra wide top with a square lock for supporting and aligning the headstocks and saddle. The main spindles of the machine have tapered journals on the front ends which run in annular bearings lined with Lumen metal; the spindles are bored No. 12 Brown & Sharpe taper and the noses are threaded. An arched bar is cast integral with the power shaft bearings to assist in maintaining their alignment. The spindles have unit control to provide for elevating or lowering them simultaneously. The overhead arm or tie-bar has three pendants for supporting the arbor, these pend-

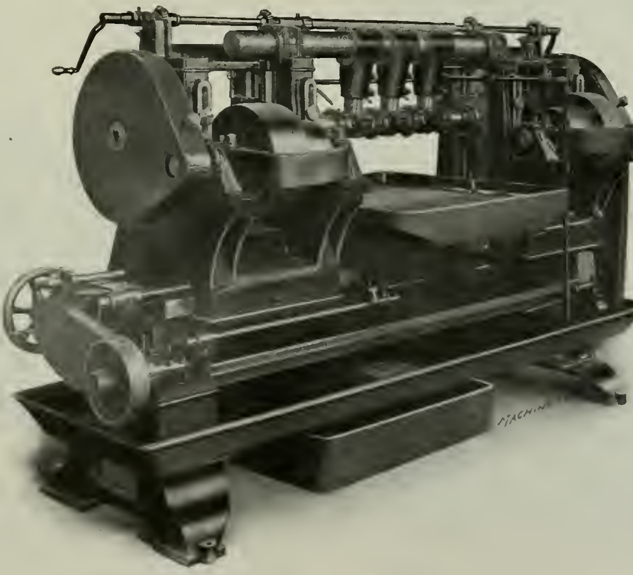


Fig. 2. Opposite Side of Hendey Miller shown in Fig. 1

ants being fitted with split bearings which are hinged so that the bottom half falls away to facilitate quick removal of the arbor. The table is fitted with power quick return and is geared for a speed of approximately 100 inches per minute. High sides are provided on the table for confining the cutting lubricant. The machine is made with different lengths of bed and furnished with tables of different working dimensions. It is equipped either with or without an oil pan, pump and piping, according to the requirements of different users.

ANDERSON ROLLED GEARS

In the November, 1910, number of MACHINERY, a description was published of a machine developed by H. N. Anderson, chief engineer of the Speedwell Motor Car Co., Dayton, Ohio, for the purpose of producing gears by a method styled the "molding-generating process." By this method the gear blank is heated to a forging temperature and rolled in contact with a roller in which accurate gear teeth of the required size have been cut. This results in forming the teeth in the gear blank. At the time the article referred to was published, gears were being produced by this method on a commercial basis, but the results obtained were somewhat crude. The metal displaced in rolling the teeth in the gear blank was forced out to the sides of the blank, thus leaving an irregular surface from which it was necessary to trim the flash.

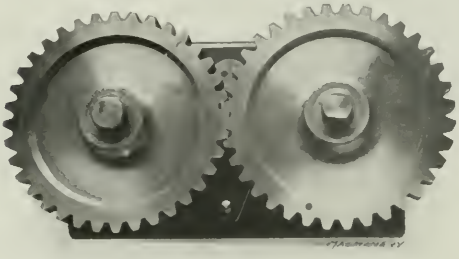


Fig. 1. Spur Gears rolled by the Anderson Process

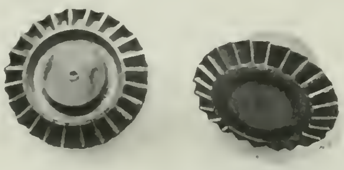


Fig. 2. Bevel Gears rolled by the Anderson Process

This method of producing gears has been steadily improving and the Anderson Rolled Gear Co., Cleveland, Ohio, has now been formed for the purpose of manufacturing gears by this method. As produced at the present time, the metal displaced in rolling the gear teeth is prevented from flowing out at the sides of the gear. The result of rolling the teeth in gears, under these conditions, is that the metal is compressed and its strength is said to be considerably increased. The accompanying illustrations show examples of spur, bevel and herringbone gears produced by this process, from which an idea can be gathered of the excellence of the work that is secured. The Anderson Rolled Gear Co. is prepared to take orders for gears produced by this method, but the company does not intend to build gear-rolling machines for the market.

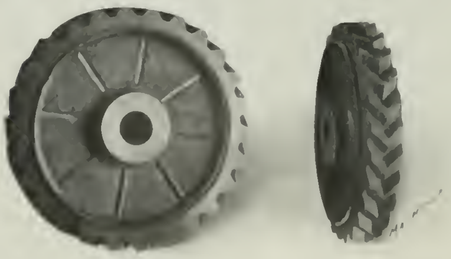


Fig. 3. Herringbone Gears rolled by the Anderson Process

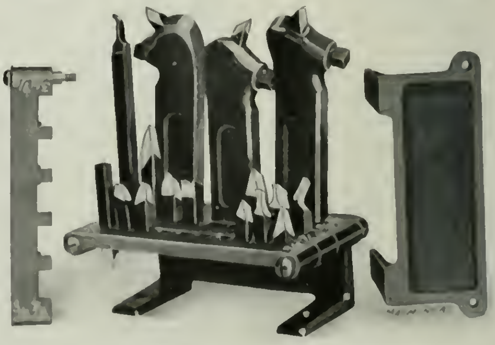
SELF-STARTING ALTERNATING-CURRENT MOTORS

The distinctive feature of a line of small self-starting, alternating-current motors which has been placed on the market by the Electric Specialty Co., Stamford, Conn., consists of the elimination of the usual starting clutch, owing to the inherent difficulties arising from its use. A special split-phase winding has been used which gives a starting torque and overload capacity of 175 per cent of the full load rating. In designing these motors, special attention has been given to the elimination of all magnetic "hum," making them especially adapted for use on musical instruments and for driving office and household fixtures where such a noise is objectionable. Particular care has also been given to the prevention of temperature rise which does not exceed 30 degrees C. These motors are built in sizes ranging from one-tenth to one-third horsepower. They are equipped with underfeed wick oil-cups, the oil being fed through special ¼-inch wicks. The same general type of motor is also built in sizes ranging from one-sixth to one-half horsepower and equipped with oil-ring bearings.

Electric Specialty Co.'s Self-starting Alternating-current Motor

DRIVER TOOL RACK

In addition to the sectional drill rack which automatically gages drills when put into it, that was illustrated and described in the September, 1911, number of MACHINERY, C. H. Driver, 1419 Sixteenth St., Racine, Wis., is now making a sectional tool rack for holding steel bits and the holders for them. This rack is also adapted for holding all sizes of forged tools. The sectional feature affords an arrangement by which racks can be made to hold any desired shapes or sizes of tools and holders. Each section of the rack is made in such a way that it will only hold the size of tools for which



Driver Sectional Tool Rack for Steel Bits and Holders it is intended; tools that are larger than the size for which the section is made cannot be put into that section, while smaller tools will fall through. In this way, the rack automatically arranges the tools according to size when they are put into it. By putting the tools in the rack with the cutting ends up, the required shape and size of tool can be picked out at once. These racks can be stood on tool boards, secured to a side wall or post, or set in any position on the machine on which the tools held in the rack are to be used. The use of these racks is the means of saving time lost in hunting through a miscellaneous collection of tools in a box, in order to find the tool required for handling a given job.

LIBBY COMBINATION BAR AND CHUCKING TURRET LATHE

The application of a collet chuck which the International Machine Tool Co., Indianapolis, Ind., has recently introduced on the Libby heavy turret lathe, meets the demand which has existed in the turret lathe field for a combination bar and chucking machine. With this equipment, the machine can be transformed from a complete chucking machine into a complete bar machine or *vice versa*, in a few minutes' time and without requiring any alteration of the machine except changing the chuck and tools in the turret. Figs. 1, 2 and 3 illustrate the Libby lathe with different equipments. In Fig. 1 an 18-inch Libby turret lathe is shown with the new heavy-duty collet chuck mounted in position, ready for handling bar work. Fig. 2 shows the same machine 15 minutes later with the collet chuck housing and body removed. Fig. 3 shows the same machine five minutes later with the standard four-jaw combination chuck mounted in position for handling chucking work. The time required to change the machines over for handling chucking work or bar work is less than twenty minutes. The entire headstock, including the main driving gear, remains undisturbed as well as every operative part of the machine.

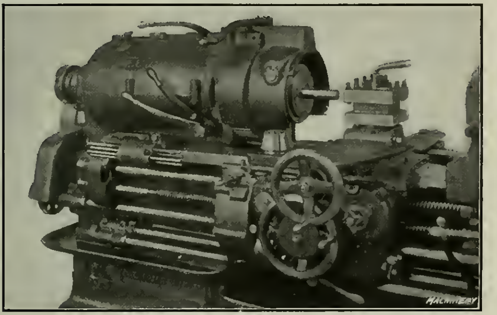


Fig. 1. Libby Turret Lathe with the New Collet Chuck in Position

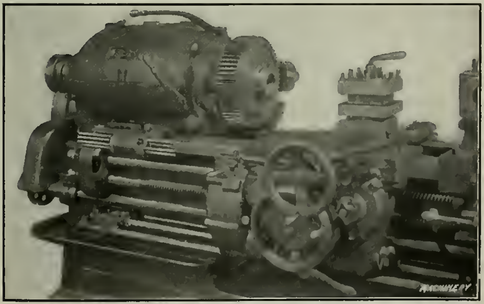


Fig. 2. Machine shown in Fig. 1 (Fifteen Minutes Later) with Collet Chuck removed

The new collet chuck is a self-contained unit. The housing which carries the lever control and the fork is bolted to a pad on the machine headstock housing at a point over the front spindle bearing. By removing four bolts, the collet chuck housing can be quickly removed. The collet chuck body screws onto the threaded nose of the machine spindle and like the housing, can be quickly removed as a single unit. The taper seat on the spindle locates the collet chuck or the standard chuck firmly and accurately in place. The collets have a parallel powerful grip on the stock and are so arranged that they retain their approximate position when there is no stock in the chuck. The collets are in four segments and each set is arranged for one-eighth inch variation in the diameter of the stock. The chuck has a capacity for bars from ¾ to 3 inches in diameter and collets can be furnished in one-eighth inch intervals for this complete range. Collets can be furnished for holding either round, square or hexagonal stock. All sliding or wearing parts are of hardened steel and the control lever for operating the collets is conveniently located at a point close to the speed changing levers on the headstock.

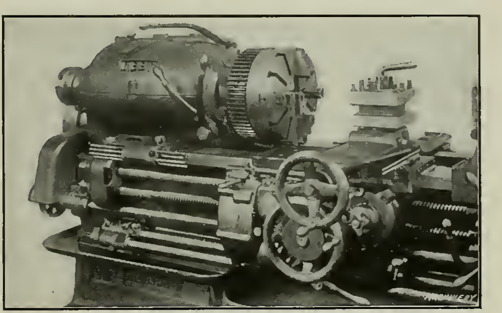


Fig. 3. Same Machine (Five Minutes Later) with Four-jaw Chuck in Position

TOWNSEND TAPER TURNING ATTACHMENT

The cast-iron base of the Townsend taper turning attachment is intended to take the place of the regular toolpost, and washers are provided which enable the operator to set the tool at various heights in order to bring it to the center of the work. The base carries a sliding tool-holder which is adapted for using standard 5/16-inch square tool bits. The tool-holder is provided with a hardened steel follower shoe which bears against a templet that guides the tool in forming the work; this templet is anchored against longitudinal movement by means of a bracket secured to the tailstock by

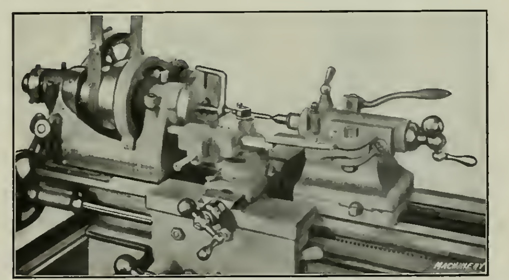


Fig. 1. Townsend Taper Turning Attachment set up on a Lathe

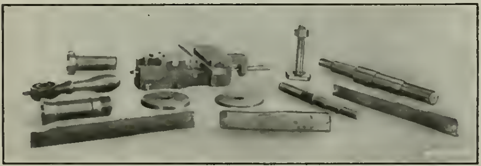


Fig. 2. Taper Turning Tool and Templets used in machining Different Classes of Work

two screws. The arm of the bracket is held by a clamp bolt and can be swung to any position required to bring the stud which holds the connecting link in line with the templet, thus preventing all tendency toward cramping.

The tool may be set up and adjusted almost as quickly as an ordinary lathe tool and is handled in exactly the same way. The carriage of the lathe is free to be moved to any position, and as the cross-slide may be moved in and out to bring the tool to or from the work, it will be evident that the use of the tool is not at all complicated. The follower shoe on the sliding tool-holder is held against the templet by means of a coiled spring and will follow any form of templet desired. The split collet shown at the left in Fig. 2, has its templet in front of it, and the spindle at the extreme right is shown with a templet which was used for turning shoulders. It will be readily seen that this tool possesses great advantages and that the only measuring required is to get the diameter at the end of the work, and the length and the position of the shoulders, all other dimensions being taken care of by the templet without requiring further measurements to be made. The pieces produced are exact duplicates. As a result, an ordinary engine lathe can be made equal to a screw machine for use in interchangeable manufacture. In turning tapers in the tool-room, the attachment is especially valuable, as the tailstock does not have to be moved and no setting of the taper attachment is required. The proper taper is secured without resorting to cut-and-try methods. Individual brackets may be used on several lathes or a bracket may be used which is attached to the lathe bed back of the tailstock. Where one of these tools is available, every lathe in the shop can be equipped with a taper attachment inside of five minutes. The H. P. Townsend Mfg. Co., Hartford, Conn., is the manufacturer of this equipment.

WILMARTH & MORMAN UNIVERSAL CUTTER, REAMER AND TOOL GRINDER

For several years, the Wilmarth & Morman Co., 1180 Monroe Ave., Grand Rapids, Mich., has been building an inexpensive type of combination cutter, reamer and drill grinder. As the company is already prepared to meet the demand for a machine of this kind, the new universal cutter, reamer and tool grinder, which forms the subject of the present article, has been designed along different lines. No expense has been spared to make the machine absolutely universal, to have its range adequate for the requirements of all classes of work for which it is intended, and to construct it along lines which provide adequate strength and durability.

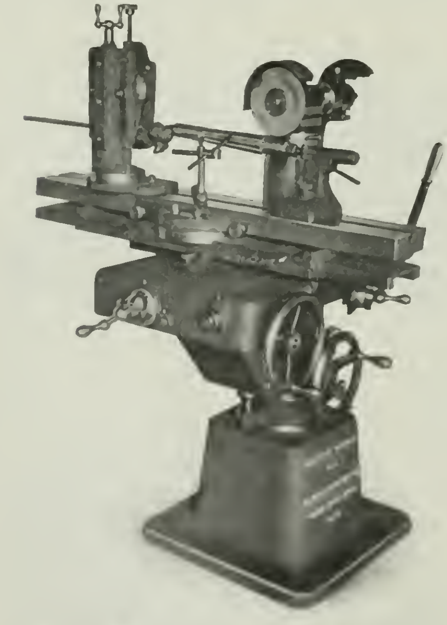


Fig. 1. Grinding Work on Centers in the Wilmarth & Morman Universal Grinder

The base of the machine is 24 by 24 inches in size and provides a rigid support. The inner column is bolted to the base and carefully ground to provide a perfect bearing surface for the outer sleeve. Particular attention has been paid to the provision of means for preventing dirt or grit from finding its way into the bearing between the sleeve and column, so that there is no danger of damage from this source. The wheel-head is bolted to the top of the column and the sleeve rotates around the column, its bearing being a tight fit so that there is absolutely no room for shake or play. After the sleeve has been rotated to the required position, it is clamped to the column by means of wedges which are drawn together by a clamping screw located near the base of the sleeve. These wedges are shaped in such a way that they fit the curvature of the base of the column. There is no tendency for the wedges to score the column but they provide an absolutely rigid lock. Reference to the illustrations will show that the sleeve is not slotted to provide this clamping action; as a result, the sleeve remains perfectly round at all times. A graduated dial at the top of the base indicates the setting of the table in relation to the grinding wheel spindle.

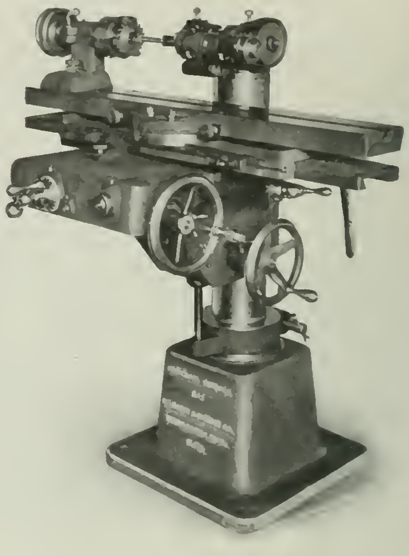


Fig. 2. Grinding the Hole in a Milling Cutter

The outer sleeve which provides the bearing for the knee is 6 inches in diameter; it is ground to provide an accurate bearing for the knee. Instead of having a bearing on V-ways, the knee has a bearing around the circumference of this sleeve which amounts to almost nineteen lineal inches. To insure having the knee move in an absolutely perpendicular line, a large key is mounted at the back of the sleeve. While there is very little possibility for wear to develop at this point, suitable means of adjustment is provided so that the knee may always be kept a tight fit on the key. The knee is not slotted to provide a clamping action on the sleeve, and as a result a perfect bearing on the sleeve is retained at all times. The knee is raised and lowered by means of the lower handwheel. Graduations are provided for making accurate settings.

The saddle is fitted to the top of the knee with an ample bearing, and means are provided which enable any wear which may develop to be taken up. The table bearing is 28 inches in length and provision is also made for taking up any wear which may develop in the table slide, a tapered gib which runs the full length of the bearing being provided for this purpose. A sub-table and the table are carried on the saddle. The table is carried on a circular bearing with auxiliary supports near the end. In this way any weight—even at the very end of the table—is rigidly supported, and there is no tendency to spring or deflect the table in any way. The circular table bearing is of generous proportions and graduated in degrees for convenience in setting for grinding tapers. In addition, a fine adjustment may be obtained by means of two knurl-headed screws at the front of the table, which provide for getting that small fraction of a degree that may be necessary in setting up a piece of work. This can be done without unlocking the bolts which provide the primary clamp. The table is provided with a single T-slot at its center and means are furnished for locating the centers absolutely in line by the same operation which clamps them to the table. Either a center, a chuck or a face-plate may be used interchangeably in the headstock.

The internal grinding attachment provides for grinding holes 3 inches in depth for diameters ranging from ½ inch up to 1¼ inch, while holes from 1¼ inch in diameter up can be ground to a depth of 5 inches. The vise is provided with both angular adjustments and a swivel base, so that even compound angles can be conveniently ground. In designing this machine, particular attention has been paid to the provision of convenient methods of handling. When engaged on surface grinding, cylindrical grinding or internal grinding, a very smooth even action of the longitudinal movement of the table is required. This work is usually handled from the front of the machine, from which point a clear view of the action of the wheel is readily obtained. When operated from the front, the longitudinal movement of the table is provided by the upper handwheel at the right-hand side, which imparts the longitudinal movement to the table by means of a worm-gear. The cross-feed movement is provided by means of a ball-crank handle at the front of the saddle and the vertical movement by means of the lower handwheel at the right-hand side. The control of all of these movements is within easy reach of the operator without requiring him to move from his position at the front of the machine, and scarcely requiring him to stoop. For grinding the teeth of milling cutters, the slow even movement of the table is not required. For such work, in order to observe the cutting action of the wheel, the operator takes a position at the back of the machine, and when operating from this position the lever movement for providing the longitudinal travel of the table is utilized. The cross-feed is obtained by the ball-crank handle leading out from one side of the saddle at the rear. The wheel for the vertical movement of the saddle is within easy reach of the operator from this point without requiring him to move. It will be clear from this description that the machine can be completely controlled from either side without the operator having to change his position. It should be mentioned at this point that the worm-operated handwheel is thrown out of mesh when the lever movement is engaged.

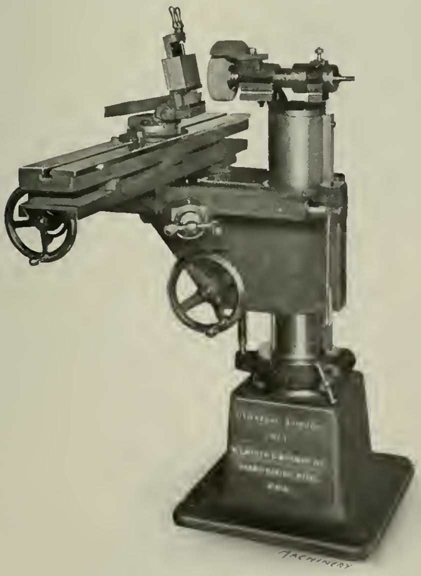


Fig. 3. Grinding a Forged Tool held in the Vise

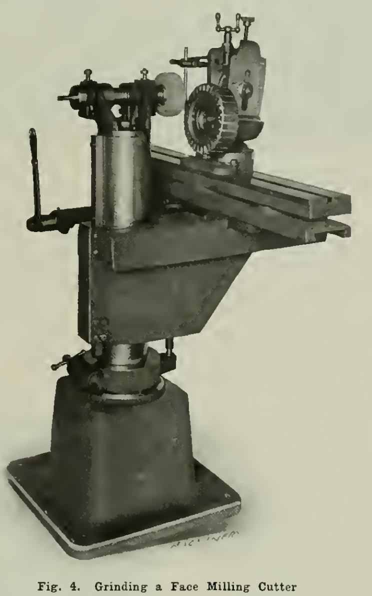


Fig. 4. Grinding a Face Milling Cutter

The capacity of the machine is as follows: The longitudinal movement of the table, 22 inches; cross movement of the table, 8 inches; vertical movement of the knee, 11 inches; swing, 10 inches; maximum capacity between centers, 30 inches; working surface of table, 5½ by 42 inches; universal attachment swings 16 inches over the table and 24 inches over the sub-table; opening of vise, 2⅜ inches; net weight of machine with attachments, approximately 1200 pounds.

NEW MACHINERY AND TOOLS NOTES

Electric Crane Controller: Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. A line of magnet-switch crane controllers which includes equipments adapted for single trolley, bridge or hoist motors, or for a combination of motors in series or parallel.

Arc Welding Machine: C. & C. Electric & Mfg. Co., Garwood, N. J. A machine adapted for handling welding and repair work in shipyards, machine and locomotive shops and foundries. The entire equipment is mounted on a truck to adapt it for portable service, and it is claimed that this portable machine possesses all of the features of the larger stationary equipment.

Chain Draw Benches: Brightman Mfg. Co., Columbus, Ohio. A chain draw bench which is said to be the largest equipment of its kind that has ever been built. It is adapted for drawing all sizes of rounds from 1 to 6 inches in diameter and irregular shapes having the same area. A push-in attachment is provided for pushing the bars through the die ready to be gripped by the drawing carriage.

Multiple-spindle Drill: Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass. This machine is of new design and is the largest of a line of four multiple-spindle drills which has been brought out by the Baush Machine Tool Co. The main drive is through a pair of spiral gears, the pinion being of hardened steel and the wheel of hard bronze; these gears run in oil. The head is accurately counterweighted and supported by means of two cables, and a safety locking device is provided so that if either or both cables fail, the head will be locked to the base. Four changes of feed are provided, two changes being obtained by means of a cone pulley and two by gearing controlled by a jaw clutch.

THE SCHOOP METAL SPRAYING PROCESS

A LATELY DEVELOPED METHOD FOR APPLYING A METAL COATING TO A GREAT VARIETY OF SURFACES

Fig. 1. Surface sprayed with Copper shown at Top, and Similar Surface after polishing shown at Bottom

Fig. 2. Surface sprayed with Brass shown at Top, Aluminum in the Center, and Copper Below

Fig. 3. Illustration showing how Thick Layers of the Coating may be applied by the Spraying Process

ONE of the most radical of recent developments in metal-working methods is the new Schoop metal-spraying process, which is now being placed in the hands of the public. Briefly, the process consists in reducing metallic wire to impalpable dust by means of an oxy-hydrogen flame and then forcing these metallic particles with great velocity against the surface of the object to be coated. The particles then embed themselves in the surface of the piece to be plated and homogeneously unite with the succeeding particles that are projected upon them. The result is an even coating of deposited metal, adhering to the coated object. The deposited metal is amorphous and not crystalline in its structure, and more dense than the wire from which it came. The spraying is done by the special torch or pistol shown in Fig. 4, the wire being fed into the pistol from one side and emerging at the torch end in a fine spray. Figs. 1, 2 and 3 show coatings applied by the process.

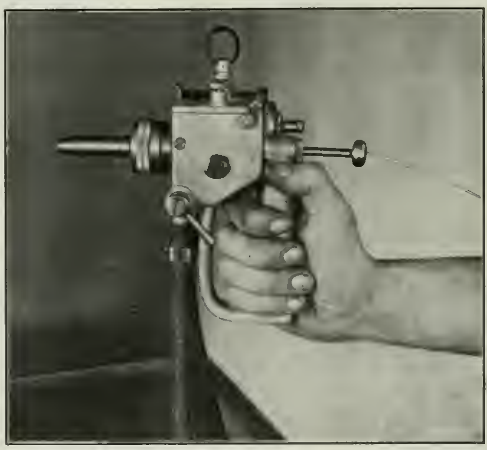


Fig. 4. Spraying Pistol used in the Schoop Metal Coating Process

Origin of the Process

The Schoop process was the result of observations made while shooting with a rifle, the inventor noticing that when the leaden bullet struck a stone or piece of cement the lead was driven into the pores of the stone, literally rooting its way in. Moreover, when a bullet struck another previously fired bullet, the two pieces of lead were homogeneously united. Mr. Schoop, who is a native of Zurich, Switzerland, first tried the use of a tank of molten metal, from which drops were atomized and then forced out with compressed air. This had the defect of being too cumbersome an apparatus and, what was more important, the hot metal rapidly oxidized, especially when in contact with the air blast. Later, metal was reduced to dust by grinding, and this dust projected as before. This method was more successful, but the expense of metallic dust and the rapid oxidization made it impracticable. The final development of the process is the one here described. The apparatus weighs but 3½ pounds, and hence is not cumbersome; oxidization is prevented by the hydrogen gas with which the metallic particles are surrounded while being projected.

By means of this remarkable process, it is possible to coat metal, wood, paper, cloth, stone, cement and other substances with lead, tin, zinc, aluminum, copper, brass, bronze, German silver, gold and even steel. It is the only known method of plating with aluminum and steel.

Details of the Process

The mechanism within the pistol serves the purpose of feeding the wire into the nozzle of the torch as indicated in Fig. 5, which best illustrates the action of the process. The nozzle consists of three tubular parts; the inner part that acts as a guide for the wire; the middle section which, in connection with the inside part, forms a conducting tube for the oxy-hydrogen gas; and the outer part, or nozzle proper, which forms a protecting case, and which, in connection with the middle section, forms a tube through which the compressed air is led to the projecting point. The metal wire is fed forward just fast enough to allow it to be disintegrated by the flame and carried to the work by the air blast, the metallic dust being held in suspension in the expanding gas, and carried forward by the air pressure. The wire used is from 0.030 to 0.040 inch diameter and is fed forward at a speed of from ten to eighteen feet per minute—the metals that melt at high temperatures being fed the slowest to allow the flame more time for disintegration.

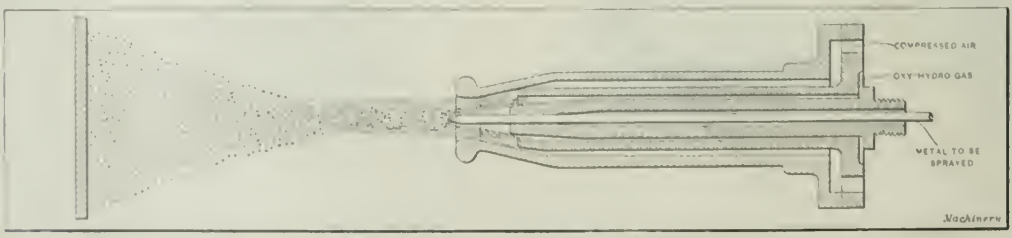


Fig. 5. Section of Nozzle Part of Device used for Metal Spraying

The oxygen and hydrogen may be supplied from standard commercial tanks, but when the process is worked on a large scale, it is advisable to make the gas on the premises for the sake of economy. The tank pressure of the oxygen is 120 atmospheres and of the hydrogen 20 atmospheres, but the oxygen and hydrogen are both used at a pressure of 30 pounds to the square inch. The compressed air is of 100 pounds pressure and is used at the rate of 35 cubic feet per minute. It is important that the proportions of oxygen, hydrogen and air be adjusted for each of the metals used, and that the wire feed be of the right speed in proportion to the flame.

Theory of the Disintegrating and Coating Action

One of the most singular facts relative to this process is that the metal is not applied in a molten state. The correct operating distance is from five to six inches from the pistol point to the work. At this distance a piece of paper or even a match may be coated without danger of ignition. The spray may be directed at the hand without injury. The reason for this is that the gaseous medium is so much larger in volume than the drop of metal reduced to a powder, that the expanding gas cools the metallic spray before it strikes the surface to be coated. The heat of collision, however, causes the particles to vaporize and condense on the relatively cold surface and thus form a homogeneous coating. In addition to the union of the projected particles themselves, the first ones to strike the surface are driven into the pores of it.

The surface produced by this process is granular in appearance; it resembles a sand-blasted surface and on this account does not lend itself readily to polishing, and the process is not recommended where a high finish must be obtained. By proper treatment in the polishing room, however, a well finished surface can be secured. There is no tendency toward peeling or flaking when polishing.

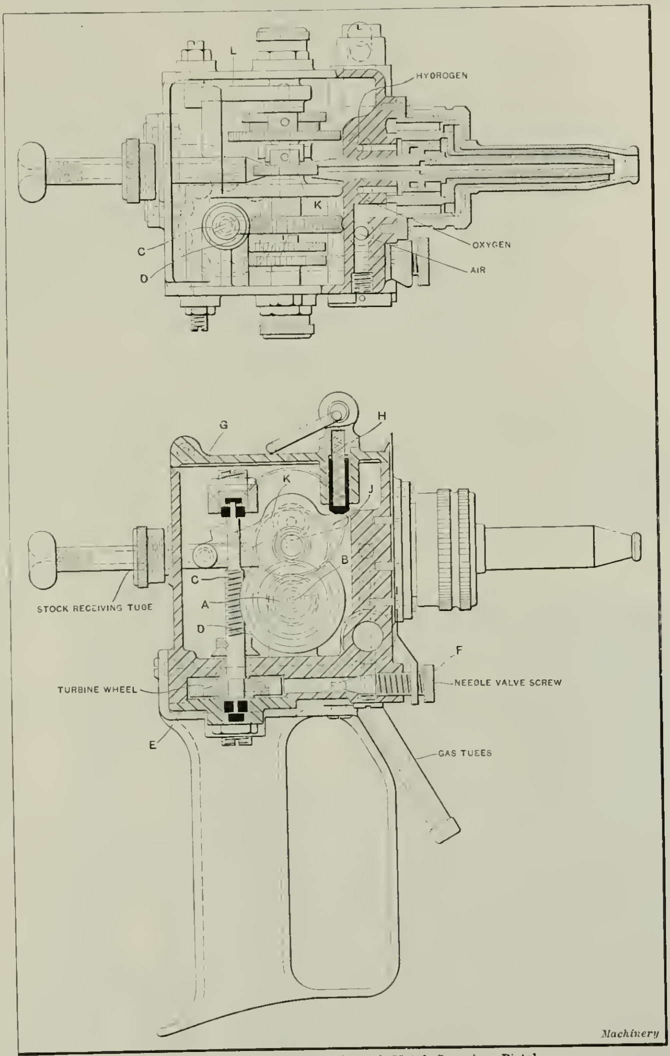


Fig. 6. Section showing Design of Metal Spraying Pistol

The Spraying Mechanism

The spraying pistol is shown complete in Fig. 4, but Fig. 6 will enable the reader to understand its operation better. It has but two functions to perform—the leading of the air and gases to the spraying point and the feeding of the wire. The gas tubes, one for oxygen and one for hydrogen, and the air tube, are placed side by side (see Fig. 6), having proper connection with the concentric tubes in the nozzle.

The wire feed is operated by an air-driven turbine. Entering the pistol box through the stock receiving tube, the wire passes to a pair of toothed feed-wheels that propel it straight forward to the nozzle. The lower feed-wheel *A* is mounted on the main shaft *B*. This shaft is driven by a worm and worm-wheel *C* and *D*. The worm-shaft has at its lower end a turbine wheel *E* mounted in ball bearings. This wheel is driven by air from the main supply tube and its speed, and consequently that of the wire feed, is governed by the amount of air that enters through needle valve *F*. A shut-off valve cuts off the air completely when the pistol is not in operation. This valve, as well as some of the internal parts, can best be seen in Fig. 7, which shows the pistol with the cover raised. The cover is shown at *G* in Fig. 6. It is provided with two spring plungers *H*; when the lid is down, these plungers bear against bracket *J* that carries the upper feed-wheel *K* and the driving gear *L*. Opening the lid for inspection, releases pressure on bracket *J* and prevents the wire from feeding. Beside gear *L* are two other gears used with corresponding pinions for speed changes. These comprise the principal parts of the pistol.

Operating the Pistol

Figs. 8 and 9 give a good idea of the operation of the process. Fig. 8 shows how the operator directs the spray onto the work, holding it within an enclosure provided with a suction draft to take away loose particles. On the right may be be seen the oxygen and hydrogen tanks. Fig. 9 shows the operation in detail, illustrating the gripping of the torch and the length of the flame. In Fig. 8, the operator is coating a wooden pattern for molding. When metal is to be coated, it must first be cleaned of all grease or dirt before spraying. The sand-blast gives the best results, as the rough finish helps the sprayed coating to adhere.

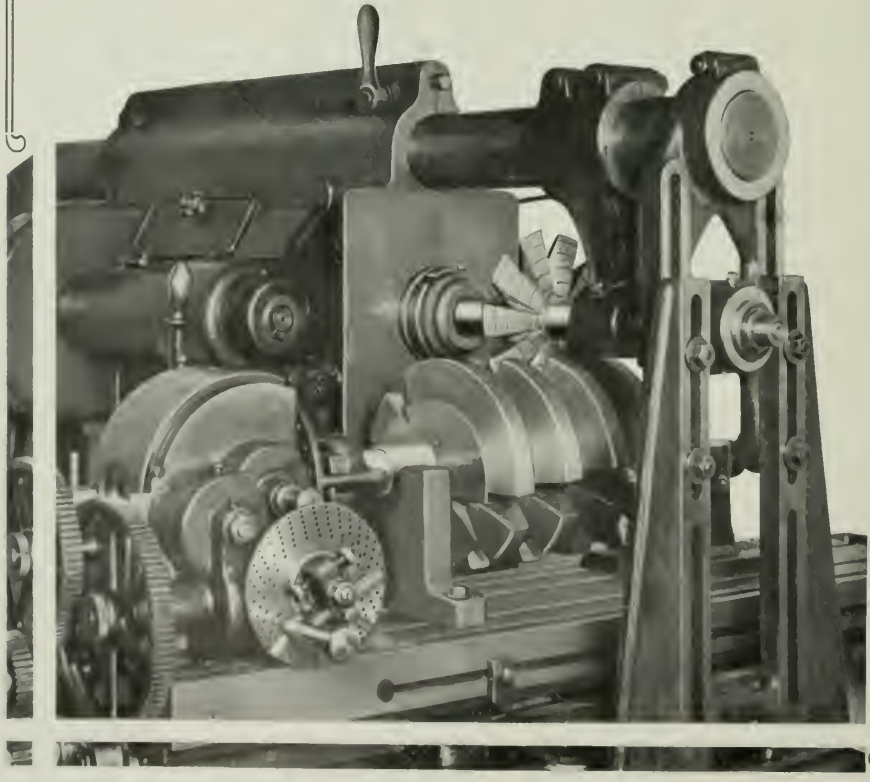
It is interesting to note some of the phenomena of the Schoop process as shown in Figs. 2 and 3. Fig. 2 shows the application of three adjoining coatings of brass, aluminum and copper. Ordinarily, the coating applied for decorative or protective purposes is about 0.001 inch thick, but if required, the coating may be made one-sixteenth inch thick or

Gashing a Big Hob

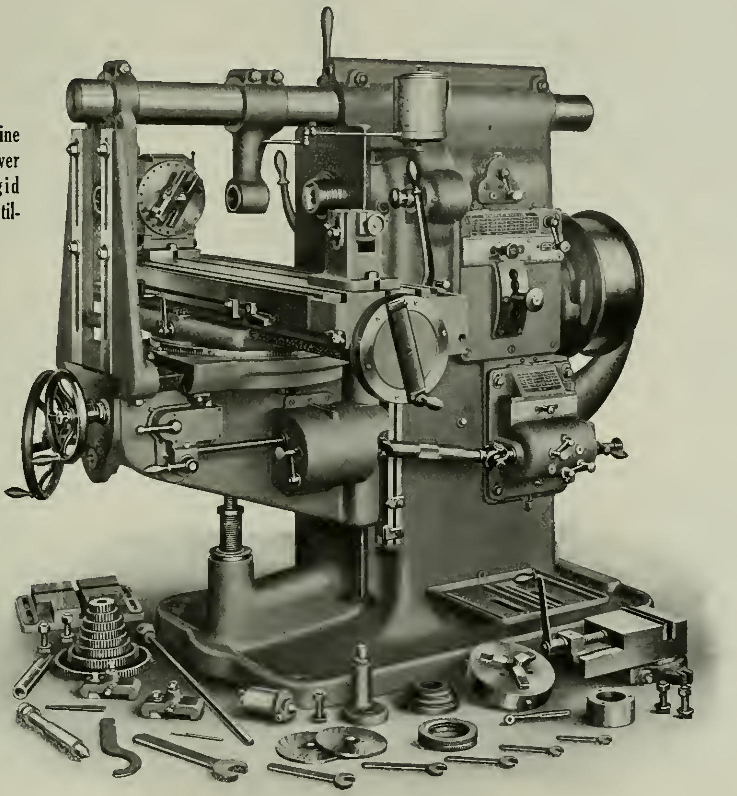
A type of toolroom milling calling for Rigid construction and fine feeds.

This is not an everyday job, but it represents a class of work that is constantly coming up in shops handling large work. This hob of special grade high-speed steel is 11″ in diameter by 12″ long and weighs about 300 pounds after gashing. The 10″ diameter cutter is taking a V cut 2″ wide at the top and 3″ deep.

In order not to break off the ends of the cutter teeth, owing to their length and thinness, a feed of only .0059″ per revolution can be used. Our heavy Universal Milling Machines with constant speed drive have a series of very fine feeds for such work driven from the spindle, **in addition to** the broad range in revolutions per minute driven from the constant speed shaft. They are machines with a capacity for the unexpected jobs.



A Milling Machine of big pulling power with parts rigid enough to fully utilize this power.



No. 3 A Heavy Universal Milling Machine

This is the machine which handled the job shown opposite. It is a rugged representative of our line of Constant Speed Drive Universal Milling Machines, all of which are adapted to rapid, accurate work in the toolroom or shop floor of heavy machinery and engine builders, railroad shops, etc. A well braced one-piece frame, with a massive knee, connected to it by stiff arm braces makes for steadiness under the heaviest cuts. Ask us for literature descriptive of its features.

BROWN & SHARPE MFG. CO.

PROVIDENCE, R. I.

OFFICES: 20 Vesey St., New York, N. Y.; 634 The Bourse, Philadelphia, Pa.; 626-630 Washington Blvd., Chicago, Ill.; 305 Chamber of Commerce Bldg., Rochester, N. Y.; Room 419 University Block, Syracuse, N. Y. **REPRESENTATIVES:** Baird Machinery Co., Pittsburgh, Pa., Erie, Pa.; Carey Machinery & Supply Co., Baltimore, Md.; E. A. Kinsey Co., Cincinnati, O., Indianapolis, Ind.; Pacific Tool & Supply Co., San Francisco, Cal.; Strong, Carlisle & Hammond Co., Cleveland, O., Detroit, Mich.; Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; Perine Machinery Co., Seattle, Wash.; Portland Machinery Co., Portland, Ore. **CANADIAN:** The Canadian Fairbanks-Morse Co., Ltd., Montreal, Toronto, Ottawa, Winnipeg, Calgary, Vancouver, St. Johns. **FOREIGN:** Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow. F. G. Kretschmer & Co., Frankfurt, a/M., Germany. V. Lowener, Copenhagen, Denmark; Stockholm, Sweden; Christiania, Norway. Schuchardt & Schutte, St. Petersburg, Russia. Fenwick Freres & Co., Paris, France; Liege, Belgium; Turin, Italy; Zurich, Switzerland; Barcelona, Spain. The F. W. Horne Co., Tokio, Japan. L. A. Vail, Melbourne, Australia. F. L. Strong, Manila, P. I.

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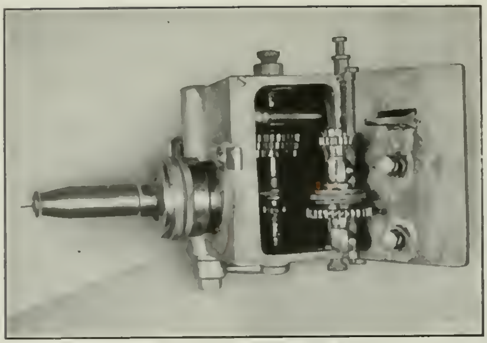


Fig. 7. Device Open, showing Feed Mechanism

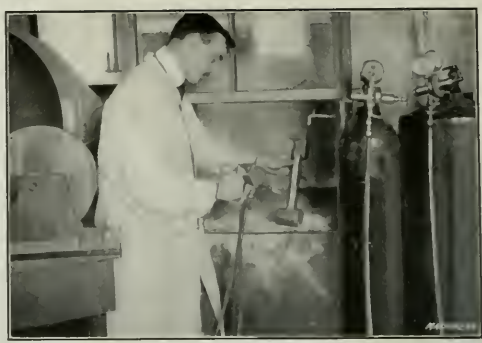


Fig. 8. Application of Pistol for coating a Wooden Pattern with Metal

more. Fig. 3 shows at the left a thick spot of spraying. The top of this spot has been filed to show the density of the structure. At the right a "mountain" of metal has been applied and the flame purposely held close to show how, under such conditions, the surface is melted and discolored. If, on the other hand, the flame is held at a greater distance than six inches, only a few of the metal particles adhere, the rest, because of loss of velocity, being lost before reaching the plate.

Applications of the Process

The applications of the process are many. In general, these may be classed under three main heads: first, protective coatings; second, decorative coatings; third, detachable coatings. Under the head of protective coatings comes rust-proofing with zinc and lead; covering of wooden patterns; covering wooden work that is to be exposed to the weather; and covering parts of metal to prevent cementation when carbonizing. It is not necessary to take large work to the apparatus, as is required in electro-plating. The wooden shingles on a roof can be just as well covered as a small metal pin. Moreover, the coating can be more evenly applied on large objects than is possible when electro-plating, but at the same time, it is possible to give an article a heavy application at points where wear will come, as, for instance, on piano pedals.

For decorative purposes, the field is even larger. Plaster statues may be bronze-coated at the cost of a few cents. Wooden carvings can be coated to resemble hand-chased metal work; aluminum can be applied to any object, and as many different metals as desired may be applied to the same piece. The vase in Fig. 10 is a good example of decorative coating. For copying medals and making electrotypes, the field is large. Steel-faced cuts may be made by coating the mold with oil and then spraying. Many other uses in the printing trades will be developed.

In Fig. 10 may also be seen an egg coated with lead; a piece of glass coated with aluminum; a name-plate coated with brass, having the faces of the letters polished; and several miscellaneous coated parts. Glass may be readily plated by first sand-blasting, and paper and fabric of all kinds may be metal coated and still retain flexibility. Recently a manufacturer had some printing press cylinders, the surfaces of which were porous. Ordinarily, these castings could not have been used, but by spraying them with brass, and then turning the cylindrical surface once more, they were made literally "better than new."

Cost of Spraying Metal

An operator can apply metal to objects at the average rate of one square foot per minute. On soft metals the coat can be applied at twice that speed and with steel or nickel the time would be longer. A pound of lead can be sprayed in less than a minute. The total cost of spraying with soft metals, coating the work about 0.001 inch thick, is less than two cents per square foot. This includes metal, labor and gases at "small-quantity" prices.

The Metals Coating Co. of America, People's Gas Building, Chicago, Ill., controls the rights of this process in the United States; this concern issues licenses for the use of the process and leases the spraying pistols. C. L. L.

* * *

The Panama Canal was formally opened to commerce Saturday, August 15. On that day the Panama Railroad steamer *Ancon* passed through the canal from Cristobal, on the Atlantic side, to Balboa, on the Pacific coast. This was the first large steamer to make the trip through the canal. She carried four hundred guests, including Governor Goethals and President Torras of the Panama Republic. The canal is now open for all commercial vessels having a tonnage not exceeding 10,000 tons. The trial trip was very successful, the locks being operated rapidly and with accuracy.

* * *

MACHINERY will be represented at the Foundry & Machine Exhibition in the International Amphitheater, Chicago, Ill., September 5-11. An exhibit of MACHINERY'S Handbook, reference books, gear books, copies of MACHINERY and field service advertising photographs will be shown in booth 215, on the west side of Machinery Hall. A hearty invitation to visit the booth and become acquainted is extended to all visiting the exhibition.

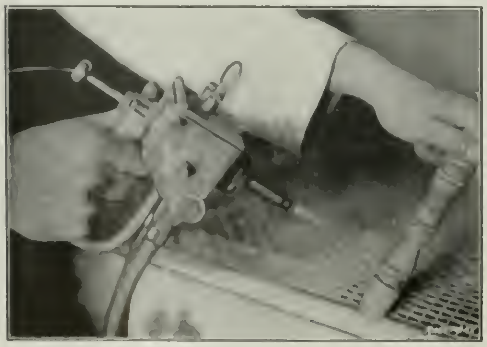


Fig. 9. Method of holding Device when coating

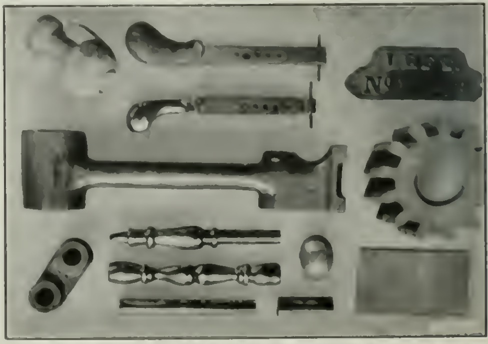
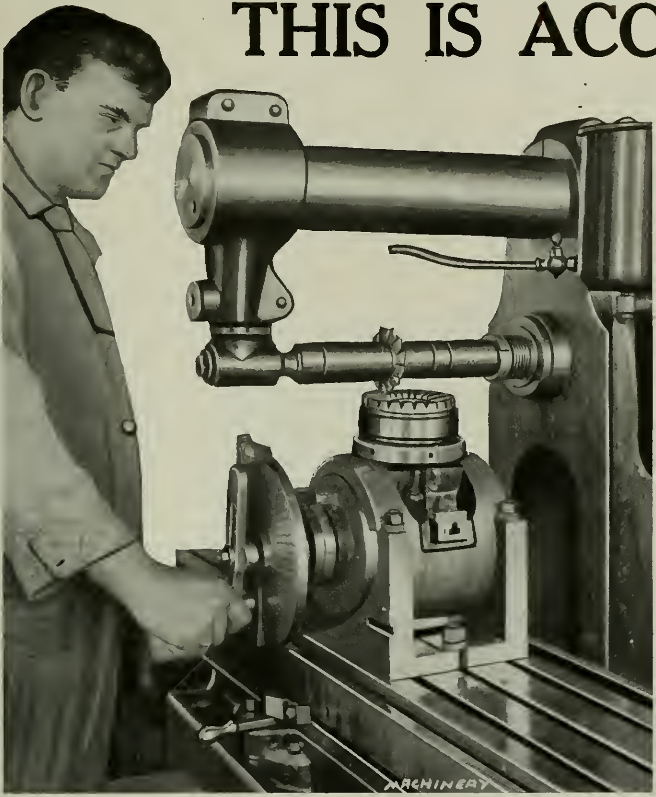


Fig. 10. A Number of Objects coated by the Metal Spraying Process

THIS IS ACCURACY



Cincinnati Dividing Heads

and

Cincinnati Milling Machines

Here's an example of Cincinnati *Accuracy* Milling—cutting a high-speed steel die 6″ diameter, 23 tool settings, in which the limits of error, plus and minus, must not exceed .00085″—and this is regular, everyday work, not a special "stunt."

You too can stop inaccurate tool-room work—when you install Cincinnati Milling Machines and Cincinnati Dividing Heads. We'd like to show you some of the features of Cincinnati design and construction. For example, our Dividing Head Worm Wheels are tested by using a silver ring 12″ in diameter having 720 graduations, the maximum accumulative error of which is .0001″. These graduations clearly show inaccuracies, not only of the worm-wheel, but also of the worm, and cover such points as eccentricity, drunken thread and improper meshing. We'd like to show you the advantages of the Cincinnati Unit System of Construction, Stream Lubrication, and other features.

Send for a copy of "Cold Chips."
It tells the whole story.

The Cincinnati Milling Machine Company
Cincinnati, Ohio, U. S. A.

PERSONALS

E. St. Elmo Lewis, for ten years advertising manager of the Burroughs Adding Machine Co., Detroit, Mich., has been made vice-president and general manager of the Art Metal Construction Co., Jamestown, N. Y.

L. E. Honeywell has been made advertising manager of the National-Acme Mfg. Co., Cleveland, Ohio, succeeding Paul E. Ryan, resigned. The assistant foreign sales work of the company has been assumed by A. E. Henn, assisting W. S. Chase as general sales manager.

W. K. Millholland, Jr., formerly chief designer with the Warner & Swasey Co., and more recently in charge of the Cleveland sales office of Potter & Johnston Machine Co., Pawtucket, R. I., is bringing out the Millholland lathe at the plant of the Greaves-Klusman Tool Co., Cincinnati, Ohio.

W. L. Rickard, of Rickard & Sloan, Inc., 20 Vesey St., New York City, will make an extended trip through South America, leaving New York the latter part of September. Mr. Rickard will visit the principal cities on both coasts and will make a thorough investigation of the markets and best methods of selling machinery and mechanical materials and devices.

Paul E. Ryan, formerly manager of publicity and assistant manager of foreign sales with the National-Acme Mfg. Co., Cleveland, Ohio, has taken the position of general manager of sales with the Osborn Mfg. Co. of Cleveland, manufacturer of molding machines and special machinery, foundry supplies, brushes of all kinds especially for the use of manufacturers, foundries, etc. The company, which also does wood turning and enameling, has plants in Cleveland, Milwaukee, Wis., and New Durham, N. H. Mr. Ryan's headquarters will be in the general and executive offices at Cleveland.

COMING EVENTS

September 5-11.—Foundry and machine exhibition, showing machinery, tools, equipment and supplies for the foundry and machine shop, Chicago, Ill. C. E. Hoyt, secretary, Foundry & Machine Exhibition Co., 1949 W. Madison St., Chicago, Ill.

September 7-11.—Eighth annual meeting of the American Institute of Metals, Chicago, Ill. Headquarters, La Salle Hotel. W. M. Corse, secretary, 106 Morris Ave., Buffalo, N. Y. The program prepared is an unusually strong one, and should be of interest to all connected with the non-ferrous metal industry in any way.

September 15-18.—Twenty-second annual convention of the Traveling Engineers' Association at the Hotel Sherman, Chicago, Ill. W. O. Thompson, secretary, care of New York Central Car Shops, East Buffalo, N. Y.

September 17-22.—Autumn meeting of the Iron and Steel Institute in Paris, France. Offices of secretary, 28 Victoria St., London, S. W., England.

September 20-25 (1915).—International Engineering Congress, San Francisco, Cal., in connection with the Panama-Pacific International Exposition. W. F. Durand, chairman, Foxcroft Bldg., San Francisco, Cal.

NEW BOOKS AND PAMPHLETS

Treatise on Milling and Milling Machines. 332 pages, 6 by 9 inches. Illustrated. Published by the Brown & Sharpe Mfg. Co., Providence, R. I. Price, bound in cardboard, $1; with cloth covers, $1.50.

This book has been prepared in as simple and non-technical a manner as possible, with the idea of making it of value to the beginner and practical man, but everyone interested in milling machine practice will find the field thoroughly covered in this interesting and valuable publication. The book is profusely illustrated with excellent engravings. Each section contains illustrations showing typical operations of the class treated. For example, in the chapter on gear-cutting, numerous typical examples of gear-cutting are shown, and, similarly, in the chapter on cam-cutting, every-day cam-cutting jobs are illustrated. The arrangement is unique in that the general description is given first, and this is followed by numerous illustrations showing the work being done. Each illustration is accompanied by a paragraph describing the set-up and operation of the machine for the job shown. The value of this information to the operator is apparent. Practically every class of work met with in every-day milling machine practice is shown. Some of the examples are: milling grooves and slots; surfacing brackets; face milling; cutting circular T-slots; cutting spur, worm, spiral and bevel gears; cutting cylindrical cams; milling gibs; milling flutes of twist drills, sawing flat stock; boring and drilling holes; planing, etc. It is not attempted, of course, to show how a job should be set up for commercial manufacturing, as special fixtures designed solely for certain operations are then employed. The contents by chapter heads are: Classification of Milling Machines; Essentials of a Modern Milling Machine; Erection and Care of Machine; Spiral Head—Indexing and Cutting Spirals; Attachments; Cutters; General Notes on Milling, together with Typical Milling Operations; Milling Operations—Gear Cutting; Milling Operations—Cam Cutting; Graduating and Miscellaneous Operations; Tables. The last section of the book contains a number of useful tables, among which are indexing tables for plain and differential indexing, tables of approximate angles for cutting spirals, tables of leads, index movements of spiral head for longitudinal graduating on a milling machine, etc.

NEW CATALOGUES AND CIRCULARS

Gurney Ball Bearing Co., Jamestown, N. Y. Booklet outlining the advantages of the Gurney ball bearing. Tables give dimensions, capacities and prices of Gurney radial bearings, radio-thrust bearings and duplex bearings.

Graham Mfg. Co., Providence, R. I. Card illustrating Graham drill vises, with and without jig attachments, drill speeders; and adjustable knurl holders for turret lathe. The card is designed as a wall hanger, having twelve pertinent business maxims of general interest.

Whitman & Barnes Mfg. Co., Akron, Ohio. Circular of "W. & B. Diamond" machinists' supplies, illustrating W. & B. twist drills and reamers and their application in drilling the guard gates of the Pedro Miguel Locks, Panama Canal. W. & B. screw and drop-forged wrenches are also shown.

National Machinery Co., Tiffin, Ohio. Leaflet showing the National die-head and the work it accomplished at a demonstration, during the recent general foremen's and tool foremen's conventions in Chicago. With this tool a one-inch thread was cut on a 1⅛-inch tapered steel blank at 50 feet per minute.

C. J. Mathison, 401 Marvin St., Beloit, Wis. Circular describing a new method of disk grinding developed by Mr. Mathison, foreman grinder in the Berlin Machine Works. This is claimed to reduce the abrasive cloth disk bill more than 75 per cent as compared with the cost of the ordinary disk-grinding method.

National Tube Co., Pittsburg, Pa. Bulletin 10 C contains three articles reprinted from trade publications on steel pipe, viz., "The Relative Corrosion of Iron and Steel Pipe as found in Service," "Plain Facts about 'National' Pipe for the Plumber and Steamfitter," and "Relative Merits of Wrought Iron and Steel Pipe."

Charles H. Besly & Co., 120-B N. Clinton St., Chicago, Ill. Samples of Besly circles for use on disk grinders. The samples are mounted on 6 by 9 inch cardboard sheets, on which is printed the price-list, order number, grain and available sizes. On the back of the cards is useful information for users of disk grinders.

American Manganese Bronze Co., 99 John St., New York City. Catalogue on high-grade bronzes, showing examples of work in which Spare's manganese bronze has been used. Among these are the hull plates of the "Resolute" and "Vanitie" ships, parts of the Catskill aqueduct and Panama Canal, and other construction work.

Neil & Smith Electric Tool Co., Cincinnati, Ohio. Pamphlet on portable electrically driven tools, illustrating portable electric center grinder, drill, ball bearing grinder and screw-driver. The center grinder automatically grinds centers to the standard angle of 60 degrees, without adjustment or attention from the operator.

Doehler Die Casting Co., Court and Ninth Sts., Brooklyn, N. Y. Bulletin 105 of die-castings in white metal alloys, illustrating a variety of parts made of white metal in steel molds, which are good illustrations of the economy of using die-castings when the number of parts required warrants the cost of making the dies.

Chicago Pneumatic Tool Co., Fisher Bldg, Chicago, Ill. Bulletin 34-W descriptive of Class A-O "Giant" fuel oil engines. These engines are built in four standard strokes: 8, 10, 12 and 14 inches. The various details of construction are completely described and illustrated and a table gives general dimensions and cylinder ratings.

D. & W. Fuse Co., Providence, R. I. Circular 204, describing the latest improvements in the magnetic chucks and appurtenances made by this company. The circular shows taper attachment for flat chucks, swiveling chucks, demagnetizing switches and demagnetizers, as well as the application of magnetic chucks to some of the commonly used grinders.

Ready Tool Co., 654 Main St., Bridgeport, Conn. Pamphlet entitled "Stellite and How to Use It Successfully," setting forth the properties of "Stellite," a new cutting alloy which is non-magnetic, non-corrosive and of extreme hardness. Instructions for the use of "Stellite" and the care of "Stellite" tools are also given. This company makes "Stellite" tools for use in "Red-E" tool-holders.

Canton Foundry & Machine Co., Canton, Ohio. Booklet showing the portable floor cranes and hoists manufactured by this company. These hoists are made regularly in eight sizes varying from a machine with a height of 5 feet 8 inches and a lift of 4 feet 6 inches to one having a height of 12 feet 8 inches and a lift of 11 feet 3 inches. Certain special sizes are made with extra wide or extra narrow beds and other slight changes in dimensions.

Standard Machinery Co., Auburn, R. I. Catalogue (tenth edition) of rolling mills. 56 pages, 6 by 9 inches. The rolling mills made by this company have cut herringbone gearing and hardened and ground tool steel rolls equipped with roller bearings. The special feature claimed for them is economy in operation. Various parts of the rolling mills are illustrated, as well as different sizes of the complete machines. Special mills and applications, spoon grading and cross-rolling mills and wire flattening mills are shown.

Hess-Bright Mfg. Co., Front St. and Erie Ave., Philadelphia, Pa. Booklet entitled "Ball Bearings in Machine Tools," being virtually a treatise on the subject of ball bearings, with special reference to Hess-Bright ball bearings. The book takes up the function of "Hess-Brights," early ball bearings, origin of annular type, uses of Hess-Bright ball bearings, special Hess-Bright features, mounting and closure, and applications. Halftone and line illustrations show the installation of Hess-Bright ball bearings on a variety of machine tools.

Ingersoll-Rand Co., 11 Broadway, New York City. Bulletins 3024 and 3030 entitled "Ingersoll-Rogler Valves for Air Compressing Cylinders" and "Ingersoll-Rogler Class ER-1 Power Driven Single Stage Straight Line Air Compressors," respectively. Bulletin 3024 is a treatise on the valve and 3030 is on the compressor, both being profusely illustrated and showing the details of the machine in section. It is claimed that the new line of compressors will deliver more air for the same power expenditure than other compressors on account of the distinct advantages possessed by the new type of valve. The operation of the valves is entirely independent of all valve gear or other mechanism.

Ready Tool Co., 654 Main St., Bridgeport, Conn. New catalogue 12, entitled "The Vital Factor in Cutting." Twenty pages, 6 by 9 inches. The Ready Tool Co. has given much time and thought to the vital factor in cutting—the tool—with the result that the "Red-E" tool embodies many improved features of tool design. This tool is made with a drop-forged chrome-nickel holder and a high-speed steel inserted cutter. The construction is such as to hold the tool absolutely rigid and prevent chatter. The Taylor-White process is employed for treating the high-speed steel, thus insuring uniformity of results. "Red-E" lathe, shaper, planer, roughing, threading and cutting-off tools, boring-bars and milling machine and lathe dogs are illustrated.

Moore & White Co., Philadelphia, Pa. New 1915 catalogue on friction clutches. 48 pages, 6 by 9 inches. The contents comprise description of the various parts of the clutches, information on installing, adjustment and operation of Moore & White friction clutches, horsepower rating of Moore & White clutches, prices and dimensions. The Moore & White friction clutch makes it possible for the operator to stop any piece of machinery instantly, without necessitating the shutting down of the entire line. This results in the saving of much valuable time, and in case of accident, obviates serious injury to workmen and machinery. The particular advantages claimed for the Moore & White friction clutch are: mechanical stability, starting power and simplicity.

Winter Bros. Co., Wrentham, Mass. Catalogue 9 on the complete line of taps and dies made by this company, including those made of high-speed steel. Ninety-five pages, 5 by 7 inches. The section of the catalogue devoted to the high-speed steel tools is printed on buff paper so that it can be readily distinguished. On pages 12 and 22 are illustrated taps with special styles of fluting that have not before been listed. It has been demonstrated that these styles are much better for machine use than the regular taps with four flutes, inasmuch as they greatly reduce the loss by breakage. Tables of specifications, including sizes, prices, etc., are given for machinists' hand taps, nut taps, machine screw taps, tapper taps, staybolt taps, pipe taps, etc. Adjustable round dies, solid bolt dies and spring screw threading dies are similarly treated. Among the tables of information included are: standards for wire gage in use in the U. S.; A. S. M. E. standards for machine screws, special screws, machine screw taps and special taps; tap drills for machine screw taps; and other valuable material.

TRADE NOTES

Morse Twist Drill & Machine Co., New Bedford, Mass., announces the fiftieth anniversary of the founding of the company May 28, 1864.

Billings & Spencer Co., Hartford, Conn., received a large foreign order in July for drop-hammers which will necessitate the machine department running full time for several months.

Adolph Leitelt Iron Works, Grand Rapids, Mich., jobbers of mill, factory and machine shop supplies, are compiling a new catalogue covering these lines. The works are desirous of forming agency connections.

MACHINERY

OCTOBER, 1914

A TEN-MILLION-DOLLAR EFFICIENCY PLAN

HOW HIGH WAGES AND MECHANICAL EFFICIENCY HAVE LOWERED THE COST OF PRODUCT

BY HAROLD WHITING SLAUSON[*]

WHEN Henry Ford first made his sensational announcement of the plan to distribute $10,000,000 among his workers as a wage bonus, the industrial world gasped; when it recovered its breath, surmises as to the automobile manufacturer's object, and speculations as to whether he had become a publicist, a philanthropist, or merely mad, were almost as plenteous as the hordes of men who applied for work at the gates of his plant the morning after the plan had been made public.

Those who considered that, by this one announcement, Henry Ford had constituted himself the greatest advertiser in the world, were, in a measure, correct; the space devoted to the outlines of the plan on the front pages of the leading daily papers, and the editorial comment that supplemented the announcement could not have been bought for twice the sum involved. So, too, those who ascribed the origin or development of the plan to philanthropic motives were not entirely wrong, for it is known that Henry Ford takes great pleasure in the manner in which his workmen have profited by their increased earnings and improved their conditions of living. In fact, a staff of some 200 examiners is kept busy investigating the merits of each case, and any workman who, it is thought, would not apply his increased earnings to the benefit of his family cannot share in the distribution. This would seem to indicate that there is more than the material side connected with the Ford plan, and that one of its primary ideas is to work the greatest good to the greatest number of Ford employes.

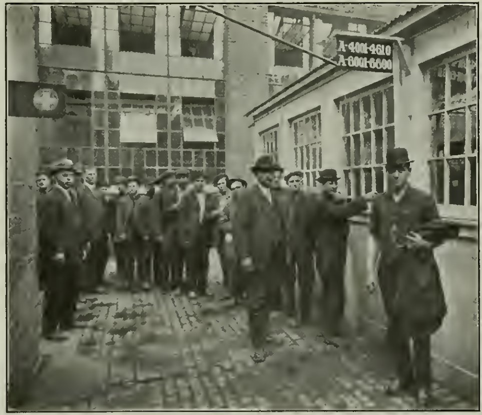


Fig. 1. Small but Representative Group of Ford Employes lined up at Paymaster's Window

But the statements of those who would call Henry Ford mad, a fanatic, or a disturber of industrial conditions have been so thoroughly disproved that the reaction has now set in, and he is hailed as one of the keenest business men of the age—a man who can spend $10,000,000 in increased wages in one year, and realize a profitable return within the first month after the inauguration of the plan. The plan itself seems so gigantic that the average manufacturer is likely to lose sight of the fact that it is merely a somewhat elaborated type of profit-sharing, commensurate with the business done by the Ford Motor Co. The $10,000,000 represents approximately, 10 per cent of the gross

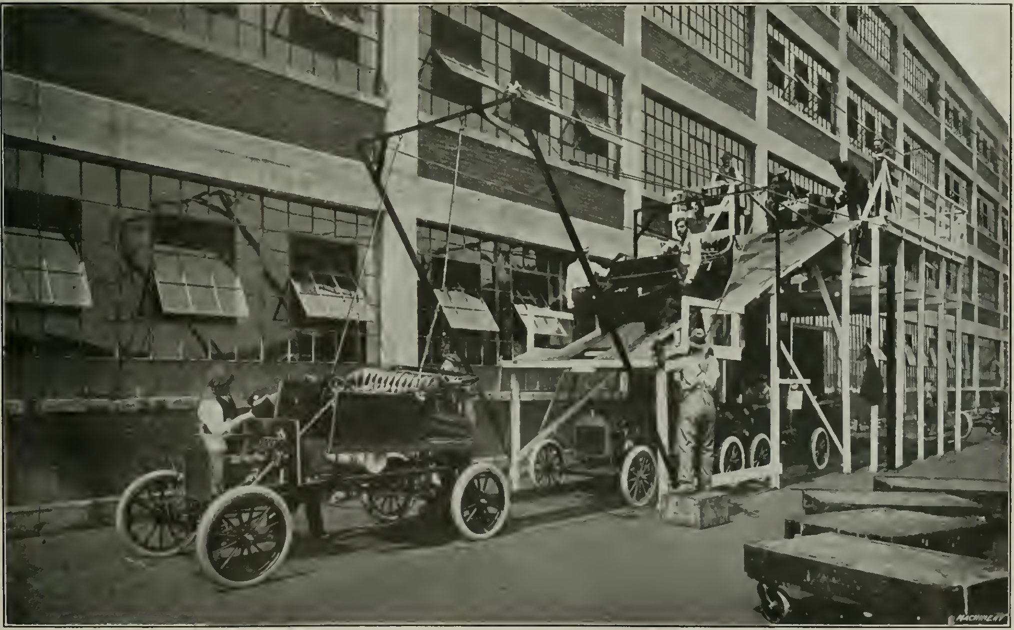


Fig. 2. A "Rolling Stone may gather No Moss," but a Moving Ford Car grows at Every Turn

value of the Ford output for 1914, and is distributed among the majority of some 16,000 men employed in the main Detroit factory and the various assembling stations in the larger cities. This money, however, instead of being paid at the end of the year, as a bonus, or in the form of a profit-sharing system, is included in the *daily* wage of every worthy man over twenty-one years of age, and of every woman or boy who contributes to the support of a family. The minimum wage paid to such persons is $5 per day, and this applies to the washers and men who sweep the floor, as well as to the more skilled classes of mechanics. A few of the best machinists and toolmakers receive $7 per day, and the whole scheme has served to give each participant a wage advance of from 25 per cent to 100 per cent over the former amount received by him.

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Thirty dollars per week as a minimum wage for the least skilled type of labor would seem to mark, not efficiency, but rather administrative extravagance. To increase the ratio of wages to gross value of product from 15 per cent to 25 per cent appears to be retrogression instead of advance—until figures are examined and the unique conditions prevailing in the Ford plant are thoroughly understood. As a single instance of the success of the plan from a monetary standpoint, it is but necessary to point out that in February, after one-twelfth of the $10,000,000 had been distributed in the form of the wage bonus, production had been increased 40 per cent over that of the preceding month, and this result was secured with a force of 200 men less. If increased production could be maintained at this rate, the 10 per cent additional cost represented by the wage increase would assuredly be money well invested. And the nature of the plan, and its application in the Ford plant is such that this continued increased production with the same force is not only a possibility—but almost a certainty.

In order the better to understand how such results are possible, and to observe in just what manner the plan was evolved to exactly fit the requirements found in the Ford factory, it is necessary to study the general plan of manufacture of this world-famous product. It might logically be supposed that a force of 15,000 men employed under one roof would be sufficient to make cars by hand, and to almost entirely eliminate the use of machinery. But when we think of the production of over 200,000 Ford cars in 300 working days, and realize that this means that each workman completes somewhat over thirteen cars during the year, it is evident that only by the aid of the most modern machine tools and efficiency of the highest type can such a feat be accomplished. The contrast is all the more remarkable when applied to the average high-priced car selling at $4000. In one of the best-known factories building cars of this type, 4000 men are employed to turn out 3000 cars—or only three-quarters of a car per year per man—and yet this plant is famous for the quantity and quality of the machine tools used in the production of its cars.

In the Ford plant, the human element has been eliminated as far as possible—and yet it was solely through its appeal to human nature that the wage bonus plan proved so successful in increasing production. However, this is but one of the many paradoxes and anomalies that are to be found in an investigation of this most wonderful of motor-car factories. The Ford plan does not provide for an extra bonus in the form of a money prize to be given to the men who excel in quantity or quality of work; the daily distribution of the "minimum wage" would have been made the same in February, even though the figures had shown a decrease in production. Henry Ford has announced that this wage will prevail throughout 1914, and that he has every reason for believing that events will warrant its continuation indefinitely; but production figures, as a goal to be obtained, are not held as a bait above the workman's head. This is probably due to the peculiar fact that the average workman has but comparatively little control over the quantity of his output; the Ford factory is one vast machine, and it is an actual fact that the speed at which a dozen or so of the conveyors are driven determines the rate of production in the factory. The Ford employes are the "breaker boys" of

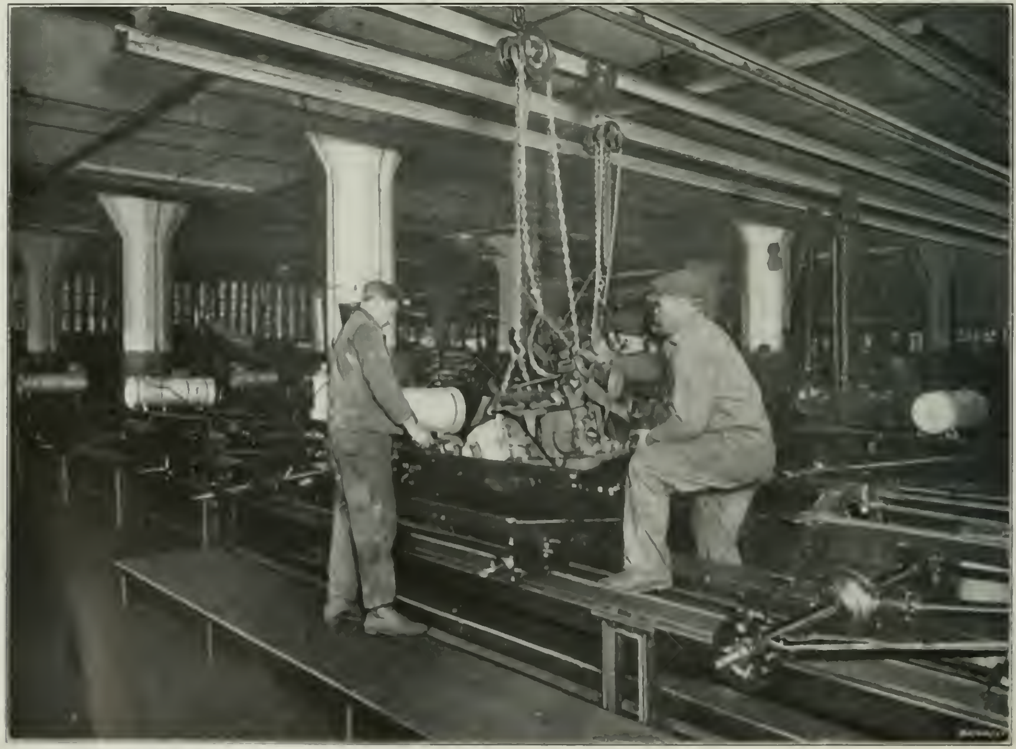

Fig. 3. Point at which Motor joins the Growing Car

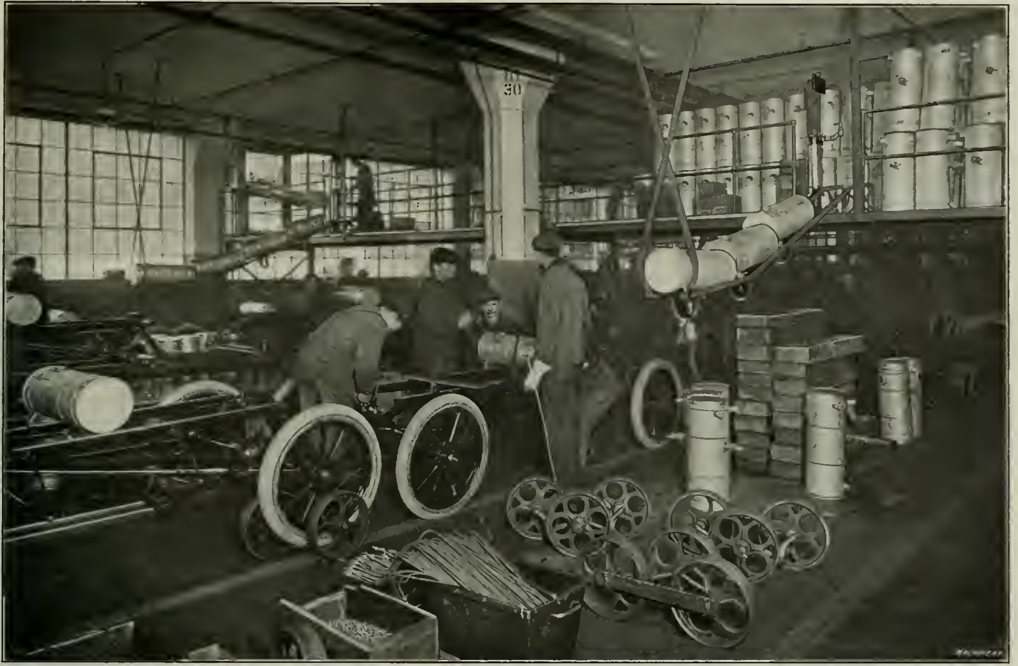

Fig. 4. There are no Finished-parts Stock-rooms in the Ford Factory—These are replaced by Overhead Bridges

the Ford automobile "mine"; the partially assembled cars or their parts move before them on an endless chain, and there is but so much time permitted for each operation. This is a feature of Ford manufacturing methods that is of comparatively recent origin, and one that was adopted primarily to meet the requirements of the new plan.

Probably the majority of those who have kept pace with improvements in manufacturing methods are familiar with the system in vogue in the Ford foundry, in which the molds are machine-made and, in the flasks, are placed on a series of moving tables. The tables are placed but two or three feet apart, and move around an oval-shaped overhead rail. As the empty tables are carried by the molding machines, the flasks are placed thereon, and a few "feet" later, the ladle men are ready to pour the molten metal into the molds. If there is a delay at the ladles, the men merely must pour faster to "catch up" with the flasks as they pass by in endless procession. By the time the flasks have been carried to the opposite side of the oval, the castings have cooled sufficiently to be removed, and the newly pressed molds are set in place. Approximately two engine castings per minute are made in this manner.

This same system is applied to practically all of the machine work and assembling operations, but it is in the latter department that the greatest strides have been made. Consider, for example, the assembly of the motor. The machined and reamed casting is placed on a pair of rails at about workbench height, and as it is moved at a constant speed, the various parts are added. Two men—standing opposite each other—will insert the pistons; another pair install the crankshaft; another the camshaft; and the next, the bearings; until finally the crank-case, cylinder-heads, valves, and gears are all set in place by as many additional "crews," and their followers tighten the bolts that have previously been inserted. By the time each motor is completed, it has reached the end of the rails and is slid onto a movable framework on which it is taken to the "limbering" department for the purpose of lapping in the pistons and rings. But as an expression of the spirit of despatch and efficiency of the system, it is interesting to note that even on this short journey it is not immune from growth, for it is accompanied by a man with a paint pot who performs his work on those parts requiring attention before the next operation is begun.

Apply this system to every important part of the car—and finally to the car itself—and we may be able to form some idea of the machine-like regularity of production in the Ford plant. The rear axle assemblies grow, as they proceed on an endless chain in front of the two lines of workmen, each individual of which is ready with some part or tool to insert or tighten as the work moves by. The two halves of the tubular rear axle are placed together by one pair of men; the next pair insert eight cap-screws in as many holes in the flange of the differential housing that serves to clamp these two halves of the "dead axle" together; and the third pair tightens these, one man holding a socket wrench against the bolt head, while his companion opposite him sends the nut home by means of an electrically driven wrench made only to fit that size and type of nut. As the rear axle assembly is completed, the entire unit is disgorged, end up, into a vat containing the paint or enamel with which it is to be covered. While in this position it is fitted into a fixture by means of which all but the exposed ends may be submerged by the movement of a lever. This operation is supplemented by a man with a long-handled brush, who touches the portions not previously covered, and the unit is then automatically transferred to an elevating chain that carries it to the roof of the building and then to the place in the factory where it is to meet the growing chassis of which it is to become a part. But this portion of the building is some three hundred feet distant from the paint vat from which the axle has recently emerged, and, therefore, in order that no time will be wasted or motions lost, a drying room, having a temperature constantly maintained at about 110 degrees, has been constructed at the roof of the building throughout the length of the horizontal travel of the axle carriers. The result is that the axles reach their destination a few moments later, completely dry and ready for installation in the car. As these chains carry the axles at a speed equal to a slow walk, and as not over two feet separate each unit, it is possible that the reader will be able to grasp an idea of the immense quantity production that prevails in this plant. Of course, the speed of assembly cannot be as great as this, for the limited number of men working side by side could maintain no such pace, and there are therefore three of these assembling tracks that unite at the paint vat, the product of which is carried on the single overhead chain.

With the frame as a starting point, the various parts of the chassis are added in the same manner—first the springs, next the axles, and then the wheels, followed in order by the gasoline tank, the driver's seat, the motor, and finally the radiator. As the rapidly growing chassis reaches the proper point, it is met by these various parts that are fed down from overhead chutes. There are no finished-parts stockrooms in the Ford plant, but, instead, the completed pieces are taken directly to these overhead bridges, from which they are fed into the chutes like so much gum in a slot machine. When the "sluice" is opened a set of four wheels, a radiator, a gasoline tank, a seat, or a pair of fenders is poured out onto the chassis that, unlike the proverbial rolling stone, has been gathering verdure at each turn. There are four of these chassis assembling tracks, and each delivers its completed car onto a set of revolving drums that serve to set the rear wheels spinning, ready to start the motor as soon as the tester is able to jump into the two-minute-old seat and throw in the clutch. While he is doing this, the radiator has been filled and a rubber hose connected with the exhaust pipe—and another Ford car has been born.

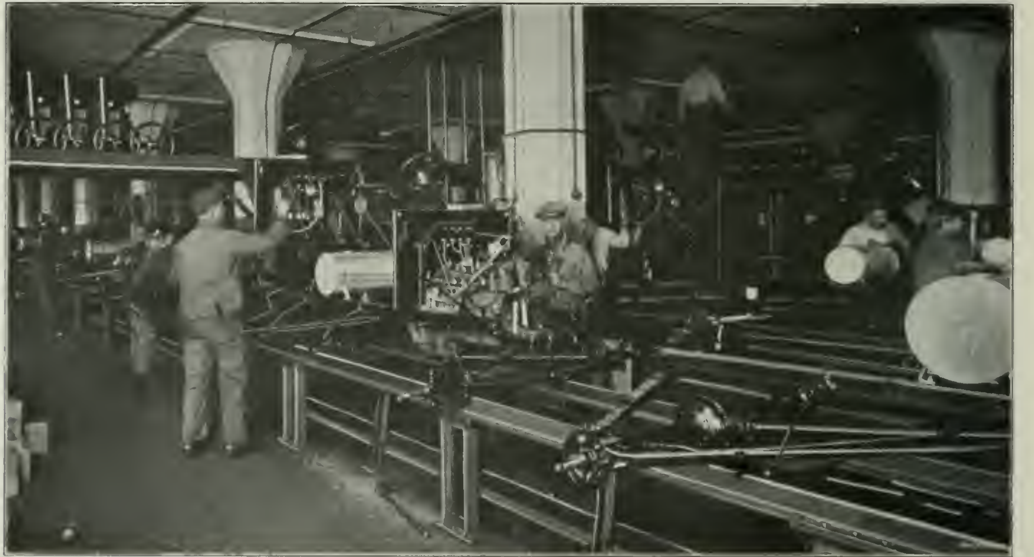

Fig. 5. Close View of Tracks on which the Ever-growing Chassis is mounted, and on which it travels at a Constant Speed

Under these conditions of machine-paced production, is it any wonder that the movements of the men become practically automatic and that output is regulated entirely by the speed at which the travelling chains are operated? Speed up the electric motors a notch and—presto! Ford production has increased another hundred cars per day without the necessity of hiring a single additional workman. No one, no dozen, no hundred of the wage earners is absolutely necessary to the organization; the work that the average man in the Ford shops performs could be learned in a few hours of instruction by an immigrant unable to speak a word of English—and yet the average wage received is $30 per week! But much as the monotony of each man's work might be expected to lead to discontent, the prospect of wages double those that could be obtained at any other factory for the same work serves as a deterrent and positions in the Ford factory are eagerly sought for. This has resulted in the elimination of what had previously been one of the serious problems of the organization—the instability of the personnel of the workmen. Before these high wages went into effect, each workman averaged less than ten months during which he remained in the employ of the company, and this necessitated the hiring of some 15,000 men each year in order to maintain the required force of 14,000 men. Now, however, with positions in the Ford factory at a premium, each man values his position, and the work of the employment office has been marvelously reduced.

As a further inducement toward permanency of employment, the new Ford plan provides for the arrangement of production so that the annual "slack season"—when inventory is to be taken, the machinery overhauled, and preparations made for the manufacture of the new models—shall occur during the summer when the great farms of the Middle West are in need of men for the harvest. This system practically provides for permanent employment of the men, the more so as the Ford Motor Co. maintains a sort of clearing house and undertakes to obtain positions in the harvest fields for its men. Another feature of the Ford plan, which must not be overlooked, is the conscientious endeavor to select only the best and most deserving workmen. As has been mentioned in a preceding paragraph, the home life of each employe is closely investigated, and the bonus is only given to those who would spend their wages wisely. The wife of a Ford workman receiving the minimum wage of $5 per day is not allowed to keep boarders, nor may she "take in" washing. Thrift is encouraged, however, and as evidence of the manner in which the men have retained or acquired this trait, it is but necessary to mention that the savings bank established near the factory had received, during the first five months of the operation of the plan, deposits amounting to somewhat over $3,000,000.

Naturally, there will be no strikes in a factory so liberal in the manner in which it treats its workmen; and if there should be, so large a number of men would stand ready to take the places deserted by the old employes that a strike would prove to be the most futile method in the world for adjusting whatever grievance might arise. The Ford automobile is a manufactured article that fills a world-wide demand, and the only problem to be met is that of producing this car as cheaply as possible. The answer to this problem lies, chiefly, in the wholesale use of machines and machine tools—"handmade" is a word unknown in the Ford factory; but the human element enters into the consideration, and this is, in reality, the one *variable* that must be dealt with. But to hold this variable within as restricted limits as possible, and, in fact, to reduce it to a *constant*, the Ford plan, dealing with the men and their compensation, was evolved. The question as to whether this plan has been proved to be successful or not can be best answered by a brief resumé of the results accomplished. Production has been increased without increasing the number of employes; the work of each individual has been so standardized, specialized, and simplified that no skill is required in the manufacture of any part; the permanency of employment has been increased; the character of the workmen has been improved; the possibility of strikes has been practically eliminated; and positions in the Ford factory have been made so desirable that the places of one or all workmen could be filled immediately from men from the other factories in Detroit.

If all of this can be accomplished with an expenditure of only 10 per cent of the previous gross income, the plan is assuredly a success, for additions to the plant and equipment, together with the extra men necessary to produce these results, would have represented an outlay greatly in excess of this sum, and one that would ordinarily be obtained through a new bond or stock issue. Successful as this plan has proved itself to be when applied to the Ford plant, it is doubtful if it would meet with equal success in the case of other manufacturing enterprises. The Ford capital, plant, equipment, organization, and work were ideally arranged for the operation of such a plan, and the time was ripe for its inception. But certain of the principles involved can assuredly be applied to other businesses, and for testing such an idea on so large a scale, the industrial world owes a debt of gratitude to Henry Ford.

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A catalogue recently published by the Hindley Gear Co., of Philadelphia, contains a historical note of interest on Hindley worm-gearing. These gears take their name from an English engineer, who, about 1857, first pointed out that if a machine could be built to cut them, such gears would be superior to all worm-gears. Nothing was attempted in the way of producing these gears commercially, however, until Stephen A. Morse of Morse, Williams & Co. of Philadelphia, took up the matter in 1878. After building an experimental machine, the gears were finally produced commercially in 1880, and from that time have been used in Morse screw elevators exclusively. The characteristics of Hindley worm-gears are a concave worm, the teeth of which are in full contact with several worm-wheel teeth at once. A comparatively recent development is Hindley spiral gears, a term applied to that class of worm-gearing in which the angle of the teeth with the gears is such that either gear will drive freely in either direction and from either gear. These are made commercially in ratios from 1 to 1 up to 10 to 1 and are used chiefly for automobile rear axle drives.

A MULTIPLE WIRE-DRAWING MACHINE*

BY S. A. J.

At present, a good deal of interest is being paid to the methods of producing fine wire used for weaving purposes, etc. The continuous wire-drawing machine built by Messrs. Werths & Co., of London, England, together with a new method and apparatus for annealing and continuous pickling, washing, drying and winding of fine wire from phosphor-bronze, gun-metal, brass, copper and other fine metals, apparently presents marked advantages over processes hitherto used. This multiple wire-drawing machine differs in several respects from machines hitherto manufactured for the same purpose, as the drawing pulleys run on vertical shafts and are grouped around the draw-stones which are combined in a single adjustable die-holder, with the exception of one die-holder, which is fitted at the place where the wire enters the machine. This gives the machine a very compact and simple construction, as illustrated in Fig. 1. This compactness is of importance not only because of space considerations, but also from the point of view of supervision of the work, and, above all, on account of power requirements.

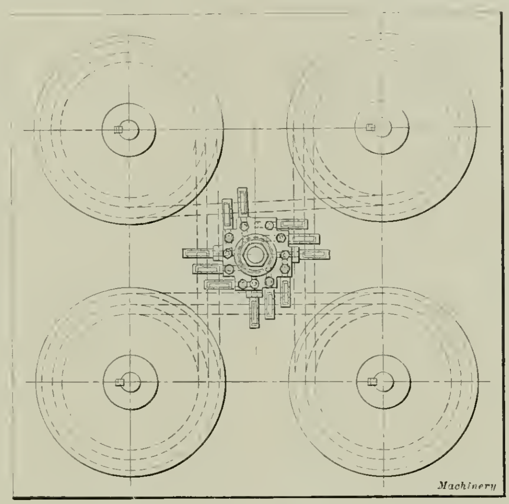

Fig. 1. Plan View of the Werths Multiple Wire-drawing Machine

It is a point of special importance that the whole wire-drawing mechanism, including the drawing pulleys, lies in one common water tank so that the entire process of drawing goes on under water. This tank can be lowered by a hand lever so that it is possible at any moment to liberate the drawing mechanism with a single movement of the hand in order to ascertain its condition. The die-holders are so constructed that the wire is passed to the drawing pulleys in a straight line. The wire thus encircles all the drawing pulleys for only three-quarters of their circumferences, except in the case of one pulley on which the winding covers somewhat more than the circumference, so that it is impossible for the wires to become entangled or cling to one another and break. The drawing pulleys have three grooves of different diameters, and hence three wire-drawing dies can be used. The ready drawn wire after passing through a short bath is wound on a collecting drum having detachable flanges; and these drums with the wire on them are placed in the annealing furnace, but the wire can also be wound on a drum in the usual way, from which it is removed in coils. The ma-

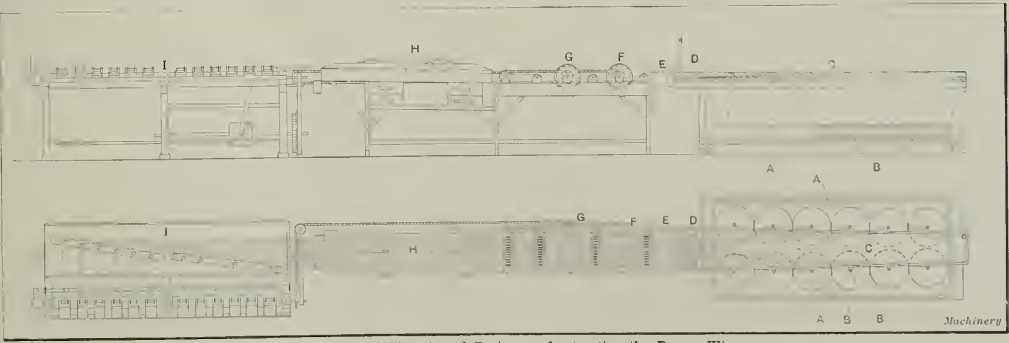

Fig. 2. Plan and Elevation of Equipment for treating the Drawn Wire

chine is also fitted with a mechanism enabling it to stop automatically when the wire breaks.

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* For additional information on the subject of wire drawing published in MACHINERY see "Wire Drawing," October, 1912, and "The Making of Seamless Gold Wire," March, 1911.

It may be pointed out in this connection that as the whole drawing process takes place under water, the wear on the drawing pulleys and dies is evidently reduced to a minimum. Skilled workmen are not necessary, and young workers can be employed almost exclusively. They have no influence on the ultimate condition of the wire, as they only handle it in the crude state. The collecting drums on which the wire can at once be passed into the annealing furnace have a capacity of 33 pounds. The space occupied is much less than with machines hitherto used; and the air in the workrooms is not filled with metal dust, so that the work is healthful. The precipitated dust is recovered in the form of slime. The drawing process insures uniformity, which is important for wires such as phosphor-bronze warp wires.

The use of this continuous wire-drawing machine is followed by the further process for the treatment of warp wires. A number of the collecting drums, which are easily detachable from the drawing machine after being filled up, are passed into an annealing furnace, and the wire is annealed on these drums. The latter contains, as previously stated, about 33 pounds of wire, and therefore there is no need to break off the wire after coiling up 5 or 7 pounds, as was formerly necessary. After annealing, the set of twelve collecting drums is plunged into a common acid bath, and the wire is then drawn off them. The drums taper toward the top so that it is easy to draw the wire off. The wire, first of all, passes through a channel in which fresh water flows continuously, in the direction opposite that of the wire. Then the wire passes through a sand bath in which adhering acid residues and the like are rubbed off, after which it passes through a tartaric acid and water bath. It now passes through a long drying box filled with sand, which is heated from below, from which it emerges bright and uniform, ready to be wound up by the winding machine without any waste. The collecting drums are made of manganese bronze, and can stand from 150 to 200 annealing processes.

Fig. 2 shows in plan and elevation the apparatus just described, in which *A* is an acid bath containing the collecting drums *B*, from which the wires pass upward to the washing bath *C*, and then through roller guides *D* into the sand box *E*; thence to the tartaric acid bath *F*, and the final water bath *G*. The drying apparatus is shown at *H*, and *I* is the winding machine. It will be seen that the whole process is so simple and mechanical in its action that it requires but little attention, and the saving in wages is considerable. It should be especially noted that all waste of material, which is so marked in the use of loose wire rings, is thus avoided, and also that the quantity of acid and other substances used is considerably reduced. A special advantage is that every wire is separately cleaned and dried, thus insuring uniformity in color and, above all, in quality. In some of the older processes, this uniformity cannot be absolutely guaranteed. Moreover, as the operator has practically no hand in the process, carelessness or poor judgment have no effect. The certainty of success is therefore greater and the output of good wire higher. The ultimate yield is a long unbroken wire thread. Naturally, the use of the continuous wire-drawing machine is not reserved to the whole process for the further treatment of the wire, as the machine can be used without the subsequent process. As already mentioned, a take up drum, otherwise used for coiling the wire, is fitted on each machine, and it is used particularly in the production of soft weft wires for weaving purposes. The whole plant appears to place the production of metal wires on an advanced basis and is therefore worthy of attention.

* * *

A mechanical idea may often be carried out without drawings, but the process is usually costly, and unforeseen errors or interferences require changes after part of the machine or device has been made. There is danger of careless thinking and a trusting to luck which is unsafe and demoralizing. Drawing, as a rule, requires logical thinking. It is furthermore a record of the thinking and is invaluable in the case of improvements and repairs.

THE "PATENT-BEE"[*]

BY H. W. WEISGERBER[†]

Where is the man who has not heard a "patent-bee" buzzing under his hat? That there are such, I know; but I also know that there are hundreds and even thousands, or tens of thousands, of poor deluded souls (who were not as wise as Ulysses of old, who stopped the ears of his sailors so that they could not hear the enticing songs of the Sirens), who when they had put in their all, found themselves financially wrecked upon the patent office shoals. What is there so enticing about a patent? Do they expect to find a short route to wealth and fame, or is it because they have heard tales of fabulous wealth being made out of some simple device? And do they imagine that they, too, can find a fortune if they but invent something, no matter how simple or useless it may be? A patented article, if there is no immediate use for it, is about as worthless as the sands of the seashore. Then, too, it is worthless if it cannot be manufactured within a reasonable price; or sometimes a seemingly useful article must have a fortune spent upon it to properly advertise the usefulness of it and to bring it to the attention of the people.

Edison will always be as a shining light that the patent attorney shark will hold up to the would-be inventor; but, whereas we have one Edison in this country, we have about one hundred millions of the common people, and does each one out of several thousand patentees imagine that he or she can become a second Edison by inventing some simple thing that any boy in a manual training school can make with a saw and hammer? One has only to look through the patent office records to find that farmers are among those who, whenever they think up some simple contrivance, rush with it to the patent office and take out a patent that costs them no less than a hundred dollars; whereas if they would write it up and, with a sketch for an illustration, submit it to some farm paper (where no doubt it would be accepted) they would be ahead a dollar or two, instead of being out of pocket a hundred and over. But, having lost on one thing they don't always stop, but continue to get out others in the hope of recovering what they have already lost and, like the gambler, they expect their luck to change and that they will catch the will-of-the-wisp that will show them to a fortune.

It is a well known fact that most inventors die poor, while others, if they have had money to start with, have gone "broke," and lost that which they had. To the uninitiated the patent office is not much more than a delusion and a snare; while the large concerns who take out patents that are of real value, must often take their claims to court and carry the case from one court to another, and sometimes to the highest court, before they are certain that they own the patent on their product. This should not be necessary, but it is so, nevertheless. I am not saying anything about the mechanical engineers who take out patents, but even they invent many costly machines from which they never realize enough to pay for the patent; nor am I saying anything against the manufacturer who wishes to protect his products against infringers, but I am warning the everyday mechanic and the man or woman in moderate circumstances, who have only their daily wage upon which to live, that they may not foolishly squander their money upon anything as uncertain as a patent.

If you have anything of real value there are honest manufacturers who would be only too willing to pay for the patent and allow you a royalty; and if they were not honest, and you had the patent in your own name, they would somehow manage to get it without paying much or by taking some of the ideas and making a new article. Then, as you would not have the money to carry a case through the courts, your invention would be useless. But there are many people who wish to add to their meager incomes, and seeing under the classified advertisements in the Sunday papers long lists of inventions that are wanted, and thinking that they too can invent some of them, write for "particulars and circulars" to the advertiser, and receive printed information that will lead them to think that a fortune is waiting for them just as soon as they get their "patent." Not long ago I received a circular letter from one of these sharks (he had seen my name and address in a mechanical journal) offering to let me in on reduced rates and a good per cent of the fee on all work that I could send him by referring my friends to him with their patent business. I recently heard an inventor —a mechanical engineer who gets his living from his inventions—say that his name never appeared in a patent list, but that he received a heavy mail of letters from these sharks asking him for his business.

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[*] For additional information on the subject of patents previously published in MACHINERY, see "Patents from a Patent Attorney's Viewpoint," September, 1914; "Filing Your Own Patent," July, 1914; "The Value of a Patent," July, 1914, and articles there referred to.

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That patent attorneys take anything and everything that a client may offer, there can be no doubt, for how else could it happen that the pages of the "Record" are filled with so many trivial and seemingly useless inventions? I once worked with a draftsman who claimed to have worked for a firm of patent attorneys, and he never tired of telling how they used to "fix" the "hayseeds," as he called them, who had "inventions," which they wished to patent. They would first finish a drawing and then "just happen" to think of some important changes, and of course the "bait" would catch and the drawing would have to be done over, making more work for the draftsman. Or they would apply for a patent and then (?) think of something else, always important, and that would mean an extra fee and more drawings; and thus they would keep it up and keep their client in the city just so long as his money lasted.

This calls to mind the case of a Danish farmer I knew in my boyhood days, and whose farm adjoined that of my uncle's. He imagined that he had a valuable invention in the shape of a potato-digger; it was just an ordinary shovel plow with a row of tines at the rear (just such a "digger" as is on the market now) and, no doubt, he imagined his fortune already made. His neighbors joked and laughed about "Jim's potato digger." Anyhow by the time he finished inventing, he had lost two farms. I well remember seeing his house and yard littered with large sheets of paper, for he was not draftsman enough to make small scale drawings, but he had to draw everything out full size. Then, instead of making a drawing and letting some mechanic make his "digger," he went to a village blacksmith who could neither read nor write and who could only work at it in spare time; so "Jim" had to put in his time and superintend the construction, which was, too, one of the cut-and-fit order. Being four miles from town was a little too far for convenience sake, so he moved to the village into a rented house; then, with nothing but expense and with nothing coming in, and with one patent following another, his cash was soon exhausted and his "invention" a failure.

A farmer's "inventions" as they appear in the official record can generally be told from those of a mechanical man, for they are usually made of wood instead of iron or steel. Fifty years and more ago all inventions were of a very simple nature, for mechanical engineers as we find them today did not exist. Times have changed. All appliances must be made of iron or steel as far as possible. Without mechanical training one cannot well get up a worthy invention, for it is hard to convey ideas to someone else, and if somebody else will have to do the head work they will also expect the reward. This calls to mind an incident that occurred several years ago when the suction sweepers were beginning to flood the market. A traveling man, who may have had an idea in mind, came to our place and wanted to know if we could make a drawing of an air pump for him. Of course, we would be glad to do it, if he knew what he wanted, but he either thought that we wanted to steal his idea or that we did not know how to make the drawing, for it was impossible to get anything out of him, save the fact that he wanted an air pump drawing. The trouble was that he wanted someone else to work up the design, for if he had an idea he was unable to convey it to others.

The average person has not the least idea of the growth of the patent business during the last two decades. I have access to a library of patent office records that extend back nearly 70 years. During those early years the annual report of patents issued did not form a book much larger than Webster's Academic Dictionary; now the business for three months fills a book larger than a Webster's International Dictionary. It is simply astounding, because a great many of the devices are useless and impractical. It should always be borne in mind that as soon as a successful invention appears there are always a multitude of imitators, so that unless one has the means to carry on the manufacture of that which he invents, or is willing to accept a small per cent of a royalty, he should not risk his all on the price of a patent.

Scarcely a week passes that the firm for whom I work does not receive an appliance of some kind on engines from inventors, but as yet they have never found anything of real practical value to them; yet, whenever any device is needed it is always worked out satisfactorily, and not patented either. And right here let me say that if every manufacturer went to the patent office for a patent for every idea and improvement, there would not be any profits left for the stockholders. It is not necessary to run to the patent office with every idea. If you have anything worth while, make a drawing and sign your name, address and date, and then have three of your friends witness it by doing the same; then go ahead and work up your invention, and if anyone else applies for a patent on the same thing, you will at least have good evidence for a priority claim when you apply. An invention is an evolution, and it is impossible to think of all the good things at first; so an invention either grows more simple than at first, or it becomes more complicated so as to extend its usefulness. To take out a patent in each step of the process is very expensive, especially if a few months of thinking and experimenting will help to improve it and so that all can be included within the one application. I know of machines for which patents had not been applied for until a year after they had been built and tried out, and improvements made upon what they were originally.

Few people realize that it often takes a small fortune to develop and place on the market a useful article. So instead of selling their idea for a small, reasonable sum, or by offering one-half of the patent and letting the manufacturer pay for the patent and taking a small royalty for their share, they expect a fortune the first thing. It is said that railroads are willing to wait until a patent expires before they will allow themselves to be held up for an invention. So don't patent anything that the patent sharks say is wanted; for the chances are that if it is possible to invent it, many patents have already been taken out and so yours would only add to the number of failures and your cash go to swell the sharks' amount of spending money. But if you must patent your ideas go to some manufacturers in your community or vicinity and in that way secure the name of some reliable attorney. In doing so you will at least have the satisfaction that you are not being duped.

* * *

It is estimated that there are at least 50,000 amateur wireless telegraph operators "butting in" all along the Atlantic coast, and it is stated that in many cases they drown the long distance over-sea messages. The *Compressed Air Magazine* states that this condition has become such a nuisance that regular operators cannot count on long distance work until after midnight when the air becomes clear. Besides being a bother, this promiscuous sending of messages gives opportunities to practical jokers who send fake messages. They are practically immune from prosecution, as there is no way to prove the source of the message.

* * *

Contributors are frequently advised to start articles with a general definition of the subject treated and a brief review of what the article is intended to set forth. Sometimes, however, authors go to the extreme in defining the obvious; the following definition of an elevator given in a paper on "Elevators—Their Uses and Abuses" before an engineering society is worthy of being recorded: "An elevator may be termed an ingenious mechanical device, invented and designed by man, to overcome nature's imperative law—the law of gravitation."

ABRASIVE PAPER AND CLOTH MANUFACTURE

MACHINES USED BY THE CARBORUNDUM CO. FOR APPLYING ABRASIVE AND CUTTING THE COATED STOCK

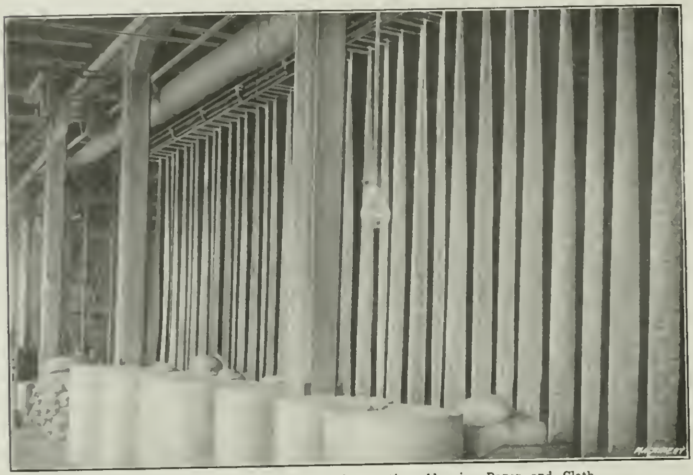

Fig. 1. Partial View of Machine for coating Abrasive Paper and Cloth

THE manufacture of abrasive paper and cloth is a more extensive and interesting process than would be inferred from an inspection of the finished product. First, there is the production of the abrasive, second the application of the abrasive to the paper or cloth, and third, the cutting of the coated stock into strips, squares, disks or special shapes such as are required by shoe manufacturers, etc. The various classes of paper and cloth manufactured by the Carborundum Co., Niagara Falls, N. Y., are coated with three different abrasives, *viz.*, garnet, carborundum and aloxite. Garnet is used in woodworking; carborundum, for finishing leather goods (especially in boot and shoe manufacture) and in disk form on disk grinding machines; whereas aloxite is more particularly adapted for general machine shop work. As is well known, both carborundum and aloxite are artificial abrasives, whereas garnet is a natural product. In this article, the method of coating cloth and paper with an abrasive and the cutting of the coated stock into commercial shapes will be described.

The principal problem connected with the manufacture of abrasive paper and cloth, aside from the production of the abrasives, is that of drying the glue which holds the abrasive grains in place. In order to coat the stock efficiently, the process must be continuous, and as the coating is done quite rapidly miles of coated stock accumulates before that which first passes the coating rolls is dry. The way in which this stock is automatically stored while drying in one continuous length is the most interesting part of the process.

The path followed by the stock from the time it is unwound from the roll at one end of the machine until it is again wound at the other end, after having been coated with an abrasive, is as follows. First the stock passes between circular rolls which print on one side the name of the company, the kind of abrasive used and its number; it then passes between two rubber rolls, the lower one of which is immersed in a tank of hot glue. The coat of glue which is deposited on one side, is next spread evenly by a narrow brush which extends across the stock and has a very rapid reciprocating movement. Just beyond the brush there is a hopper, from which an even stream of abrasive falls upon the stock; the latter then passes under a steel roll which forces or imbeds the abrasive grains into the glue, holding them firmly on the stock.

The paper or cloth next passes over an elevated drum and is then gathered up into loops about 12 feet long by an endless chain mechanism, which at regular intervals carries a wooden cross-bar up under the sheet as it feeds out. When one of these sticks upon which one of the loops is suspended is conveyed to the top, it enters upon a horizontal track and is conveyed along by a slow intermittent motion so that the first coat of glue will have time to partially dry before the next coating operation. This intermittent motion is obtained from a framework that extends above the track and moves back and forth. The stroke of this frame is about 12 inches, and with each forward movement pawls on it engage the cross-bars upon which the loops hang and push them forward a distance equal to the stroke of the frame. On the return stroke, the pawls simply lift and glide back over the sticks and then engage another set on the next stroke. As the result of this intermittent movement, the loops of cloth or paper swing to and fro as they gradually move along, presenting a rather grotesque appearance.

About one hundred feet from the starting point, the paper which has partially dried passes through a second glue coating process. This is known as "sizing." The glue is much thinner than is used for the first coat and is applied to fill up the interstices between the abrasive grains and hold them more firmly in place. When one of the loops approaches this second or sizing machine, it is straightened out as the paper is drawn between the tensioning and gluing rolls and this straightening out draws the loop cross-bar (which has

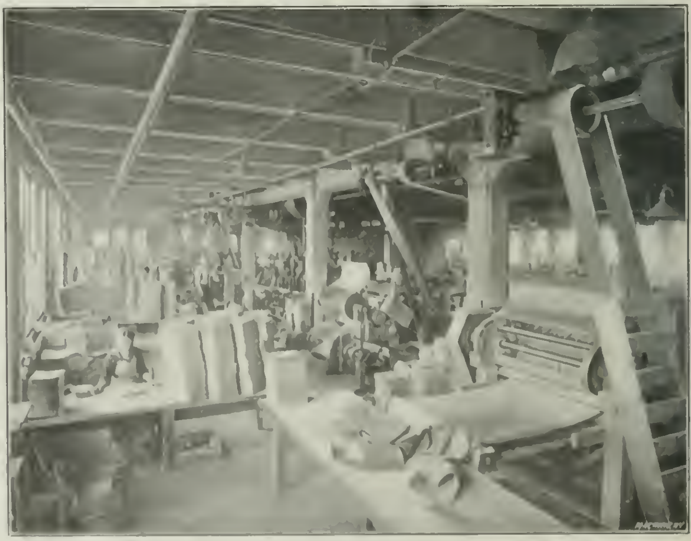

Fig. 2. Department where Paper and Cloth is cut and formed into Various Shapes

passed beyond the feeding pawls) forward, and the cross-bar drops upon conveyor chains and is lowered to the floor.

The paper, after passing the point where the cross-bar support is removed, is drawn over a curved platform down to the tensioning rolls and then to the second set of gluing rolls. After the sizing operation, the paper passes over a drum or roll, on the periphery of which are raised strips that incline from each side toward the center, similar to the teeth of a herringbone gear. This roll is to center the paper before it again enters upon the drying track. The paper is now gathered up into loops upon cross-bars which are automatically elevated at proper intervals, the arrangement being the same as that used after the first coating process. This endless chain conveyor for the cross-bars is partially shown at the top in Fig. 1, the movement of the coated stock being toward the observer.

The loops of coated paper now begin a long journey which continues in a straight line to the end of the room, the motion being intermittent and effected by the feed pawl mechanism previously referred to. When the procession of swinging loops reaches the end of the room it makes a short turn on a curved track and proceeds back in the opposite direction. The feed of the cross-bars around this curved end is obtained by a pawl feeding mechanism similar to that described except that it is curved to conform to the track, and this curved fan-shaped frame has an oscillating movement instead of a straight-line motion.

After passing the curve, the loops, which hang quite close together, as Fig. 1 shows, travel in an unbroken line and on a continuous track from one end of the building to the other several times. At the end of the last track the supporting cross-bars fall onto another chain conveyor and are carried down to the floor. The stock is then drawn over another curved platform, just beyond which there is a series of rolls which iron out the wrinkles and also provide tension preparatory to winding the coated stock onto an arbor. This is the end of the coating operation.

The complete passage from the first coating rolls to the end where the coated and dried stock is wound onto rolls requires several hours. When the tracks are completely filled with paper, they hold a continuous sheet (joined by glue where breaks have occurred or where a new roll of paper has been started) which, if straightened out, would extend about eleven miles.

The coating process is practically the same for cloth as for paper, except that the cloth stock requires two passages through the coating machine, one for coating with glue and another for coating with both glue and abrasive. A preliminary coat of glue is necessary because the cloth absorbs more glue than the paper. Stock varying from 18 to 48 inches wide can be run through this coating machine. When a lot of paper or cloth is to be coated, the wide stock is put through first, the order being from wide to narrow. This is done so that any wear which might occur on the rubber glue coating rolls will not affect the narrower widths. Similarly, stock requiring the coarse abrasives is coated last, the order being from fine to coarse to avoid any possibility of coarse grains which might have remained in the machine being deposited upon a paper of finer grain.

The large rolls of coated stock are cut into various shapes in another department, a general view of which is shown in Fig. 2. At the right of this illustration is one of the machines used for cutting the stock into squares. A roll of coated cloth or paper is fed into this machine and first passes between the edges of cast steel wheels which split it into several narrower widths. As these narrower widths continue to feed forward, they are cut into squares by a single revolving knife or blade. The relation between the speed of this knife and the feeding movement of the stock is such that suitable lengths are obtained. The splitting wheels used on this type of machine resemble small cylindrical pulleys and operate in pairs, that is, the pulley rims are set close together to form a shearing roll. Other machines in the department which are simply used for splitting into narrow widths have circular knives or narrow sharp edged blades which engage grooves in another roll and the stock is split by feeding it between the rolls. These narrower widths are afterward wound into rolls for shop and factory use.

Circular disks such as are used on disk grinders are cut by two different methods. Small and medium sizes are blanked out in a press equipped with dies, whereas large disks are cut by shearing wheels similar to those previously referred to, which impart a circular motion to a square of stock that is rotated about a central pivoting device.

Owing to the varied use of abrasive cloth and paper at the present time, many odd shapes are required such as small circular pads, convex belts for special leather finishing machines, etc. The production of these irregular shapes involves the use of special tools and constitutes an important branch of abrasive cloth and paper manufacture at the plant of the Carborundum Co.

* * *

NEW METHOD OF PRODUCING HOLLOW BARS

A new method for producing hollow bars is described in *Page's Engineering Weekly*. The production of hollow metal bars with a hole through them from end to end has hitherto only been possible by drilling. By a hollow bar is meant a bar with a comparatively small hole in the center and thick walls, in contradistinction to tubes, which have a large hole and thin walls. The need for hollow shafts in almost all branches of engineering is generally admitted and elaborate machinery is constructed to produce them. The cost of deep hole drilling, however, is great and, in many cases, almost prohibitive, and the difficulties and cost of production limit the application of the hollow bar principle, so that designers are forced to avoid this construction as much as possible, using instead roundabout and complicated designs.

By a recently patented process, owned and worked by Dunford & Elliott, Ltd., of Attercliffe Wharf, Sheffield, England, it is now possible, however, to obtain long bars with a small hole from end to end. As an example, a 3/4-inch bar, 30 feet long, can be produced with a 1/4-inch hole from end to end. The process is briefly described as follows:

The billets or blooms are drilled with a hole from end to end. This hole is afterward packed tight by a special composition, the ends are plugged up, and the bloom thus prepared is elongated in the rolling mill to a bar of the desired dimensions, the packing being also simultaneously elongated in exact proportion to the metal. This packing, or core, is afterward removed by high pressure liquid, which is caused to impinge on the material to be removed. In this way long bars in rounds, squares, octagons, or hexagons, are produced. The hole, though not mathematically circular or central, is true enough for a number of engineering purposes, and where greater accuracy is required, as, for instance, in spindles, it is a comparatively simple operation to ream out the hole, in which case the hole produced by the process described merely serves as a pilot hole. Mechanics will readily appreciate the great advantage derived from being able to lubricate the cutting edge of the drill from the opposite end. Any kind of iron or steel may be treated, from the most expensive alloy steels to the common basic grades.

The process is not merely in an experimental stage, thousands of tons of these hollow bars having already been produced. The process was originally devised to supply the demand which was gradually making itself felt for hollow mining steel, the cost of which was prohibitive by the old method of producing by drilling. Large quantities of mining hollow drill steel have already been produced, and the demand is rapidly increasing, since the advantage of the hollow bar for mining drills is beyond dispute.

* * *

"CHILLS" FOR CAST-IRON CALENDER ROLLS

Chilled rolls for paper calenders, etc., are cast vertically in cast iron "chills." The chills are made in sections about thirty inches long with flanges at each end. Odd lengths are provided so that any desired length and diameter of roll can be cast. The Lobdell Car Wheel Works have many hundreds of these chills in all commercial diameters. Each section is bored and faced and is provided with trunnions in the center for convenient handling. The investment aggregates many thousand dollars.

MAKING A SET OF SINGLE TYPE ARMATURE DISK NOTCHING TOOLS*

KINKS FOLLOWED IN MAKING "FINGER DIES" FOR NOTCHING ARMATURE AND FIELD DISKS IN THE GENERAL ELECTRIC CO.'S LYNN PLANT

BY CHESTER L. LUCAS†

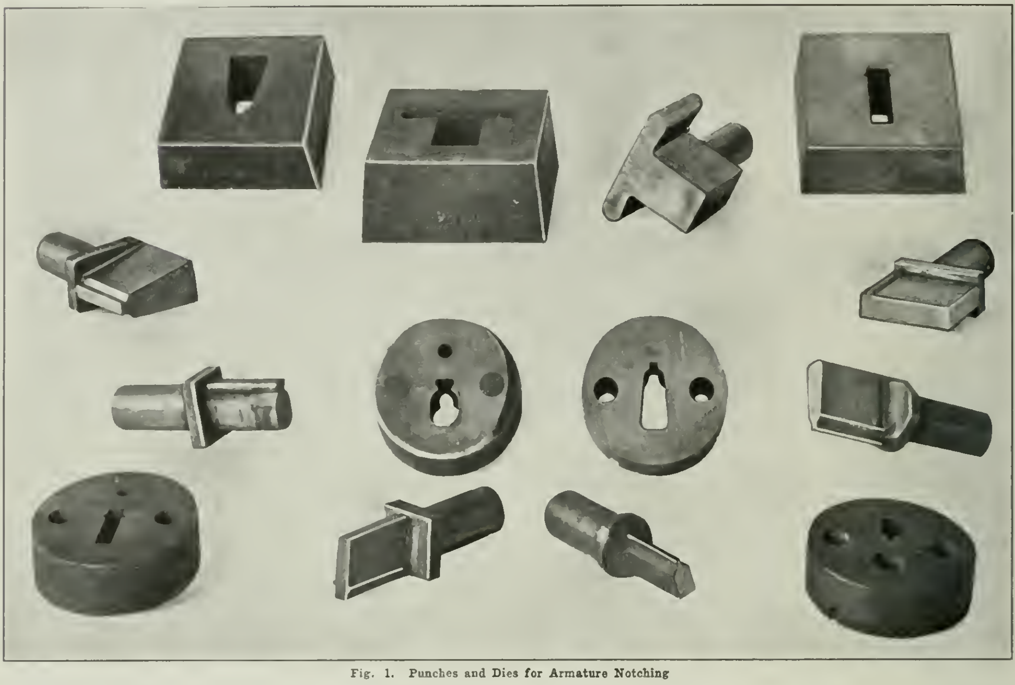

Fig. 1. Punches and Dies for Armature Notching

On account of the large number of armature disk notching tools of the single type required in the General Electric Co.'s plant at Lynn, Mass., the work of making the dies has been specialized and the operations reduced to the lowest possible number. This class of die-making, while simple in theory, requires a high degree of skill in order to produce the tools rapidly and accurately.

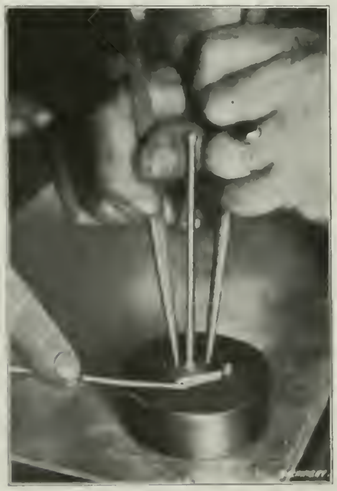

Fig. 2. Scribing the Outline of the Templet on the Die-blank

After the drawing has been made for a new armature disk and the size of the winding hole slots, as the notches are technically called, has been figured out by the engineering department, a detailed drawing showing the slot itself and its position on the blank is sent to the diemaking department. One of these drawings is represented in Fig. 4. To those not accustomed to this class of work, it seems strange that the dimensions of the slot must be held so accurately. As a matter of fact, a variation of over 0.002 inch is enough to condemn the die. The diemaker makes his templet from the detailed drawing of the slots. One of the methods followed in making the templet is to use a piece of ground tool steel stock, about 1/8 inch thick. After the surfaces have been finished on the surface grinder, the steel is blued by heat and the outline laid out from a center line. The principal dimensions are obtained by setting a pair of dividers to one-half the distance required and scribing it from the center line on each side. If there are any curved sections in the outline, they are put in from a center point which is first accurately located. The outline of the templet, when scribed in and ready to be cut out, has the general appearance shown in Fig. 6.

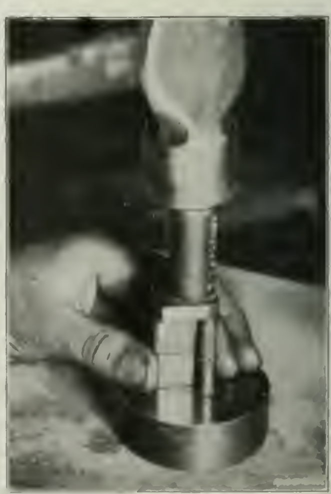

Fig. 3. Fitting the Punch

It is, of course, important that any measurements struck off with the dividers from the center line be accurate. Three methods are commonly used among diemakers for setting dividers accurately. One is to set the dividers as close as possible to scale measurement. This distance is then spaced off, say, ten times on a scribed line on a piece of brass and the total length measured. If the total length shows no multiplication of error, the setting of the dividers is correct. Should the total measurement register longer or shorter than standard, the dividers are changed, accordingly, one-tenth the amount of the error. The second method of setting dividers accurately is by using a Brown & Sharpe "improved graduation" rule. By means of a magnifying glass and this rule, a pair of dividers may be set very accurately. A third way of setting dividers to accurate measurements is obtained by using a vernier caliper. The center points on a vernier caliper are always a prescribed amount in excess of the reading of the caliper; therefore, by making the proper allowance, the dividers may be set from the caliper. With the magnifying glass and ordinary care, a good workman can set a pair of dividers with a scale graduated to hundredths of an inch as close as 0.002 inch.

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* For articles on making armature disk notching tools previously published in MACHINERY see "One-piece Armature Disk Tools," March, 1914; "Indexing Tools for Notching Armature and Field Disks," September, 1914.

† Associate Editor of MACHINERY.

The templet is next sawed from the sheet of steel roughly —under no circumstances is chipping resorted to—and then filed to the line. At every point where the measurement can be checked by the micrometer this is done. At the corners, for instance, where there is usually a curve, the templet is first filed straight out to a point so that the measurement across corners can be taken before filing away to the curved outline. The curved ends of opposite sides of the templet may be readily checked by means of a radius gage. As the templet is ⅛ inch thick great care must be taken to have the filing done squarely with the face of the templet. A hardened and ground block is held in a vise; the templet is clamped to the top of this block and the diemaker files by the square side of the block so that the templet is absolutely square. This is far better than using a square free-hand.

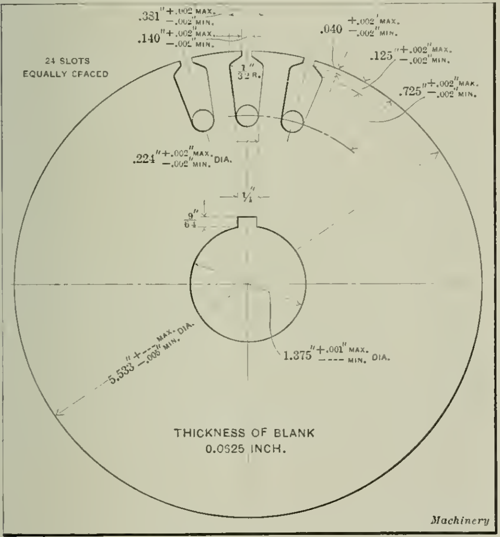
.331" +.002 MAX. −.002" MIN.
.140" +.002" MAX. −.002" MIN.
.040 +.002' MAX. −.002" MIN.
.125" +.002" MAX. −.002" MIN.
.725" +.002" MAX. −.002" MIN.
24 SLOTS EQUALLY SPACED
1/32" R.
.224" +.002" MAX. −.002" MIN. DIA.
1/4"
9/64"
5.533" +--- MAX. −.003" MIN. DIA.
1.375" +.001" MAX. ---- MIN. DIA.
THICKNESS OF BLANK 0.0625 INCH.
Machinery

Fig. 4. Drawing of Armature Disk showing Type of Dimensions to which the Dies are made

Finger dies are of two types, round and square, both of which are shown in Fig. 1. In die-making, the same methods are employed for both, the principal difference being that the round die-blanks are only about half the thickness of the square dies. Of course this makes the square type of die the more difficult to work out. The templets are usually made by the same man, especially trained on the work. The diemaker is given a die-blank, the surface of which has been ground off and blued and is ready to have the outline of the templet scribed upon it. He first takes the templet and solders a piece of drill rod about one-eighth inch diameter and four inches long at the center of the back. This is to facilitate handling the templet while fitting the die to it. The next thing the diemaker does is to scribe a center line upon the die-blank. The templet is then laid face down upon the die-blank in position so that its center line will coincide with the center line of the die-blank. Fig. 2 shows the method of holding the templet in place with two files while the outline is being scribed. As the illustration shows, one man bears down with the two files upon the templet while another man scribes the outline, keeping the sharp scriber very close to the edge of the templet. Another and better method of holding the templet to the die-blank while the scribing is done is illustrated in Fig. 5. This shows a special dis clamp being used for holding the templet. This clamp is also useful in holding the punch-blank to the finished die when laying out the punch.

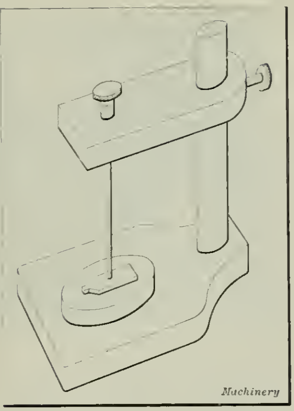

Fig. 5. Die Clamp used for holding Templet to Blank while marking

Cutting the Opening

In cutting the opening in the die, the procedure is the same as in other die-making operations. The outline is drilled, taking care to first drill out any radius sections with drills of the proper diameter, following up with the reamers to give the necessary clearance of one-half degree. After drilling the outline, the core is chipped or drifted out and the steel is taken out with coarse files nearly to the scribed outline, as shown in Fig. 7. As the filing approaches the outline, the templet is tried from time to time until it starts to enter from the rear side of the die. From this point on it is a case of taking away the high points so as to let the templet through evenly. Great care is taken to keep the filing as nearly straight as possible, and under no circumstances should the opening be allowed to become larger at the face side. When the templet has been entered in the opening of the die to a point half way to the face, finer files should be used. On this operation the filing machine is used to great advantage. The table of the filing machine may be set so the filing will be straight or so the desired amount of clearance is given. Gradually, the high spots are taken down until the templet can be pushed in from the back clear through the opening flush with the face of the die-blank. The manner of trying the templet is shown in Fig. 8. If the die has been properly made, the insertion of the templet in this manner will completely shut out the light. By the

Fig. 6. A Templet Outline scribed on the Steel and ready to be cut out

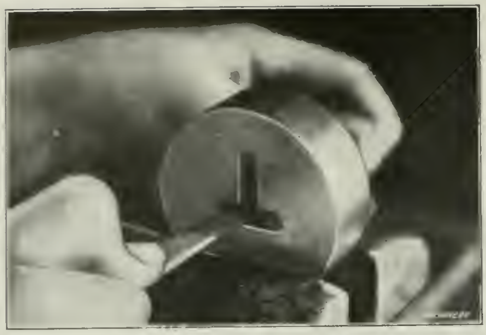

Fig. 7. Rough-filing the Outline in the Die

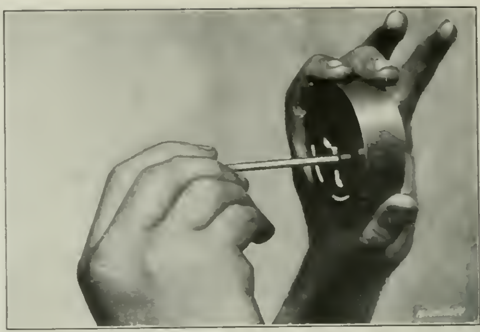

Fig. 8. Trying in the Templet

proper use of the filing machine, all danger of filing the die out of square will be eliminated. The die is tested for clearance from time to time as shown in Fig. 9, using a small die-square. The correct clearance is one-half degree in all sections of the die.

The Allowance for Shrinkage in Hardening

After the clearance has been put in all around the die, the allowance for hardening is made. This allowance varies with the thickness of the die-blank, the general size of the opening, and the proportions of the opening. In the case of a die made from a templet such as may be seen scribed on the piece of stock in Fig. 6, the allowance for hardening would be about 0.001 inch for width and 0.0015 inch for length. This means that the die will shrink this amount in hardening and that the opening must be correspondingly increased in size by these amounts so that the die when hardened will fit the templet. In hardening, there is a tendency for the sides of the die cavity to bulge; therefore it is customary to concave these sides slightly to offset this trouble.

While the time for making a die of this kind varies with the intricacy of the outline, and the size and thickness of the blank, it is approximately seven hours' work on the average shape. This only includes the putting in of the opening and has no reference to the fitting of the punch.

After the countersunk holes have been drilled at the sides of the opening in the case of round dies like those shown in the center of Fig. 1, they are filled with fireclay or wet asbestos, and the die is then ready for hardening. The hardening temperature depends, of course, on the grade of steel being used, but after the steel has been brought to the proper heat and is ready for quenching, it is plunged, always face down, into the brine tank. Here it is left until it is nearly cold—the length of time usually being judged by the rapidity with which the water evaporates from it when it is temporarily taken from the tank. Considerable heat still remains in the die, and with emery cloth and stick the face is polished off and it is put on the tempering plate and drawn until it has reached a straw color. The reverse side and the face of the die are now given a "once over" by the surface grinder and it is ready for the fitting of the punch.

Making the Punch

The punch-blanks are turned up from square, oblong or round bar stock, according to the shape of the die opening. The different sized blanks are kept in stock and the diemaker simply selects one which conforms most nearly to the shape of the templet he is working to. The face of the punch-blank is coppered and the outline of the templet scribed on it. The outline of the punch is roughed out to 1/64 inch of the line at all points on the vertical milling machine, using a special punch-holding attachment. If a workman is careful, he can follow the line of almost any punch on the vertical milling machine, bearing in mind that the punch-holding attachment can be swiveled so as to work with the end of the cutter or the side, whichever best suits the case. The diemaker takes the roughed-out punch and shears it into the die under a screw-press. It is only necessary to enter the punch 1/16 inch or so at this time. The "witness" that the shearing operation leaves on the punch is the guide by which the finish-milling is done. The finish-milling is done in exactly the same manner as the rough-milling, except that on this operation the stock is milled away until it is almost even with the sheared-in section. The diemaker now takes the punch to the vise and files away the slight amount of excess stock so that the punch can be driven through to the shoulder. The punch is sheared in for the full length under a screw-press. Then the punch is coppered for its full length and, as shown in Fig. 3, is tapped through the die. This operation leaves the coppered surfaces marked at the places where the punch needs "easing."

The final filing operation on the punch is illustrated in Fig. 10, below. On this class of work it is essential that the dies have a grinding life of very nearly an inch in the case of the square blank type, and the punch must have a working section of at least an inch and a quarter—an inch and a half is better. The punch is hardened and drawn to a very dark straw color and its face ground. After using the die for shearing in, it is necessary to regrind its face. On this work, no strippers are fitted to the punches. Either a stripper that can be set up and adjusted for the work on the press is used, or the more simple form composed of layers of India rubber fitted on over the punch is made use of.

Fig. 9. Testing the Die for Clearance

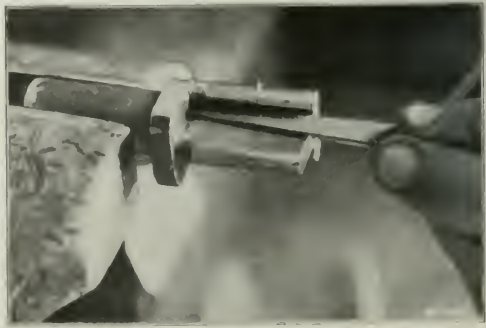

Fig. 10. Relieving the Punch after it has been fitted

SELECTION OF WHEELS FOR CYLINDRICAL GRINDING

CONDITIONS WHICH DETERMINE THE SUITABILITY OF A WHEEL FOR GRINDING ANY PARTICULAR CLASS OF WORK

BY F. B. JACOBS*

THE grinding room foreman, and the purchasing agent of any concern where the grinding machine is depended upon for accurate and economical results are interviewed very frequently by grinding wheel salesmen. As a salesman's duty is to sell goods, of course, each and every one has just the wheel that will surely reduce production costs. All salesmen are convincing talkers, which is one reason why they are salesmen; therefore, they have many arguments in favor of their goods. However, as one salesman's assertions almost invariably upset not only the theory but the logic of the previous salesman, it is no wonder that the selection of grinding wheels is often looked upon as a complex problem. There are some thirty grinding wheel manufacturers in this country, but of that number there are only a few who supply wheels for precision grinding. This statement is not made at random, but from experience gained from traveling in one of our great manufacturing belts—the Middle West.

Abrasives for Grinding

Before considering the selection of grinding wheels, it may be well to touch briefly on the materials from which they are made. Abrasives are divided into two general classes, namely, natural and artificial. The natural abrasives are emery and corundum. Emery is the oldest known abrasive; it was called smyris by the Greeks, from which its German name schmirgel is taken. The best grade of emery comes from the island of Naxos. It is sold under the name of Naxos emery and is distinguished by its reddish-brown color. A good grade of emery is found in Asia Minor. It is black in color and is known to the trade as Turkish emery. Emery is also found in our own country, principally in Massachusetts and New York. While emery will always have a commercial value for some purposes, its use as a material for precision grinding wheels is limited, owing to the fact that the very best emery is impregnated with a high percentage of oxide of iron. As this impurity cannot be eliminated, wheels made of emery cut slowly when compared with the modern artificial abrasives. We must not lose sight of the fact, however, that emery owing to the impurity previously mentioned, gives a very high finish. For this reason, emery wheels are still used to a certain extent on such work as jig bushings or other tool parts where a "dead smooth" finish is required without the necessity of over-lapping to remove the wheel marks. On commercial work where only a commercial finish is necessary, the emery wheel has almost entirely been replaced by the faster cutting artificial abrasives.

Before the advent of the artificial abrasives corundum was the best abrasive to be obtained. Corundum might be called a high-class emery, for like emery its chief constituent is alumina. However, corundum differs from emery in two important respects: It contains a higher proportion of alumina, and under the pressure of grinding its grains split with a clean sharp fracture, thus presenting a new cutting surface, whereas emery grains simply smooth down and present a highly glazed surface. The best and purest corundum is found in Canada, while an inferior quality is found in this country. Much of the so-called corundum is often highly impregnated with oxide of iron. When this condition exists, its value as an abrasive is little or no better than emery. It cannot be denied that pure corundum makes a fast-cutting wheel for some purposes, but owing chiefly to the prohibitive cost of the raw material, corundum wheels are not commonly sold in competition with wheels made of artificial abrasives.

The artificial abrasives are also divided into two classes, *i. e.*, those made in furnaces of the resistance type, which are called carbide of silicon abrasives, and those made in arc furnaces called aluminous abrasives. In this country, carbide of silicon is made by the Carborundum Co. and sold under the name "carborundum." It is also made in Canada by the Norton Co. and sold under the name of "crystolon." It is also made in Germany and Austria, being marketed under various trade names. These abrasives are all made from materials high in carbon and silica. Under the intense heat caused by the resistance to the passage of the current, a chemical change takes place wherein the elements of carbon and silicon unite, forming carbide of silicon. The best known aluminous abrasives are "alundum," "aloxite" and "boro carbone." These are made from bauxite, a form of clay containing a high percentage of oxide of alumina. The furnace used for this purpose consists principally of a receptacle which contains a quantity of the raw material, and two carbon electrodes between which the current arcs, causing an intense heat. As the mass melts it circulates, thus bringing all of the material into direct contact with the arc. Practically all of the constituents of the crude material with the exception of alumina, are eliminated and pass off in the form of gas, thus leaving practically pure alumina.

Bonds for Grinding Wheels and Manufacturing Processes

After securing an unlimited supply of a good abrasive, it is necessary for the wheel manufacturer to use extreme care in the selection of the material to bind the grains of abrasive into the form of a grinding wheel. There are three bonding methods in common use, *i. e.*, vitrified, silicate and elastic. For the majority of grinding operations, the vitrified bond is considered the most practical. In this process, the bonding material consists chiefly of a pure grade of kaolin. The correct proportions of bonding material and abrasive are mixed wet by what is known as the puddled process, the mass being agitated for a number of hours in mechanical mixers. This mass, which has the consistency of the mud pies of our childhood, is drawn off into molds and dried by steam heat. It is then shaved into shape on a machine not unlike a potter's wheel. The wheel, which is now technically termed "green," is placed in a receptacle made of fireclay called a sagger. The saggers are loaded into a kiln, similar to a pottery kiln, where the process of vitrification takes place. The process of "burning the kilns," as it is called by wheel makers, has everything to do with obtaining correctly graded and sound wheels. The heat has to be watched carefully and kept at known temperatures for definite lengths of time. If the process were hurried, it is probable that 75 per cent of the wheels would come out cracked. The time and attention required to make wheels by the vitrified process is one reason why the grinding department cannot get special wheels a few days after the requisition is sent to the purchasing department.

In the silicate process, the abrasive grain is mixed with silicate of soda and then tamped in a mold by hand. As only a slight heat is required in this case, silicate wheels can often be turned out in a day. Silicate wheels are sometimes used for cylindrical grinding, but not often. For the mechanical grinding of tools on machines of the Sellers type, and for wet grinding of tools by hand, this bond generally gives better results than can be secured with the vitrified bond. In the elastic process, the bonding material is ordinary orange shellac. This material, in a powdered state, is mixed with the correct percentage of abrasive and then baked slightly while under pressure in a hot mold. A second baking in an oven completes the process. The heat causes the shellac to melt, thus firmly binding the wheel together. Shellac wheels are very durable, and for this reason thin wheels, both straight and dished, are often made by this process. These wheels give good results in cutter grinding, as they leave a smooth-edged tooth. For the grinding of the large calender rolls used in paper mills, these wheels give excellent results, leaving the much desired "mirror finish."

Grain and Grade of Grinding Wheels

When speaking of a grinding wheel, "grit or grain" as it is often called, means the same as the number applied to emery cloth or bulk emery. Thus, a fifty-grit wheel is composed of particles of abrasive that have passed through a screen having fifty lines or meshes to the inch. Grits vary from 4 (coarse) to 225 (fine) and after the numbers, there are the powders designated by the letters *F*, *FF* and *FFF*. The grits commonly used for precision grinding vary from 24 to 60. There are two kinds of grits, *i. e.*, straight and combination. In a straight grit, all the particles of abrasive are of the same size. In a combination grit, the particles are of different sizes. To determine the sizes and proportions for successful combination grits requires expensive experimenting on the part of the wheel manufacturer. For this reason the well known wheel manufacturers keep their grit combinations as secret as possible. A correct combination grit cuts fast and leaves a good finish at the same time, and generally will remain in a cutting condition for a longer period than a straight grit.

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Grade means the degree of hardness of the wheel. The particles of abrasive break away very rapidly from the bond in a soft grade, whereas in a hard grade they are retained longer. As the first grinding wheels (or emery wheels as they were called in the early days of the industry) were for practically one purpose—tool grinding—but few grades were called for. As the industry grew and the scope of the grinding wheel broadened, it became necessary to make a wider range of grades to suit different classes of work. The majority of wheel manufacturers who supply wheels for cylindrical grinding use letters to designate different grades.

Selection of Grade—Effect of Wheel Speed

Under actual working conditions the wheel should be of the correct grade to allow the particles of dulled abrasive to fracture, or wholly break away from the bonding material as soon as they are dulled from wear. While the abrasive cuts the metal away in minute shavings, the work also has a wearing action on the abrasive. Now if the grade is too soft, the particles of abrasive material will break away from the bond before doing their share of the work, which causes the wheel to be short-lived. On the other hand, if the grade is too hard, the particles will not break away from the bond when they become dull, thus causing the wheel to cut slowly and with excessive heat.

The peripheral speed of the wheel has everything to do with determining the correct grade for a certain class of work. High speeds call for softer wheels than low speeds. Thus a wheel of a certain grade might give satisfaction for the grinding of thirty point carbon steel, when run at a peripheral speed of 6000 feet per minute. As the wheel wears away, however, it will gradually appear too soft if the peripheral speed is not increased. For example, after a 20-inch wheel has worn to a diameter of say 19 inches, it will not give as high efficiency as when new because it is under speeded. This condition causes the grains of abrasive to break away from the bond before they should, and the finish left is not so smooth. It is to be regretted that all grinding machines are not driven by variable speed motors. If this were the case, and the operator was provided with an instrument for determining at a glance the surface speed of the wheel, a vast amount of time and trouble could be eliminated. As grinding is at present only in its infancy, or at best in its early childhood, these improvements may come in time.

At the present time, however, the grinding department has to get along without refinements of this kind. Take as an example the wheel just referred to, assuming that it were used for grinding machinery steel. When the wheel was new, the finish left was satisfactory and the wheel stood up well. After it had worn to a diameter of 19 inches, the operator noticed that the finish was not so good and that the wheel seemed to wear more rapidly than it did at first. Perhaps he increased the speed; and if so, what was the result? The wheel seemed too hard under the new operating conditions and glazed readily. The wheel was now over-speeded because the steps on the driving cone were not designed to give correct speeds at all diameters. The preceding may seem trivial in itself, but this one factor has caused more grinding troubles than all others put together. There is, however, a makeshift method of overcoming this difficulty that will be explained later.

Now along comes the grinding wheel salesman from a concern in competition with the one that furnished the wheel that appears unsatisfactory. His head is full of theory and his note-book full of data. When he learns that his competitor's wheels are not giving satisfaction, he takes a nice long inward smile, looks extremely wise and asks innumerable questions about operating conditions, after which he generally winds up, by getting permission to submit several of his wheels on approval. He may improve conditions and again he may not. It all depends on whether he is a real expert who thoroughly understands cylindrical grinding conditions, or simply what is termed a clever salesman who is willing to take a pot shot at any condition or circumstance that may bring him future business.

Now a dozen trial wheels may not remedy the difficulty referred to, because the fault is not with the wheel but with the conditions under which it is run. In a case of this kind, the wheel should be dressed with a dull diamond, using a fine feed. This will give it a cutting surface not unlike a slightly glazed wheel. Under these conditions the grains will not break away from the bond so readily, and the finish will be the same as when the wheel was used under normal conditions and up to speed. After the wheel has worn to a diameter of say 18 inches, it can be speeded up again and trued in the regular way with a sharp diamond. The condition of the diamond has much to do with the finish left by the wheel. As a matter of experiment, take a wheel that is running at the proper speed, and that has been trued with a sharp diamond. It is giving a good finish and cutting fast. Now dress the same wheel with a dull diamond and it will be found to cut slowly and glaze readily. For this reason many operators use a sharp diamond to dress wheels that are running at correct speeds, reserving a dull diamond for wheels that are found to be too soft between changes of speed. It is, of course, a good plan to test wheels of different makes occasionally; otherwise, one is likely to fall into a rut and become behind the times.

Factors Affecting the Grain and Grade—Work Speed

In ordering wheels for test purposes, either direct or from the salesman, it is necessary to give the following authentic information: Surface speed of wheel; finish desired, rough, commercial, or fine; material to be ground; diameter of wheel; width of wheel; size of hole; and diameter and depth of recesses, if any. The foregoing specifications may appear meager to one who has seen the order blanks carried by many grinding wheel salesmen, with the columns for data concerning depth of cuts, traverse feeds, work speeds, etc. The writer does not hesitate to state that this information is of absolutely no value in selecting the grit and grade for a certain class of grinding. These details are insisted upon by some wheel manufacturers, it is true, but scientific research or practical experimenting has yet to prove that depth of cut, work speed or traverse feed are important factors in the selection of grits and grades. As far as grit and grade are concerned, it does not matter whether 0.010 inch or 0.100 inch is to be removed. To be sure, a coarse wheel in a straight grit will grind faster than a coarse wheel in a combination grit; also a soft wheel will cut faster than a hard one. Thus it is seen that the finish desired really determines the grit and grade. For example, suppose that a wheel was ordered for roughing out machine steel, a fast cutting wheel being wanted and finish being of no consequence. This would call for a coarse straight grit wheel, in a soft enough grade to allow the grains of abrasive to break away before becoming dulled. A 24 straight grit of suitable grade is often specified for this class of work. If the work were both roughing and finishing, only a commercial finish being desired, a wheel in 24 combination grit of the proper grade would probably be selected. If, on the other hand, a very fine finish were desired, the wheel could be as fine as 60 grit.

On the subject of work speed, authorities of recognized ability differ. The Norton Co. recommends slow work speeds for finishing cuts when coarse combination grit wheels are used. On the other hand, the Landis Tool Co. advocates high work speeds for finishing. The following is taken from the Landis "Grinding Data and Tables." "For rough-grinding steel, traverse nearly the full width of the wheel for each revolution of the work. This will cause the wheel to wear more uniformly and require less truing, but when a fine finish is desired, a faster work speed with a slower traverse is required."

As a matter of fact, we can vary the work speed from 10 to 50 feet per minute surface speed or even reverse the direction of motion (that is, have the wheel and work revolving in opposite directions) and get good results. The traverse feed of the work is always determined by the work speed and the width of the wheel. The wider the wheel, the faster the traverse feed. This is readily understood, as the work can be traversed very nearly the width of the wheel for each revolution. Thus when the work speed is increased, the traverse feed can be finer, and still be practically the same number of linear feet per minute. Slow work speeds are necessary while taking heavy roughing cuts; otherwise, unnecessary frictional heat is developed. Thus it is seen that depth of cut, work speed and traverse feed are not important factors in the selection of grits and grades for different classes of work, as these factors are readily regulated to suit the wheel. While three points only are generally considered in the selection of wheels, namely, surface speed, finish desired and material to be ground, there are eight factors that determine efficient results. They are the ones just named, together with grit, grade, depth of cut, work speed and traverse feed. The grit and grade is determined by the material to be ground and the finish desired. The surface speed of the wheel also has to be considered when selecting the proper wheel, as a comparatively soft wheel always calls for a higher peripheral speed than a medium grade wheel. The other points, depth of cut, work speed and traverse feed, can always be adjusted to conform to the wheel and local conditions.

Trial wheels should be tested by competent operators and, when possible, under the direct supervision of the grinding room foreman. The following points should be carefully considered:

(1) Is the wheel being used on the class of work that it was ordered for? (2) Is it being run at the correct peripheral speed? (3) Does it leave the required finish? (4) Is it too hard, requiring frequent dressing? (5) Is it too soft, wearing away too rapidly? (6) Does it cut faster than the wheels previously used; that is, will it turn out more work per day? All these details should be considered before forming a decision, for if it is worth while to order wheels for test purposes, it certainly is worth while to form a correct opinion of the results attained. In other words the operator's, "I think this is a pretty good wheel" should not be considered sufficient. The sixth question should be given careful consideration, for it is the earning power of a wheel that determines its efficiency. In cases where wheels are used on routine work, a satisfactory method of testing is as follows:

(1) Weigh the wheel. (2) Note its cost. (3) Use the wheel for a week on one kind of work. (4) Note the number of pieces ground. (5) Note the labor cost. (6) Weigh the wheel again. As an example, suppose we are testing a 24-inch by 2-inch wheel. This weighs approximately 70 pounds and costs 18.8 cents per pound, as the cost of the wheel is $13.18. We use this wheel a week, and in this time grind say 1000 pieces, at a labor cost of $20. The wheel wears to a diameter of 18 inches, then weighing 45 pounds. From this we have the following:

25 pounds of wheel at 18.8 cents per pound	$4.70
One week's labor	20.00
Total	$24.70
Cost per piece for grinding	2.47 cents

In a test of this kind we have authentic data to prove whether or not one wheel is more efficient than another.

Some grinding wheel manufacturers lay great stress on their service department, aiming to appeal to concerns who have not enough routine work to conduct accurate tests. The title "service department" would suggest to the uninitiated an elaborate array of modern grinding machinery for the testing of various kinds of materials and varieties of work, with the object of securing authentic data as to what wheels should be recommended for certain kinds of work. These conditions, however, are generally as far from actual facts as dreams are from realities. A service department generally consists of one man having a thorough knowledge of wheels, not only of his own concern's but of his several competitors' as well. He has on file for ready reference data concerning successful wheels for practically every known grinding operation. This, together with the information sent with the salesman's order, guides him in his decisions. He is guided principally by the three factors: surface speed of wheel, finish desired, and material to be ground. In due justice to him we must admit that he generally makes very accurate decisions. When he fails, he relies on the salesman to furnish him with data as to why the wheel was not successful. With this information he forms a new decision, changing the grit and grade, and in some instances the bond to overcome the previous failure.

Some grinding wheel manufacturers employ demonstrators who are experts at grinding. Now a demonstrator may come to any shop and show remarkable results because he works at high tension to have his wheels make good. It does not follow, however, that the operator who does the actual work, day after day, can get the same results, and as a matter of fact he seldom does. Grinding wheel demonstrators are like grinding wheel salesmen in that they have plenty of arguments to offset the other fellow's. Any demonstrator can cite numerous instances where his wheels have made good, but he keeps very quiet regarding cases where one of his competitor's won out over him. These are reasons why it is always a good plan for the manufacturer to work out his own grinding problems in his own shop with his own men, ever bearing in mind the fact that the crucial test should result in a few cold hard figures that have been obtained through common sense experimenting under actual working conditions.

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POLISHING ALUMINUM CASTINGS

The following directions for polishing aluminum castings are given in the *Foundry*: When polishing aluminum it is advisable to avoid the use of coarse abrasives if possible, as they drag or pull the metal and render the surface difficult to finish. If, however, the castings are quite rough, first polish with No. 70 emery, then grease on No. 120 emery with a compressed canvas wheel, and follow with No. 160 emery on a felt wheel; then impart the final luster by buffing, using a good grade of white polish on a stitched cotton wheel. If the castings are not rough the treatment with No. 70 emery may be dispensed with and the castings finished on No. 120, followed by No. 160 emery, and buffed.

If the castings are of simple pattern, the polishing may be accomplished almost entirely by tumbling. If rough, use coarse sand or crushed granite to produce a uniform surface; this treatment may appear too harsh, but owing to the peculiar nature of the metal it requires a sharp abrasive for roughing in a tumbler. The sand or granite is used wet, about the consistency of thin mortar. When sufficiently roughed, the castings are washed and transferred to a wooden or wood-lined tumbling barrel and tumbled with steel balls or smooth steel punchings in water containing ¼ ounce oxalic acid to the gallon. This treatment requires from two hours to two days, depending on the shape and condition of the castings and the speed of the barrel, the proper speed being just sufficient to cause the load to roll and not to jump across the barrel. When properly tumbled in this manner and finished on a buff wheel as previously stated, the finish is equal to and in many cases superior to a wheel polish, and the cost of production is decidedly less, as many hundreds of pieces can be treated at one time. But little labor is required and a boy can soon be taught to load and unload the tumblers. Naturally, if the utensils are large and thin, or hollow, the wheel treatment must be employed.

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MACHINERY

DESIGN—CONSTRUCTION—OPERATION

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COST DATA URGENTLY NEEDED

There is a great scarcity of technical literature relating to manufacturing costs, and few indeed are the articles published that give the actual figures for producing the component parts of a machine. This is a lamentable weakness of technical publicity for which the conservatism of manufacturers, and not the lack of enterprise of editors, must be held accountable. Yet there is no subject of greater importance to the average designer, contractor and builder than that of costs; for without a thorough knowledge of that subject he cannot safely undertake to design and build machinery in competition with other concerns.

There must be considerable data of that kind which could be made public without injury to the manufacturers concerned, covering the cost of building machinery, and starting from the drafting-room. It is especially desirable that all items should be given, including designing, drafting, patternmaking, foundry work, machining, selling, shipping, overhead and profit. The salaries and wages of officials, superintendents, foremen, designers and draftsmen, machinists and salesmen would be of great value; also the approximate location of the plant, shipping facilities, costs of coal, pig iron, structural iron and other materials required. The name of the manufacturer need not be given.

* * *

SPECIALIZING IN TECHNICAL WRITING

Many contributors to technical journals make the mistake of trying to cover too many subjects at once, and are therefore unable to cover any one thoroughly. Some apparently believe that the editor prefers long and discursive contributions to short and concise ones, which is an erroneous idea. A short article which covers a single subject completely is in most cases far more worthy of publication than a long treatise containing a great deal of matter which is merely incidental and desultory. Some writers—and very good ones at that—have the habit of saying that a certain subject will require more space than can be given to it, and it is therefore not treated at all. This is a mistake. If so little is known on the subject that it requires extended explanation, covering a great deal of space, it is ten to one that such use of the space would be justified. But if the subject is so unimportant that it is not worthy of extended space it is very likely it could be disposed of with a few general remarks, making unnecessary any reference to the space it will take.

The editor often entertains a strong suspicion that the real reason why a writer does not use up space to discuss a certain subject is because he is not sure of his facts and makes a statement of this kind in order to cover up his own shortcomings. As one of the most valuable results from writing for technical journals is the self-instruction the writer himself receives, it would be worth while for any writer who finds himself using the old evasion, "This would be too lengthy to treat in detail here" to set himself the task of obtaining all the information available on the subject, and then writing an article to cover it completely and concisely. In this way he would inform himself thoroughly on the subject and would handle it with that ease which only definite knowledge and perfect confidence give.

* * *

HOBBING RATCHETS AND SPLINED SHAFTS

The gear hobbing process is by no means confined to the cutting of spur, spiral and worm gear teeth. Hobs are usually made to generate symmetrical teeth, but they may be also designed to generate other forms as well. Ratchet teeth of various shapes, including radial faces and straight backs, can be hobbed rapidly, the product being equal in every respect to teeth cut by the usual indexing method. The study of forms that can be produced by the hobbing generating process is fascinating, and some surprising results are likely to come from the investigations now being made by specialists in this old-new art.

The hobbing of four-, six- and eight-spline shafts for automobile gear boxes is a comparatively recent development that is likely to become an important feature of manufacturing practice. Square shafts for sliding gears are being replaced by splined shafts having the splines integral with the shaft. To produce them by planing or shaping machines is a slow and costly process, requiring the attention of skilled workmen. The hobbing process is rapid and practically automatic in action. The splines can be made with square corners and straight sides, or with rounded corners and fillets and sloping sides. Broaching is the only alternative method.

The hobbing of wheels with square teeth and tooth spaces is readily accomplished, making possible the production of certain types of wheels used in adding machines, counters, etc. The cost of production is reduced to so low a figure that it seems almost absurd to attempt to still further cheapen it, as it has been lowered to a point that is practically negligible when compared to the retail prices of the machines in which they are used, but the manufacturer must never stop in the pursuit of more efficient methods. To do so means stagnation, and stagnation is industrial death.

* * *

THEORY AND PRACTICE IN MACHINE DESIGN

The beginner or the man untrained in designing has often the view that theory has a formula to fit every case which may arise in practice. While his reason for this view differs, the assumption is in its effects the same as that of the occasional man of science whose relation to the mysteries of the universe is summed up in the arrogant creed that everything to which he applies it must yield to his power of analysis. The words of the dying Lord Kelvin—who knew more of the material universe than any man since Sir Isaac Newton's day—tell a different story. "So much to do; so little done," he said, after a lifetime of unceasing mental toil. He knew that even his superb reasoning faculties were relatively slow and inefficient for the many tasks before them; that they could work only with effects, never with the first causes which must lie always hidden behind time's veil; and that his only knowledge of those effects must reach his brain through the medium of a group of very imperfect senses. With such limitations, the wonder is, not that the designer fails in his theoretical analysis of some difficult cases and must seek the aid of empirical data derived from practice, but that he has done so well in pointing the way to the correct solution of so many complex problems of strain and stress.

The history of machinery gives many instances of the intricate calculations which the demands of progress have forced upon the mathematician and designer. For example, take some of the many problems of inertia and vibration. Rankine by his early study and Dunkerley by his later analysis have made it possible to predict and provide for "whirling," that violent and dangerous whipping action of mill shafting which occurs at one—and only one—critical speed, when there is coincidence between the natural period of vibration of the shaft and that of its vibration as, in revolving, it sags between its bearings. Similarly, Normand, Dalby and Schlick, through their years of investigation, have enabled the designer so to distribute the weights of the rotating and reciprocating masses of a machine as to eliminate unbalanced moments and absolutely prevent vibration. Finally, the more recent experiments of Frahm and others have shown that it is unsafe to design large shafts for only the power to be transmitted, since besides the natural torsional vibration, there is usually an added synchronous vibration with a corresponding increase in torsional stress.

These, however, are questions of pure theory. Let us glance briefly at the practical side of designing. For example, in a flywheel, it is possible for the designer to calculate with reasonable accuracy the stress produced in the rim by centrifugal force; but for the actual effect of the arms of the wheel in modifying this stress, he must rely on the bursting tests of practice. Again, in designing the rod for a large slide valve, he can readily figure the normal inertia stresses, the maximum unbalanced load on the valve, and assuming some conventional coefficient of friction, the corresponding force which will resist the valve's motion; but a rod designed for these stresses only would be far too weak. The engine may be started suddenly and carelessly, making the valve's resistance a suddenly applied load of twice its static effect, or scale, core-sand, or rust due to a long idle engine may make his assumed coefficient absurd. For these reasons an empirical constant must be introduced in the calculations.

Instances like these abound throughout the whole range of designing; they are the rule, not the exception. The function of pure theory is hence simply to point the way, to blaze the path through the jungle of the unknown for the broad road of progress which practice, following in its steps, must build; and occasionally, too, theory wanders far afield, only to receive in due time from practice and experience a rude jolt backward to the right course. For the beginner in designing there can therefore be no safer guide than that old saying, prehistoric in its wisdom: "It is better to know a few things well than so many that are not so."

* * *

COURTESY PAYS

A traveling salesman of a well-known machine tool builder, although a philosopher, sometimes yields to the impulse to write to the editor about his troubles, and the following is reproduced for the benefit of those who regard such visitors as intruders, to be treated discourteously on general principles:

> Why do so many proprietors of machine shops seem to think that a machinery salesman is a natural enemy of the machine shop proprietor? At one place where I recently called I got "two orders," one to get out and the other to stay out. At a neighboring place I didn't get an order, but was politely received and conducted through the shop. I found the product of that shop was such that their claim that they had no use for the kind of machinery I was trying to sell was well founded. At the same time I learned that they were making something that I had no idea was being made in that section, and they seemed to be making it well. I will pass that word along. I had been told at the place where I got the "two orders" that they made special machinery to order, but on account of the "two orders" I don't really know anything about it. Hardly a day passes that I am not asked where this or that can be obtained. "Where can I get a tool-maker, where can I get a draftsman, and also where can I get a special machine built?" There is a moral.

This is the view of a salesman—in this case an unusually intelligent salesman. If the manufacturer's view were given it would probably be to the effect that only a small percentage of the salesmen who call are able to give any information of value to a manufacturer, except about the line of goods they are selling; and sometimes not about that. Whichever view is correct, there can be no question that courtesy to every caller is a good investment, if for no other reason than that you make a friend instead of an enemy.

* * *

CONVENIENT FORMS OF LEWIS FORMULA FOR STRENGTH OF GEAR TEETH[*]

BY J. H. CARVER[†]

When figuring the strength of gear teeth, the terms usually under consideration are horsepower, diametral pitch, number of teeth and width of gear face. In Kent's Handbook are found the two following forms of the Lewis formula for strength of cast-iron and steel cut gear teeth:

$$\text{H. P.} = 0.0000079\, dspfy \times \text{R. P. M.} \qquad (1)$$

$$W = spfy \qquad (2)$$

where H. P. = horsepower transmitted;
d = pitch diameter of gear in inches;
s = unit stress, depending on peripheral speed at pitch line;
p = circular pitch;
f = width of face in inches;
y = a constant relating to the 14½-degree involute tooth and depending on number of teeth;
R. P. M. = revolutions of gear per minute;
W = load transmitted by teeth in pounds.

TABLE I. VALUES OF THE FACTOR OF STRENGTH y FOR 14½-DEGREE INVOLUTE AND CYCLOIDAL TEETH

No. of Teeth	y	No. of Teeth	y	No. of Teeth	y
12	0.067	20	0.090	43	0.110
13	0.070	21	0.092	50	0.112
14	0.072	23	0.094	60	0.114
15	0.075	25	0.097	75	0.116
16	0.077	27	0.100	100	0.118
17	0.080	30	0.102	150	0.120
18	0.083	34	0.104	300	0.122
19	0.087	38	0.107	Rack	0.124

Machinery

Formula (1) transformed to one where the terms most generally known are used becomes:

$$\text{H P.} = \frac{0.000095\, Vsfy}{P} \qquad (3)$$

Treating Formula (2) in the same way, we have:

$$W = \frac{s\pi fy}{P} \qquad (4)$$

where V = velocity in feet per minute at pitch line;
P = diametral pitch.

Formulas (3) and (4) are obtained by substituting in Formulas (1) and (2) the following values:

$$V = \frac{\pi d \times \text{R. P. M.}}{12} \text{ or } d = \frac{12V}{\pi \times \text{R. P. M.}}$$

$$p = \frac{\pi}{P}$$

$$\text{H. P.} = 0.0000079 \times \frac{12V}{\pi \times \text{R. P. M.}} \times s \times \frac{\pi}{P} \times f$$

$$\times\, y \times \text{R. P. M.} = \frac{0.000095\, Vsfy}{P} \qquad (3)$$

$$W = spfy = \frac{s\pi fy}{P} \qquad (4)$$

Example 1: What horsepower will a 30-tooth, 5-pitch, 3-inch face cast-iron gear transmit running at 900 revolutions per minute? A 30-tooth, 5-pitch gear has a pitch diameter of 6 inches.

---

[*] For additional information on the strength of gears and allied subjects published in MACHINERY, see also "Tests for the Strength of Gear Teeth," January, 1914; "Logarithmic Chart for Finding the Strength of Gear Teeth," by H. T. Millar, October, 1912; Charts for Horsepower Transmitted by Gearing and Belting," by C. E. Evans, August, 1912; "Strength of Gear Teeth—Derivation of the Lewis Formula," September, 1911; "Strength of Helical Gears," October, 1908; "Variation of the Strength of Gear Teeth with their Velocity," by Ralph E. Flanders, January, 1908; and "Strength of Gears," by John S. Myers, December, 1906.

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$$V = \frac{\pi \times \text{pitch diameter}}{12} (\text{R. P. M.}) = 0.26 \times 6 \times 900 =$$

1404 feet per minute at pitch line.

s = say 2270 (from Table II)

$y = 0.102$

$P = 5$

TABLE II. SAFE WORKING STRESS s FOR VARIOUS SPEEDS

Speed at pitch line in feet per minute	100 or less	200	300	600	900	1200	1800	2400
Cast Iron	8000	6000	4800	4000	3000	2400	2000	1700
Steel	20,000	15,000	12,000	10,000	7500	6000	5000	4300

Machinery

$$\text{Therefore H. P.} = \frac{0.000095 \times 1404 \times 2270 \times 3 \times 0.102}{5} = 18.5.$$

Load safely transmitted by this gear is:

$$W = \frac{\pi s f y}{P} = \frac{\pi \times 2270 \times 3 \times 0.102}{5} = 436 \text{ pounds.}$$

TABLE III. SUITABLE PITCHES FOR GEARS TRANSMITTING VARIOUS HORSEPOWERS

Horsepower Transmitted	Pitch	Horsepower Transmitted	Pitch	Horsepower Transmitted	Pitch
⅙	12	3	6	25	3
¼	10	5	6	50	2½
½	10	7½	5	60	2½
¾	10	10	4	75	2
1	8	15	3	100	2
2	8	20	3	150	1½

Machinery

Table III shows suitable pitches for various horsepowers. Using a smaller sized tooth, of course, means a wider face for a given horsepower and a narrower face for a larger tooth; but in general the pitches given are satisfactory regarding proportion of face to diametral pitch.

Example 2: An 18-tooth cast-iron gear is needed to transmit a maximum of 20 horsepower at 600 revolutions per minute. What pitch and face width should be used? From Table III we find that 3 diametral pitch is suitable, which means the use of a gear of 6 inches pitch diameter; and running at 600 revolutions per minute, this gives a speed of $0.26 \times 6 \times 600 = 936$ feet per minute at the pitch line.

From Equation (3) we have:

$$f = \frac{P \times \text{H. P.}}{0.000095\, V s y}$$

$s = 3000$

$y = 0.083$

$$f = \frac{3 \times 20}{0.000095 \times 936 \times 3000 \times 0.083} = 2.7 \text{ inches, say}$$

2¾ inches face.

* * *

Attention is called in the *Travelers' Standard* to the danger of the bursting of a grinding wheel used for internal grinding. An internal wheel is most likely to burst when it is first withdrawn from the hole. It becomes heated while in use and the air inside of the hole where the grinding is done is likely to be quite warm. When the wheel is then quickly withdrawn and exposed to the cool air outside of the work, the chill that it receives gives rise to severe contraction stresses which sometimes cause the wheel to fly apart violently

* * *

It is stated that all of the 15-inch guns for the five British battleships of the Queen Elizabeth type were ordered without a trial gun being made and tested. When they were tried, the results agreed exactly with the calculations of the designers. The new guns are said to be the most accurate at all ranges yet built for the British navy. The explosive charge is 50 per cent greater than for the 13½-inch guns previously used on the super-dreadnaught type of battleships

CUTTING METALS WITH TOOTHLESS DISKS

Technical literature of the past contains the records of many inventions generally considered modern, and the cutting of metals by toothless disks has formed the subject of numerous re-inventions. Though a certain German firm now claims to hold master patents in this field, the principle of cutting hot or cold metals by a rapidly rotating disk of relatively soft metal was known and applied at such an early date that, as pointed out by Prof. Codron in *La Machine Moderne*, machine tool designers are at liberty to evolve freely special types of "toothless saws." In 1880, Reese of Pittsburg discovered that a rapidly rotating soft iron disk would cut cold steel, but references to the same process are to be found in writings dated very early in the nineteenth century. Reese held the view that the soft disk did not actually touch the bar cut, but compressed and heated intensely the air between disk and bar, so that cutting was due to violent projection of hot air particles onto the steel or other metal severed. This and other hypotheses were much discussed in the early eighties, but it was soon admitted generally that cutting was due to melting by heat generated by friction between the soft disk and the bar cut.

Toothless cutting disks absorb considerable power while in service, but the rapidity with which they work and the excellence and importance of the results obtained make the total cost of energy relatively negligible. For example, the cost of cutting a bar 4 inches by 0.55 inch at 0.12 inch per second by a disk absorbing 15 horsepower is only 0.44 cent if electrical energy is available at 2 cents per unit. Prof. Codron finds that the power (W — watts) absorbed by a toothless cutting disk is expressed by: $W = Ka^m$ where K and m are numerical constants and a is the feed in millimeters per second. The power W_1 required per cubic millimeter of metal removed varies rapidly with the feed, and, to reduce the net and total energy expenditure required, the feed should be as great as possible, particularly since the power required merely to drive a large disk at high speed is considerable. For cold iron, $W_1 = 55.5 \div a^{0.42}$ (the normal pressure between disk and work being 5, 23½, and 50 pounds, respectively, with feeds of 2, 39, and 118 millimeters per second). At a red cherry heat, the power required to cut iron by a toothless disk is: $W_1 = 32.7 \div a^{0.37}$ (roughly half that required for cold cutting), but a toothed saw absorbs only one-eighth as much power ($W_1 = 4.12 \div a^{0.36}$). It follows that toothed saws should be used to cut hot pieces which have not to be heated specially for sawing (*e. g.*, rails leaving rolling mills). In cutting cold pieces of small or medium thickness, toothless disks are more rapid and less expensive than toothed saws, and are now used extensively (often in automatic machines) to cut bolts, high-speed tool blanks and slots in screw heads.

It is easy to adapt existing grinding and milling machines to carry a toothless cutting disk, and circular metal sawing machines may conveniently be fitted also with a toothless cutter. Thin pieces of iron can be cut easily by the back of a wood-cutting band saw running at 50 feet per second, and toothless band saws running from 80 to 120 feet per second, in specially designed machines, can be used advantageously to cut tubes, fretwork, etc. A simple iron wire is useful in special cases, but breakages are frequent, owing to the considerable tension under which the wire must be used. A paper disk, say ¾ inch in thickness, 15 inches in diameter, and running at a peripheral speed of 160 feet per second, will cut its way easily through wooden planks ½ inch or even ¾ inch in thickness. The wood is burnt away at the cut, clean brown ends are left on the pieces, and the wear of the cutting disk is surprisingly small. Though power-driven saws are now used extensively to cut hot metal, one rarely finds hand saws used for this purpose, yet an ordinary carpenter's saw is extremely useful in severing special, fairly light sections of red-hot iron. The saw should be worked quickly to prevent excessive local heating, and should be quenched at intervals during and after use. Though the teeth of the saw lose some of their effectiveness for cutting wood after such treatment, they can be used repeatedly to cut hot iron without sharpening and resetting.

SHAFT TURNING OPERATIONS AT THE POND SHOPS

TOOLS AND METHODS EMPLOYED IN EFFICIENT SHAFT TURNING

BY A. SPANGENBERG*

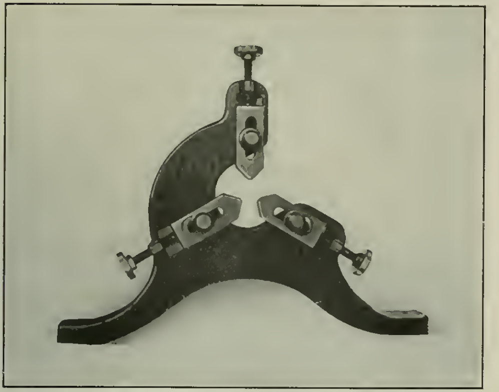

Fig. 1. Commercial Type of Follow-rest which is Unsuitable for Shaft Turning

THE turning of long shafts in an economical and efficient manner may be considered a separate branch of engine lathe work, since it requires special tools and fixtures and special knowledge and skill on the part of the operator. Accuracy, both as regards diameter and straight turning, is essential, and to maintain these standards throughout a shaft 75 feet or more in length without resorting to practically any filing is the principal difficulty involved. Two general methods are described and illustrated in the following article which represent the practice employed at the Pond Works of the Niles-Bement Pond Co., Plainfield, N. J. The first is applicable to turning shafts up to 2 inches in diameter and employs the principle of high cutting speed and light feed, while, inversely, the second method illustrates the idea of turning larger diameters at a comparatively slow cutting speed, using a heavy feed. This is logical, since the diameter in each case and also the length of shaft control to a great extent the permissible speeds and feeds.

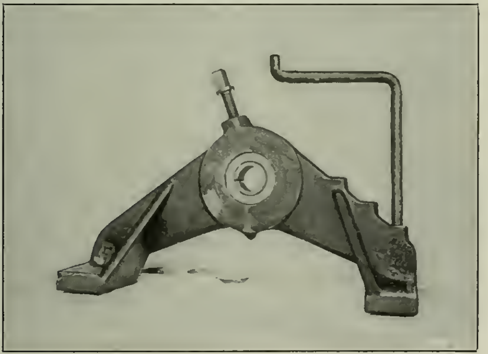

Fig. 2. Improved Form of Follow-rest for Small Shafts

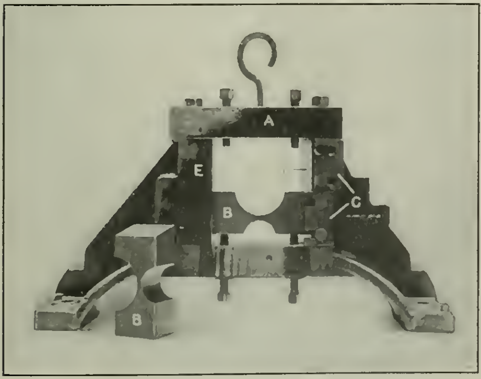

Fig. 3. Follow-rest adapted for Large Shafts

Special Types of Follow-rests and Supports

As the principal factor tending toward accurate and economical shaft turning is the provision of a rigid support for the shaft near the cutting tools, attention is first directed to the various types of follow-rests, which, as the name implies, are rests bolted to the lathe carriage for following the cut and supporting the work. The nearest approach to absolute rigidity in this supporting member is essential, and a study of the commercial type shown in Fig. 1 will at once impress the observer with the fact that it lacks rigidity and durability. Two follow-rests of an improved form are illustrated in Figs. 2 and 3. Fig. 2 shows the type best suited to shafts of small diameter—2 inches and under. After being bolted and doweled to the lathe carriage, this rest is bored concentric with the lathe centers. Cast-iron split bushings of various diameters to suit the work are provided. The idea of the set-screw and split bushing is to take up

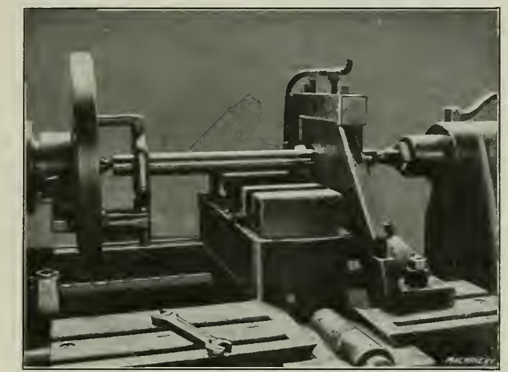

Fig. 4. Method of boring Follow-rest to insure Hole being Concentric with Lathe Centers

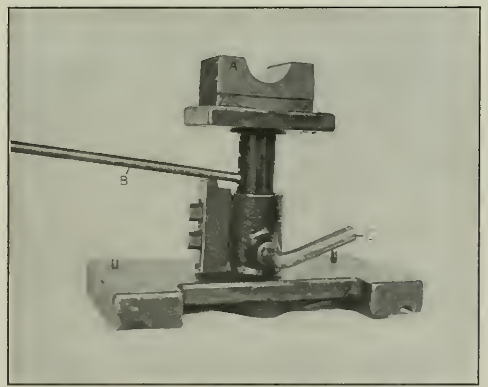

Fig. 5. Support or "Jack" for Long Shafts—used in Place of Regular Center Rests

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* Address: 951 W. 5th St., Plainfield, N. J.

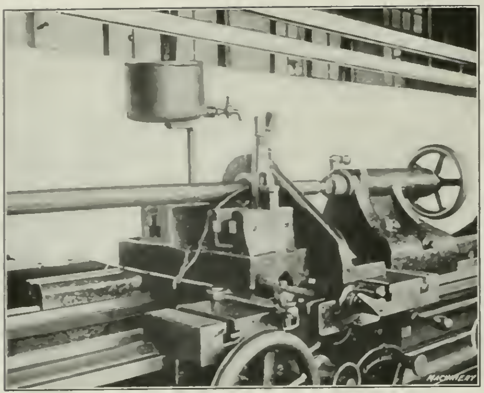

Fig. 6. Illustrating Method of High Cutting Speed and Light Feed

slight wear, and when worn out the bushings are rebored to the next larger size.

The rest shown in Fig. 3 is designed for large shafts, and being provided with a cap *A*, it can easily be put into position on the lathe carriage with a shaft in place without having to slide it on from the end of the shaft. This feature is particularly valuable when the length of the shaft exceeds that of the lathe bed on which it is being turned. The blocks *B* are adjustable for height and are held in position by the slotted clamps *C*. One of the blocks is removed to show that guiding surface *D* is beveled, while *E* is straight. It will also be observed that one set of blocks serves for two sizes of shafts. Fig. 4 shows the method of boring out follow-rests, and the operation is so simple as to need no explanation.

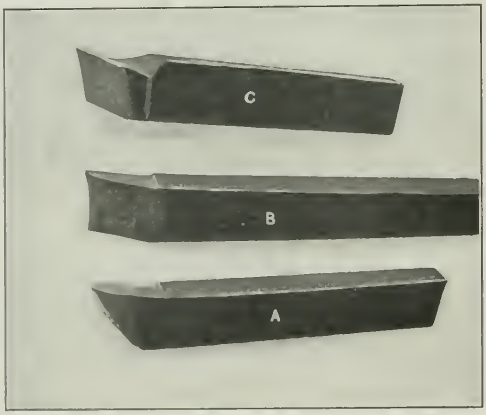

Fig. 7. Types of Shaft-turning Tools—made of High-grade, High-speed Tool Steel

A most convenient form of support, or jack as it is sometimes called, is shown in Fig. 5. This jack carries a hard-wood block *A*, the height being adjusted to suit the work by means of the bar *B* and clamping screw *C*. A number of these jacks, together with an assortment of various sized wooden blocks, are provided for each shafting lathe.

The High Speed and Light Feed Method

It was previously stated that the diameter and also the length of a shaft control to a great extent the permissible cutting speed and feed. An example of high-speed turning is illustrated in Fig. 6 which shows part of a shaft 2 inches in diameter and 15 feet long. The reduction in this case is 1/16 inch in diameter at 200 feet peripheral speed and 1/32 inch feed. The material is machinery steel. When necessary, on account of several diameters on a shaft of about this diameter and length, it is frequent practice at the Pond Works to make a ¼-inch reduction in diameter at the same speed and feed as just mentioned. As shown in the illustration, but one tool is used and one cut finishes the shaft to size, a final polishing with emery cloth producing a good finish. The tool is a "diamond point" tool with a slightly rounded end. The form of the tool is shown at *A* Fig. 7. The angles to which the three shaft-turning tools shown in this illustration are ground are as follows:

	Clearance	Side Slope	Back Slope
Diamond point tool *A*............	30	7	10
Roughing tool *B*................	15	5	10
Finishing tool *C*................	20	10	0

In order to convey an idea of the possibilities of high-speed turning, a concrete example is shown at *A* in Fig. 9. The dimensions of the shaft, which is of chrome-nickel steel, are indicated in the illustration, and the actual time for turning it all over was 7 minutes.

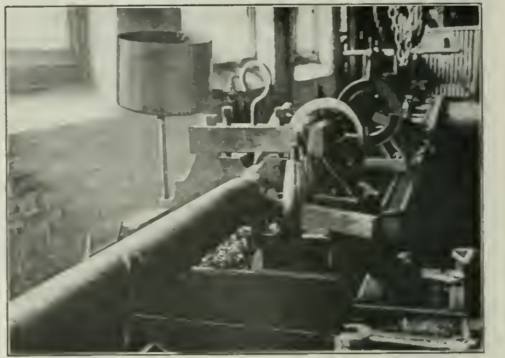

Fig. 8. Roughing and finishing a Large Shaft in One Operation, using Two Tools

The Slow Speed and Heavy Feed Method

In turning long shafts over 2 inches in diameter, it has been found advantageous to use a slower speed and a coarse feed, because with a given depth of cut, metal can be removed more quickly than by using a fine feed and a proportionate increase in speed. This method also lends itself readily to the use of two tools simultaneously, one roughing and the other finishing. An example of this kind is illustrated in Fig. 8. The cutting speed in this case was 60 feet per minute on a machine steel shaft 3 inches in diameter, with a reduction of ⅜ inch in diameter and a feed of ¼ inch. About 0.010 inch in diameter was taken by the finishing tool. A better idea of the tool settings is obtained from an inspection of Fig. 10 in which the tools were moved away from the cut and the follow-rest was removed for the purpose of illustration. When setting tools for shaft turning it has been found advisable to set the cutting edges considerably above the lathe centers, as in this way chattering is practically eliminated, and with

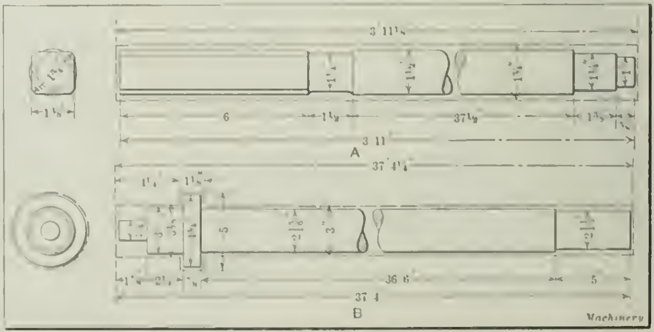

Fig. 9. (A) Example of High-speed Turning: Material, Chrome-nickel Steel, Time for Turning, 7 Minutes. B) Example of Turning by Slow-speed and Heavy-feed Method, Material, Machine Steel; Time for Turning, 6 Hours

greater clearance angles the tools cut much more freely and consume less power. In the present case, with a 3-inch diameter, the tools shown are set about ⅛ inch above the centers.

The shapes of the tools here used are indicated at *B* and *C* in Fig. 7. The finishing tool *C* is particularly interesting inasmuch as it has an unusually broad cutting edge, 2 inches wide, which is on an angle of 18 degrees with the shank. By using lard oil as a lubricant, and having the cutting edge of the tool slightly rounded, an excellent finish is obtained on the work. Shafts 4 inches in diameter and 96 feet long have been turned at the Pond Works by the methods just described. Another example of turning is shown at *B* in Fig. 9. This is a machine steel blank shaft for a lathe lead-screw and the time, in this case, was 6 hours for turning the shaft all over.

Threading Operations

It is well known in machine shop practice that thread milling is the most economical method of producing threads where the sizes are beyond the capacity of threading dies. However, there are many cases when the shafts to be threaded are too large in diameter or too long to be handled by a thread milling machine. In such cases thread chasing in the engine lathe must be resorted to. Fig. 11 illustrates a time-saving method of thread cutting in an engine lathe. The work is rigidly supported by two follow-rests, the rest *A* being used in addition to the regular rest *B*. The utility of the special tool-slide *C*, having T-slots for front and rear tool-posts, is also indicated. A tool-slide of this design is more rigid and suitable for the purpose than the regular compound tool-slide.

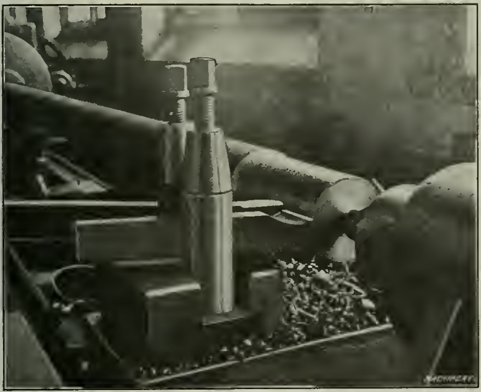

Fig. 10. Same Job as shown in Fig. 8, but with Follow-rest removed to show Tool Settings

When roughing out, the thread tool *D* is used for the forward cuts and tool *E* cuts on the reverse. This scheme saves the time usually lost in running the lathe carriage back for the next cut. During the last two or three finishing cuts the front tool only is used.

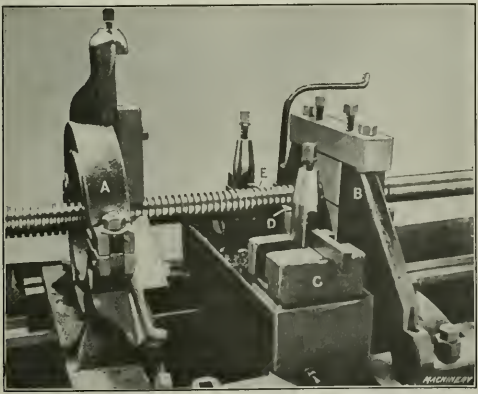

Fig. 11. Threading Operation, using Two Tools to permit cutting on both the Forward and Reverse Movements of the Carriage

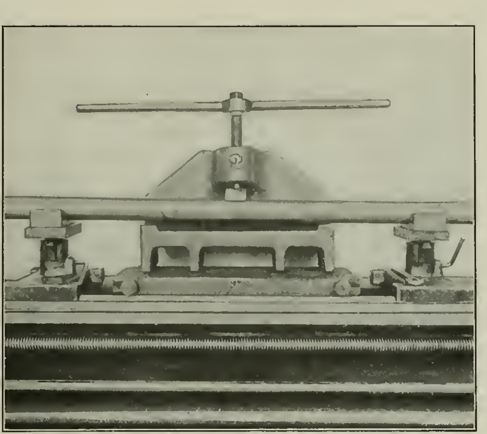

Fig. 12. Hand-operated Shaft Straightener, mounted on Truck which fits Lathe Bed

Straightening Operations

To quickly and accurately straighten a long shaft requires considerable skill and experience. A shaft may run out at a certain point but the trouble there may be caused by eccentricity somewhere else. The best way is to find the point of greatest eccentricity and straighten there, and then proceed in the same manner until the shaft runs true everywhere. It really is a process of elimination. All long shafts have to be straightened before the turning operations, and all such shafts require more or less straightening after turning.

A hand-operated straightener of convenient and powerful form is shown in Fig. 12, and as will be seen, it is carried on a suitable carriage running on wheels that fit the lathe bed. The shaft supports are easily moved when required.

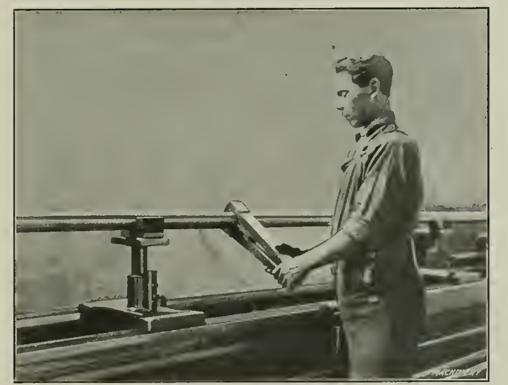

Fig. 13. Method of polishing Shafts

Polishing Shafts

The polishing operation, which is clearly illustrated in Fig. 13, is so simple as to need little explanation. The emery cloth is folded and lies between the two hard wood blocks which are joined at one end by a piece of leather. Oil is used and the outfit really becomes a lap.

Sizes of Stock for Shafts

In ordering rough stock for shafts it is advisable, when conditions permit, to leave as little stock as possible for turning, for by so doing not only is stock saved but greater production results. As a general proposition it may be stated that 1/16 inch in diameter is sufficient for finishing, when the shafts are properly straightened. It is good practice when designing shafts to use sixteenths for the finished maximum diameter, *i. e.*, 1½-inch diameter machine steel should be used for a 1 7/16-inch finished shaft; 2-inch stock for 1 15/16-inch shaft; 2 3/4-inch stock for a 2 11/16-inch shaft, etc.

Summary

Summarizing the principles referred to in the foregoing, we may consider the following to be the principal factors tending toward economical and efficient shaft turning.

1. Shaft turning, being a special branch of lathe work, requires specially trained and skillful workmen.
2. Accurate and powerful lathes are required to handle the heavy cuts. Motor-driven lathes are preferable on account of their flexibility and convenience.
3. Rigidity of the follow-rests is essential for heavy cuts.
4. An ample supply of high-grade, high-speed steel tools, properly ground in the tool-room, is absolutely necessary for proper results.
5. Abundant tool lubrication is required, and this is best supplied by a system of pump, pan, and piping.
6. A specially designed tool-slide having T-slots for front and rear toolposts saves time, as it enables a rear tool to be used during the reverse movement of the carriage when threading.
7. Accurate sizing is essential to save filing.
8. Care should be exercised when ordering stock so that there is a minimum amount of stock to be turned from the maximum diameter.

By using the tools and methods previously described and illustrated, results will be secured that will increase production fully 200 to 300 per cent over the average shop methods. No mention has been made of the grinding process for finishing shafts because the class of work covered by this article either does not require the high degree of accuracy produced by the grinding method or the shafts are beyond the capacity of any grinding machine on the market today.

* * *

TRADE SCHOOLS—THEIR STRONG AND WEAK POINTS

BY CON WISE

The state aided trade schools of Massachusetts cater largely to the machinists' trade and only one—that at Northampton, which is primarily an agricultural school—does not offer courses in it. In the others, it was the first trade to be taught and still draws more pupils than any other one trade. This is probably due to the facts that Massachusetts needs large numbers of skilled mechanics in its machine shops, and that in spite of the comparatively small wage offered to machinists in that state, the prospects of a capable mechanic are good. Massachusetts has of late years been a fine recruiting ground for industries in the Middle West, where a more liberal spirit both in money and social surroundings has made a great appeal. In turn, she has tried to recruit from the north of Europe, but she finds that she is only a way station for these men on their journey toward the setting sun. Now she is trying to bring up her youth the way they should go. Whether she will be able to fill the demand from the West, so that there will be no place there for her sons to go, or whether she will wake up to the situation and offer inducements enough for them to stay at home is an open question. In the meantime the experiment which the state is trying is an interesting one, irrespective of the destination of the graduates.

A recent trip which I took around the more prominent of these schools made me believe that they are suffering from certain unnecessary handicaps, which are inherited from the older ideas of machine shop practice and from antiquated school methods. The first of these handicaps finds expression in the employment of so many toolmakers as instructors. The result is that wherever I went I saw work being done at a snail's pace, even when the machines and the work would stand high speeds and liberal feeds. It seems to be characteristic of New England toolmakers that they should look upon a piece of tool steel with a sort of reverence, as something which should not be unduly disturbed, for fear that it would not harden properly if anything was done to it hurriedly. Time is something that has no meaning to them, and rightly so in one way, because the time spent in making a tool is spread over so many pieces on which it may be used that its cost may sink into insignificance. On the other hand, when we stop to think that time lost can never be recalled, it seems a pity to allow a machine to run slowly, when, without any extra labor, it might run quickly. The effect on the pupils in these schools is the thing which is more deplorable than any consideration of time wasted on the product. The output of the schools is, or should be, machinists. If they are educated in slow ways of doing work, there remains something to be added to their education in the shops to which they go, that should not be necessary. The reason why so large a proportion of former toolmakers are selected for teachers is twofold. First: it is easier to get men who look the part from tool-rooms than from the general shops; second: there is a scarcity of all-around men in the general shops to draw from. There is no doubt that this is true. A general machinist with an all-around training, if he has some executive ability, usually finds an opening that pays better than any school can afford to.

The other handicap under which these schools labor is inherited from manual training schools. The usual school committee man can see no difference between manual training and trade work. It is the custom to ask a manual training teacher to make requisition for all supplies during the summer vacation, and he orders so many thousand feet of pine shorts and so many kegs of nails, etc., knowing that if he does not get his supplies then, when he needs them some other department will have used the money. Imagine doing things on that basis in a going shop? In August the owner comes around and wants a list of all the castings that you are going to want in the next ten months. If you order a dozen gears and spoil one, you wait till next year to get a new casting. If a customer who wants some work done comes in, you tell him that next year you will order in the castings and get right at the job. This is not an exaggeration. There is, of course, no doubt but that it should be possible for the head of the machine shop to send up to the foundry for castings to be delivered hot the next morning, just as he would in any other shop. It should be possible to buy any supplies without more than a day or two delay. The school committee could keep an all sufficient oversight of expenditures if they simply appropriated so much for the year's supplies and then checked up the bills to see that the account was not overrun. In one school I found that the only way they had of getting castings was by trading with a foundry. The school would do certain work, in exchange for which the foundry would supply castings. The work was not just what the school needed but it served a purpose.

The schools are doing a wonderful work when the handicaps under which they labor are taken into consideration. There is hardly a school that has a very definite aim which it is sure it will be allowed to carry out. They are all hard put to find suitable work. In this they are as much handicapped by their friends as their enemies, if they may be said to have any of the latter. The work which is offered them, and which they sometimes feel obliged to take, regardless of consequences, is often of a more difficult nature than the good of the pupils demands. They require large amounts of very elementary work—lathe work especially—on which the boys can be kept busy until they get the habit of doing careful work. A relatively small proportion of advanced work is needed, because that can only be done by the boys who stay through the course, which cannot be expected to be more than half of those that start. The question of whether these schools can turn out machinists is amply proved by the positions which their graduates get and hold. They go into the best of shops, take hold with the other men, and make good with as little delay as most men experience who go from one shop to another. Possibly this is to some extent on account of these very handicaps. The boys are thrown more on their own resources than they would be if things were running as they ought. At the same time, it costs more for instruction than it should, because an instructor cannot possibly give the time to teaching that he has to devote to digging up work for his pupils to do.

* * *

Iron ore heads the list of Sweden's exports. During 1913 6,440,000 tons were exported to foreign countries, chiefly England and Germany.

PROPORTIONING STEEL HOOPS FOR WOODEN TANKS*

THE ACTION OF WATER PRESSURE AND METHOD OF SPACING HOOPS TO WITHSTAND IT

BY EDMUND B. LASALLE†

IN connection with the design of elevated wooden tanks and steel towers for supporting them, as discussed in previous articles, there is one other part of such a structure that comes under the province of the engineer, and that is the steel hoops for the tank. There are three types of hoops in general use, the round, half-round and flat, as shown in section in Fig. 1. The round hoop is used more than any other shape, and for tanks used by factories for fire protection none other is permitted by the insurance companies handling that class of risks. Therefore in this article we will consider that type of hoop in our calculations. The method is the same for any other section used as a hoop, except that special calculations to find the net area must be made.

The purpose of the tank hoop is two-fold: to draw the staves tightly together and prevent the tank leaking, and to prevent the tank from bursting on account of the pressure of the water. In large tanks, this pressure becomes enormous. The weight of a cubic foot of water is generally taken as 62.5 pounds, and to arrive at the pressure per square foot for any depth of water, we multiply 62.5 pounds by the depth in feet. For instance, if we wish to obtain the pressure per square foot on the bottom or at the base of the stave of a tank 20 feet deep, it is found to be $62.5 \times 20 = 1250$ pounds per square foot. In calculations relating to this kind of tank, it is more convenient to have the amount of pressure per square foot than per square inch, as will be shown later.

The action of the water tending to burst the tank is shown in Fig. 4, the pressure being uniform in all directions for a given depth below the surface. The effect of this condition is shown in Fig. 5. Consider the half circle shown as being a solid of indefinite length; then the effective pressure of the water would act as shown and tend to separate two such halves that the tank is regarded as being made up of, the water taking the place of the imaginary solid substance. The resisting force of the hoops would then have to act in the opposite direction, as shown by the arrows at the circumference of the circle. It falls on the hoops around a tank to resist the total bursting pressure of the water in the tank.

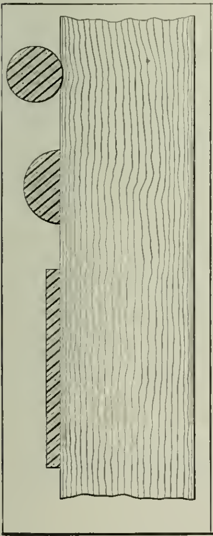

Fig. 1. Types of Hoops used on Wooden Tanks

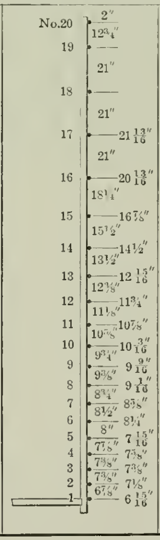

Fig. 2. Preliminary Spacing of Hoops

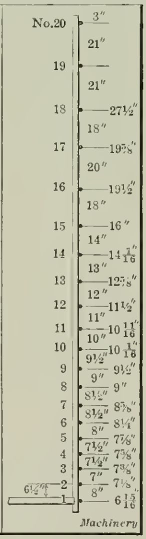

Fig. 3. Adjusted Spacing of Hoops

As we have in previous articles taken a tank 20 feet in diameter and 20 feet high for the calculations, we will use the same size here. Owing to the manner of constructing wooden tanks, the depth of water contained will not be identical with the height of the staves because the tank bottom is set up about 4 inches above the lower end of the staves. The bottom of the tank is approximately 3 inches thick; therefore, the water would be 7 inches above the bottom of the staves. In a 20 by 20 foot tank, the actual depth of water when the tank is full would be 20 feet — 7 inches = 19 feet 5 inches. This is the depth used in the calculations. The insurance companies specify that on tanks less than 20 feet in diameter one extra hoop must be added at the bottom to take care of the swelling of the bottom. For tanks 20 feet or more in diameter, two extra hoops must be added. In the formulas to follow, we will use the following nomenclature:

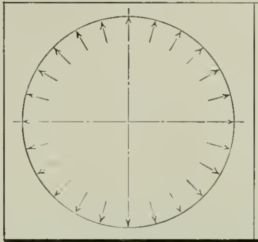

Fig. 4. Diagram showing Action of Water Pressure

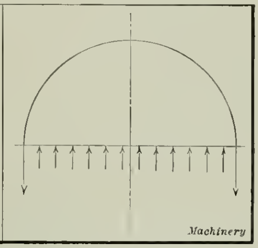

Fig. 5. Diagram showing Effective Water Pressure

D = diameter of water, in feet;
H = depth of water in tank, in feet;
h = depth of water above point under consideration, in feet;
R = radius of water, in feet;
P = pressure supported by hoop or hoops, in pounds;
p = pressure per square foot at point considered, in pounds;
S = safe strength of one hoop, in pounds;
A = total net area of hoops required, in square inches;
a = net area of each hoop;
N = total number of hoops required;
f = fiber stress in pounds per square inch in hoops;
B = vertical surface of stave in feet, supported by a hoop;
b = vertical surface of stave, in inches, supported by each hoop.

The pressure p for any position on the stave is the distance from the surface of the water to that point multiplied by 62.5.

$$p = 62.5\,h. \tag{1}$$

The average pressure for all the water in the tank occurs at a point half way between the surface of the water and the bottom of the tank:

$$p = \frac{62.5\,H}{2}. \tag{2}$$

From this formula we obtain the average pressure per square foot exerted by the water against the sides of the tank in all directions, as illustrated in Fig. 4. Then, according to Fig. 5, if we wish to obtain the total effective pressure on the tank at the point under consideration, we multiply the diameter by the pressure per square foot, thus:

$$p = \frac{62.5\,HD}{2}.$$

This gives the pressure exerted on a space one foot wide, that is, vertically on the stave. We now have the average bursting pressure per vertical foot of water; so to get the total bursting pressure we multiply the height of the water by this average bursting pressure, thus:

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* For additional information on the design of gravity tanks see "Designing Steel Towers for Wood Tanks," published serially in MACHINERY for January, February, March and April, 1913, and other articles there referred to.

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$$P = \frac{62.5\,HHD}{2} = 31.25\,H^2D. \qquad (3)$$

As there are two sections of the hoops that resist the total bursting pressure, to get the amount of pressure for which the hoops have to be proportioned we divide Formula (3) by 2, then:

$$P = \frac{62.5\,H^2D}{4} = 31.25\,H^2R. \qquad (4)$$

When f is the allowable fiber stress in the hoops in pounds per square inch, the total net area A in square inches required to resist the bursting pressure in Formula (4) would be:

$$A = \frac{31.25\,H^2R}{f} \text{ square inches.} \qquad (5)$$

We have now shown how to obtain the total area of hooping for the tank. Next we must decide how many hoops are necessary. We cannot, as one would naturally suppose, divide the total area required by the net area of each hoop and thereby obtain the required number. There are several reasons, arising from practical considerations, why this cannot be done. The top and bottom hoops, owing to their position, can only take half a load, because on one side they have no load and on the other side they divide their load with the next hoop. For that reason, we lose the value of one hoop. The maximum center-to-center distance of any two hoops, as permitted by the insurance companies that regulate such matters, is 21 inches. In railroad work this distance is exceeded, but a distance of 23 inches should be the maximum for work of any importance. It will be found that, owing to this spacing limit, when the hoops approach the top of the tank they can support more than this limit will allow, and so they do not assist to their maximum capacity in supporting the load. This causes another loss of hoop value. When distributing the hoops, it is not advisable to space them to small fractions of an inch. It is better to take the next lower ¼ inch. From these two causes, it will be found that we lose practically the value of one hoop, and so we lose altogether the value of two hoops for which we must make allowance in our formulas. The theoretical number of hoops required would be found by dividing A by a and when we allow for the two hoops lost through the causes just mentioned, the formula would read:

$$\frac{A}{a} = N - 2 = \frac{31.25\,H^2R}{fa}. \qquad (6)$$

$$N = \left(\frac{31.25\,H^2R}{fa} \right) + 2. \qquad (7)$$

In case the specification requiring one or two extra hoops for the swelling of the bottom has to be adhered to, the formulas could be changed to suit, or the extra hoops added to N in Formula (7). We have now shown how to determine, as nearly as possible, the number of hoops required on a tank; the next step will be to space the hoops on the staves in such a way that no hoop is overloaded and all are doing their share of the work. There is one thing we might call attention to before going further, and that is that the value of N in Formula (7) provides for all hoops to be of one size. It very often happens that it is economical to change the size of the hoops, making them smaller toward the top. Three sizes are sometimes used, but it will generally be found that two sizes are enough, the top three or four hoops being a size smaller than those at the bottom. In such a case, it is best to solve for A in Formula (5); then deduct the combined areas of the three or four hoops at the top and divide the remainder by the area of the hoop it is intended to use. The sizes can be assumed for this purpose and then changed later if they do not space well. If we proceed in this way, we will have to make the additions for extra hoops called for in Formulas (6) and (7) after determining the theoretical number of each size required.

To find how much vertical space in feet each hoop (or set of hoops) will support we use the formula:

$$B = \frac{S}{31.25\,Dh}. \qquad (8)$$

This formula is derived as follows:

$$p = 62.5\,h = \text{pressure per square foot.}$$

$$P = 62.5\,hRB \text{ or } 31.25\,hDB.$$

$$P = S = af = 31.25\,hDB.$$

$$B = \frac{S}{31.25\,hD} = \frac{af}{31.25\,hD}.$$

$$f = \frac{31.25\,DhB}{a}. \qquad (9)$$

$$a = \frac{31.25\,DhB}{f}. \qquad (10)$$

If we wish to obtain the space b the hoop will support in inches instead of feet we multiply Formula (8) by 12, thus:

$$b = \frac{12\,S}{31.25\,Dh} = \frac{S}{2.60417\,Dh}. \qquad (11)$$

We will now take an actual problem of tank design and work it out by the foregoing formulas. As we have in the preceding articles used a 20 by 20 foot tank as an example, we will use the same size in the present instance. The depth of water would, as previously mentioned, be 19 feet 5 inches. The staves are nearer 2¾ inches thick than 3 inches, so, to be on the safe side, we will call the diameter of the water 19 feet 6½ inches. We will use a fiber stress f in the hoops of 12,500 pounds per square inch, as that is common practice, and we can then use Formula (5) to arrive at the total area of hoops required:

$$A = \frac{31.25\,RH^2}{12{,}500} = 0.0025\,RH^2.$$

$$A = 0.0025 \times 19.4167^2 \times 9.77 = 9.209 \text{ square inches.}$$

As a trial we will assume 1-inch round hoops, whose net area at the root of the thread is 0.55 square inch. From Formula (7) we find the number of 1-inch hoops required thus:

$$N = \frac{31.25 \times 19.4167^2 \times 9.77}{12{,}500 \times 0.55} + 2 = 16.74 + 2 = 18.74.$$

Taking the next larger whole number we find it will require nineteen 1-inch hoops. By calculation we find that 1-inch hoops would be much too large at the top, so will assume the four top hoops to be ⅞ inch in diameter. The net area at the root of the thread for a ⅞-inch hoop is 0.42 square inch, the combined area of four hoops being 1.68 square inch.

Then $9.209 - 1.68 = 7.529$ square inches.

This remainder is the theoretical area of the 1-inch hoops required in addition to the four ⅞-inch hoops at the top. Then $\frac{7.529}{0.55} = 13.69$ = theoretical number of 1-inch hoops necessary. Calling that number fourteen and adding two, as usual, we find we need sixteen 1-inch hoops and four ⅞-inch hoops. The next operation is to give the hoops their proper spacing, and we always begin at the bottom in doing this, as it works out best in that way. The number of inches of stave each hoop will safely support is found by Formula (11).

$$b = \frac{S}{2\ 60417\,Dh}$$

where $S = af$.

Substituting in this formula for 1-inch hoops we have:

$$b = \frac{0.55 \times 12{,}500}{2.60417 \times 19.5417\,h} = \frac{135.1}{h}.$$

Resolving the formula thus to its simplest form facilitates the computations, and the designer can use the slide-rule if he chooses, which will lessen the work still more. The use of logarithms is the easiest way if greater accuracy is desired. For the ⅞-inch hoops we would use the same formula with the following substitutions:

$$b = \frac{0.42 \times 12{,}500}{2.60417 \times 19.5417\,h} = \frac{103.17}{h}.$$

The first hoop at the bottom of the tank would be placed in the middle of the bottom but, as far as resisting the water pressure is concerned, it would be 19 feet 5 inches from the top; therefore, the space the first hoop is able to support is:

$$b = \frac{135.1}{19.4167} = 6.958 \text{ inches} = 6\ 15/16.$$

The bottom hoop is given only a half load, to permit it better to resist other stresses that occur at that place, such as swelling and increased stresses due to tightening. This may be true of any hoop, but the bottom hoops are likely to be pulled up tighter than the others. In the following calculations, we will take the value of the hoops to the nearest lower 1/16 inch and the spaces will be worked out to the nearest lower ⅛ inch. This will be a greater refinement than is usual, as the nearest ¼ inch is considered close work. However, in order to illustrate the values obtained by the formulas as nearly as possible, we will use dimensions to the limits above mentioned. Referring to Fig. 2 it will be found that the second hoop from the bottom (marked 2) is placed 6⅞ inches from the first hoop. As the space or load between the hoops is taken equally by them, it can be seen that hoop No. 1 gets 3 7/16 inches, which is a half load, as previously mentioned. In Fig. 2, hoop No. 1 is shown even with the upper surface of the tank bottom, or 19 feet 5 inches from the top. This is to permit of the calculations being followed more easily. However, if the specifications calling for extra hoops to take care of swelling are adhered to, this position could be the same for one extra hoop, but should be raised slightly if two extra hoops are used. Otherwise, the hoop should be placed as shown in Fig. 3. The depth of water above the top of hoop No. 2 is then 19 feet 5 inches — 6⅞ inches = 18 feet 10⅛ inches. The value of b for hoop No. 2 is $\frac{135.1}{18.8437}$ = 7.169 = 7⅛ inches.

To arrive at the space between hoops No. 2 and No. 3, and give hoop No. 2 the full load it is capable of holding, we subtract half the space below hoop No. 2 or 3 7/16 inches from 7⅛ inches and get 3 11/16 inches. Doubling this we have 7⅜ inches for the next space. The same result can be obtained by doubling the value of the hoop, 7⅛ inches, which gives 14¼ inches; and then subtracting the space below, or 14¼ — 6⅞ = 7⅜. This method is simpler. Continuing our calculations in this way for each hoop, we find that when we get to hoop No. 19 we have only 14¾ inches left and one more hoop to add. The top hoop should be from 2 to 4 inches from the top of the stave. Using 2 inches makes the space above hoop No. 19 only 12¾ inches. This does not give it a full load or, in other words, it is not assisting to its full value to resist the load.

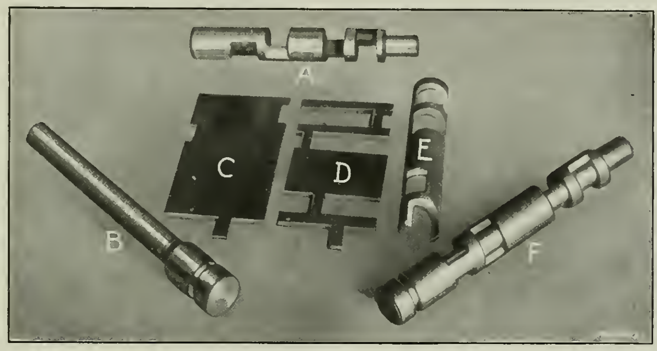
It is preferable, however, to so space the hoops that the lower ones will be underloaded rather than the top ones. With this in view, we proceed to respace the hoops as shown in Fig. 3, which gives a more uniform loading throughout. We have omitted all the small fractions of an inch and used nothing closer than ½ inch, which is better in practical work although, if the value of the hoops is very close to the total load, we may have to use eighths of an inch in order to have the hoops come out right at the top. In the case just worked out, there was some strength to spare, so it came out well even if a trifle of the value of each hoop was lost, as in Fig. 3. The nearer we make the spaces equal the theoretical value of the hoops, the higher we will raise each succeeding hoop, as is demonstrated by the case illustrated in Fig. 2. Had we used the exact value in decimal parts of an inch, we would have raised hoop No. 19 still further—perhaps 2 inches—but it would not have been enough to allow us to leave out a hoop. So in justice to the other hoops, *i. e.*, to better distribute the load, we respace them. There are times when it will be all we can do to make the hoops selected suffice, that is, when there is no strength to spare.

CRANKSHAFT MADE ON THE SCREW MACHINE AND PUNCH PRESS

In designing the tools for manufacturing the parts of an automobile starter, the Sloan & Chace Mfg. Co., Ltd., of Newark, N. J., was looking for some way to manufacture the crankshaft shown at *A* in the illustration.

The work which this small crankshaft does, which is ⅝ inch in diameter and 4 inches long, is simply the moving of plungers for a very slight distance. These plungers are entirely free from the crankshaft and as their ends are beveled the throws need not be finished in order to act satisfactorily against the plunger ends.

These crankshafts were formerly made by milling, but a milling operation of this kind is somewhat expensive and the tools required would not be simple, to say the least. It was therefore proposed by the engineering department that the piece be made a combination of a punching and a screw machine shaft. Therefore the shaft was turned out after the manner shown at *B*, and then a punching was made, the blank for which is shown at *C*. This punching was pierced as at *D* and then bent up into semicircular shape as shown at *E*. At this point a closing die wrapped the partly formed punching around the shaft in such a manner that it would be held tight. The result is shown at *F*.



Making a Crankshaft with a Punching and a Shaft

It will be noticed that the piercing of the blank is done so that the throws will be made by the edges of the punched slots. Referring to *E*, it will be seen that these slots are of different depths, thus giving the throws the right sequence. This solution of the problem proved to be a far easier manufacturing proposition than milling, and the combined punching and shaft was as effective as a milled crankshaft. C. L. L.

* * *

PANAMA-PACIFIC INTERNATIONAL EXPOSITION NOT TO BE POSTPONED

President C. C. Moore of the Panama-Pacific International Exposition at San Francisco, has issued a statement to the effect that the directors have no thought of postponing the opening date of the exposition on account of the European War. The exposition will open February 20, 1915, as scheduled, and will close December 4. Forty-four states have made appropriations and are engaged in building state pavilions and preparing their exhibits. The exhibit palaces are completed and installations are now being made on a large scale. Thirty-four foreign countries have made appropriations and are erecting their official buildings and preparing exhibits, regardless of the war. The management of the exposition points out that this is a great opportunity for the United States to advertise her products and to extend her commercial relations with those countries with which she has heretofore had little dealings. The operation of the new regional banks and the added number of American ships making quick time from coast to coast through the Panama Canal places the United States in a most favorable position to capture the world's commerce. The exposition offers the best medium for bringing American manufactured products to the attention of distributors and consumers of the world.

* * *

Endurance tests for automobiles, the prizes for which are to be orders for winning cars, have been held by the Russian army authorities. The first prize will be an order for 250 cars, the second, an order for 150 cars, the third, for 100 cars, and the fourth, an order for 50 cars.

THE MANUFACTURE OF "VEGETABLE IVORY" BUTTONS

DRYING THE NUTS, CUTTING THE BLANKS AND MAKING THEM INTO FINISHED BUTTONS

BY RICHARD WILCOX[*]

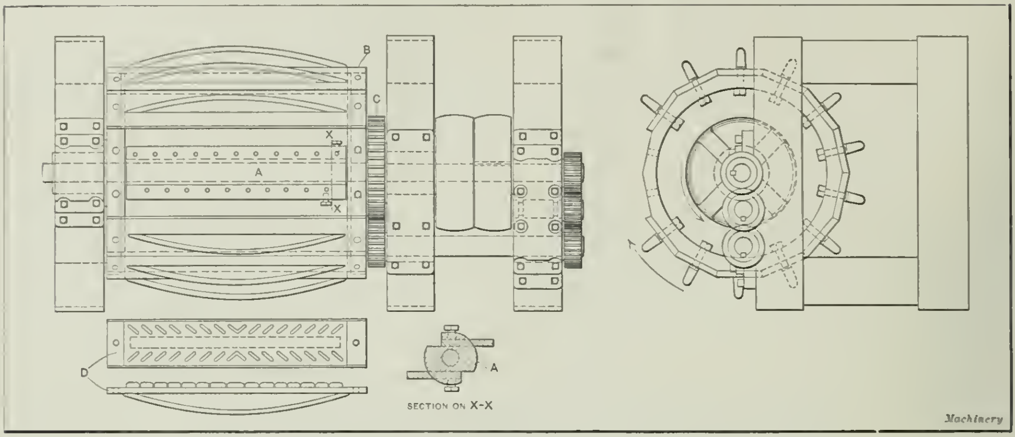


Fig. 1. Tumbling Barrel in which the Tagua Nuts are cleaned

ABOUT fifty years ago a party of rubber gatherers in northern Ecuador found great numbers of a previously unknown palm, which bore nuts somewhat resembling in shape and color a diminutive negro's head. These nuts were termed "negritos," but later the term "tagua" nut was applied to them, this being the name now generally used. The nuts are about the size of a hen's egg. Experience showed that the kernel of the tagua nut assumed the color and texture of dentine ivory upon being dried, and this material is now used as a substitute for real ivory in making buttons and small ornaments of various kinds. It can be sawed, carved and turned on a lathe, and it will take a high and permanent polish. The texture of "vegetable ivory," as it is called, is also such that it absorbs dyes freely, thus lending itself to the production of various forms of colored buttons. An idea of the importance of the discovery of this material may be gathered from the fact that 20,000 tons of tagua nuts, representing $1,700,000, are shipped annually from Ecuador. There are twenty-three factories in the United States engaged in the manufacture of vegetable ivory buttons and these factories use 10,000 tons of nuts per year.

A substitute for the South American tagua nuts is found in Africa. The "vegetable ivory" obtained from this source has been tested by many of the button manufacturers in Italy, but the results have shown it to be decidedly inferior to the South American product. Some ten or twelve tons of these African nuts have been sold in the United States but these have been merely trial lots and the orders have never been repeated. The African nuts cost about one-third the price of those shipped from South America. The difficulty with the African vegetable ivory is that after it has been made up into buttons it shows a decided tendency to shrivel and warp, thus seriously impairing the appearance of the buttons made from it.

It is the purpose of the present article to describe the methods used in the manufacture of these buttons, and the subject will be treated according to the sequence of operations involved. The first step consists of drying the nuts in a kiln, and in order to get the best results the temperature must not be too high; the slower the nuts are dried, the better. When thoroughly seasoned, they are put in a tumbling barrel or "shucking machine" which removes most of the outer scale. One of the machines employed for this purpose is illustrated in Fig. 1. This consists of a central cylinder *A* which has two plates extending out from it. Surrounding this cylinder is the barrel *B*, to which the driving

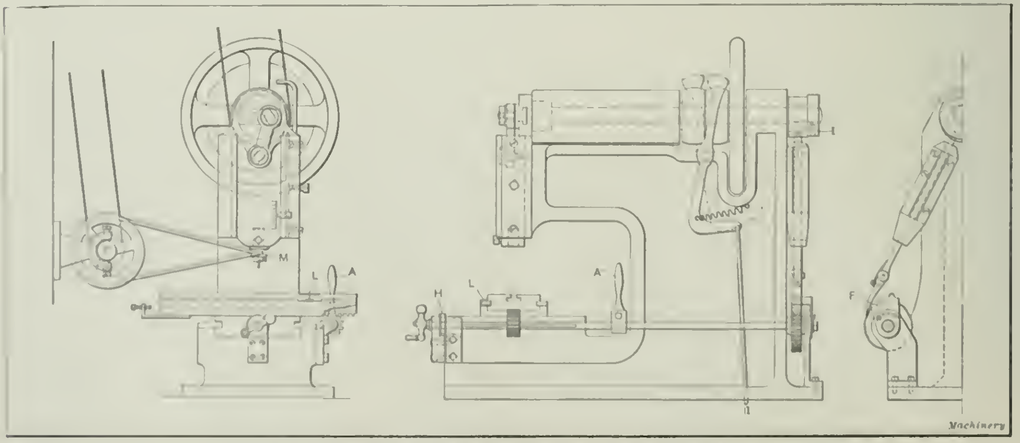


Fig. 2. Die-sinking Machine for finishing Dies used in making Fancy Buttons

gear *C* is bolted. The arrangement of the drive is such that the cylinder *A* and barrel *B* rotate in opposite directions, with the result that the nuts are tumbled over and over, and in this way most of the outer scale is removed. After the tumbling operation has been completed, two of the staves *D* are removed from the barrel to enable the contents to be taken out.

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The small amount of scale that remains on the nuts must be removed by hand, as it is very hard and would dull the saws and tools used in subsequent operations. With all the scale removed, the next step is to cut the nuts into blanks from which the buttons are made. For this purpose, the sawing machine illustrated in Fig. 10 is used. The side of a nut is placed under the projecting fork on the slide *A* and held with the left hand, while the right hand pushes the slide forward, thus carrying the nut against the saw. With this arrangement there is not so much danger of the workman's being injured as there would be if the saw were not equipped with a feed-slide of this kind.

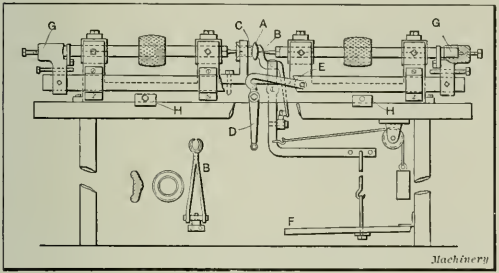

Fig. 3. An Improved Design of Button Turning Machine

The machine shown in Fig. 3 is used for turning the blanks to the required shape, ready for the final operations, which are drilling and pressing. Referring to this illustration, it will be seen that the blank *A* is placed between an adjustable grip *B* and a stationary grip *C*. The turning tools are controlled by the handle *D* which brings them forward to turn the button and cut away the surplus stock. Connecting-rod *E* is bent in order to make the cutting tool move very slowly when finishing the face of the button. After completing the operation, the treadle *F* is depressed, allowing the finished button and the scrap to fall out from between the grips so that a fresh blank can be put into place. The spindles are backed up by lignum-vitæ plugs *G*. This wood is hard and rosinous; and it has been found to stand the end-thrust better and run more smoothly than any other material. Adjustments *H* are provided for regulating the belt tension. It will be seen that the pulleys are knurled, and despite the fact that it is generally conceded that a belt runs more evenly over a smooth pulley, we found that the knurled pulleys gave better satisfaction on this machine. The pulleys are not flanged because the belts would run against the flanges when the spindles moved back and forth and cause vibration. Flanged pulleys were tried, but it was found that the vibration showed itself in the form of tool marks on the work. In order to get the most satisfactory results it is particularly important to maintain the belt tension at exactly the right point.

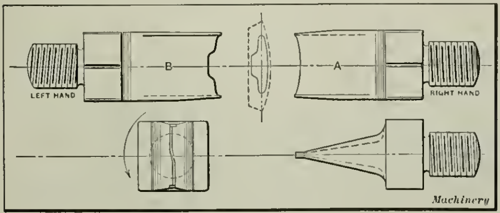

Fig. 4. Turning Tools used in the Machine shown in Fig. 3

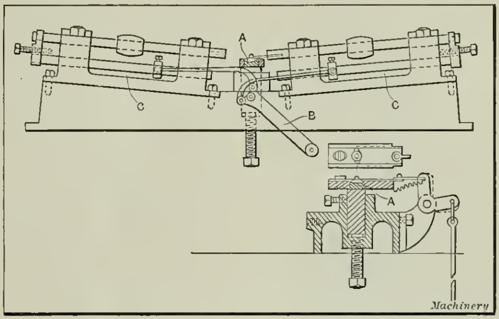

Fig. 5. Machine for drilling and counterboring the Shanks of Buttons

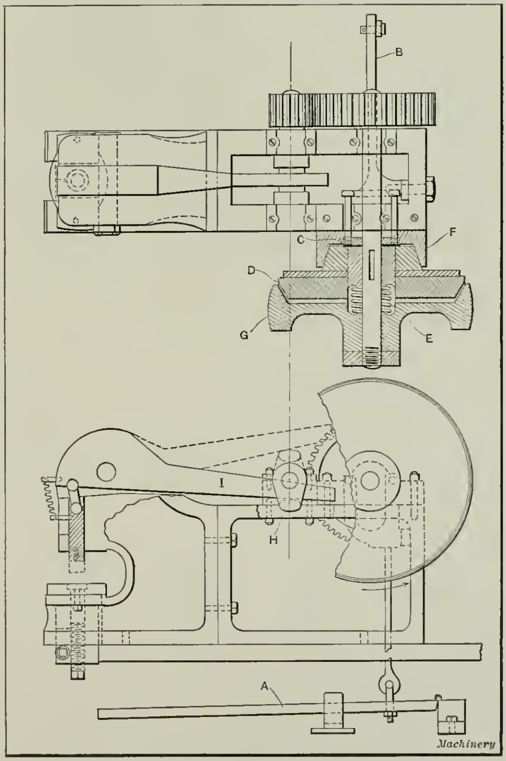

Fig. 6. Special Power Press used for making "Vegetable Ivory" Buttons

A detail of the grip *B* which holds the blank is shown in Fig. 3, and Fig. 4 shows enlarged views of the turning tools which form the two sides of the button. These tools work in the spaces at the center of the grips and cut the finished button, which is shown by full lines in Fig. 4, from the blank, shown dotted. The turning tool *A* in this illustration is brought forward against the work until the face of the button is formed, the movement of the tool being controlled by a stop. Then the tool *B* which forms the back of the button comes forward, and when this tool has finished its work the button is cut free from the blank, leaving a ring of scrap between the grips *B* and *C* of Fig. 3. This scrap drops out when the grips are opened. These forming tools scrape rather than cut the work and it requires considerable skill to grind and oilstone them so as to leave a good finish on the work. The tools must also finish the button to the required shape and size to fit in the pressing dies in which the final operation is performed. These turning tools are made of the best grade of tool steel and carefully forged by hand. In hardening them, the points are heated about ¾ inch and then dipped quickly in and out of the cooling water

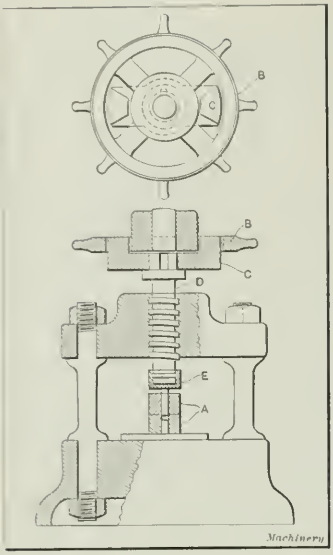

Fig. 7. Screw Operated Press for making Button Dies

until the steel has been thoroughly quenched. In this way, cracks in the steel are avoided and the required degree of hardness is obtained.

Fig. 5 shows a machine for drilling and counterboring the holes in the shanks of the buttons after the blanks have been turned to the required form. The best results are obtained by drilling these holes at a slight angle, this work being handled very satisfactorily by the two-spindle machine designed especially for this purpose. The button blank is held by the sliding jaw of a chuck mechanism, the face of the button being set against a wooden block *A* shaped to receive it. The chuck is opened by pressing down the foot treadle shown in the cross-sectional view, and a coil spring is provided which closes the chuck automatically. The movement of the spindles is controlled by connecting-rods operated by the lever *B*. The rate of feed obtained by moving the operating lever at a normal speed is such that it is seldom that the combination drilling and counterboring tools used are broken. It will be evident from the illustration that the movement of the connecting-rods is transmitted to the spindles through the guide rods *C*, both the guide rods and spindles being an easy fit, so that the machine acts very smoothly. In some cases it has been found advisable to provide a glass shield to protect the operator's eyes from the sharp cuttings.

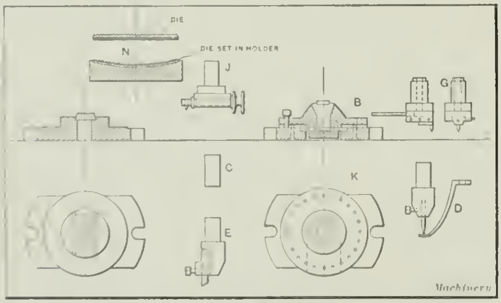

Fig. 8. Tools used in the Machine shown in Fig. 2

Fig. 6 shows a special power press for finishing the button blanks turned on the machine illustrated in Fig. 3. This power press represents the result of years of experimental work. The buttons are formed in a punch and die, and experience has shown that the punch should come down slowly and be held stationary at the bottom of its stroke, to maintain the maximum pressure for a sufficient length of time to allow the material to take the desired form. A quick action of the punch would not give satisfactory results. The press used for this purpose must be very strong in addition to being equipped with a suitable mechanism for controlling the operation. The design of the machine shown in Fig. 6 has been worked out so that the ram can be stopped in any position and backed up by hand. As soon as the pressure is taken off the treadle *A*, the lever *B* is released; and this, in turn, releases the collar *C* and friction clutch *D*. The spring *E* then comes into action and throws the friction clutch into contact with the brake cup *F*, stopping the ram almost instantly. It will be evident that, in the running position, the friction clutch is in contact with the driving pulley *G*.

In operating this press, the die is carried by a holder screwed into the ram and a small gas flame is allowed to impinge against the die. When the die has been warmed sufficiently in this way, work can be commenced, experience having shown that better results are obtained with the die warm than cold. The die is kept warm by the flame during the period that it is in use, and in the event of its becoming smoky or dirty, it must be immediately cleaned with gasoline or some other means. The girls who run these presses become expert, and are able to eject the finished button with a small hard-wood stick and put a fresh blank in the die during the brief "dwell" that occurs at the top of the stroke. This "dwell," and also the period that the ram remains stationary at the bottom of the stroke, is obtained by means of the oval-shaped cam *H* which operates the lever *I* that governs the movement of the ram. The presses are kept running continuously for extended periods of time, but in the event of a button's sticking in the die after being pressed, the machine can be instantly stopped by releasing the treadle *A*, which disengages the clutch as previously described.

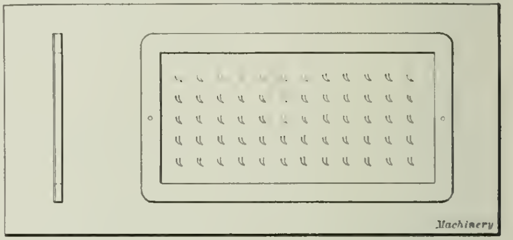

Fig. 9. "Chart" for use in spraying Dye onto the Buttons

The press shown in Fig. 7 is used for making duplicate button-forming dies from the master embossing dies. The master dies are set between the holders *A*, and the large handwheel *B* is turned until it comes in contact with the nut *C* which is keyed to the screw *D*. By swinging the wheel back and bringing it forward with a quick jerk against the nut *C*, a heavy blow can be struck. The hardened collar *E* at the bottom of the screw turns freely. A press for making dies in this way should be of exceptionally rigid construction to enable it to stand up under the severe service for which it is intended.

Another machine for producing dies used in button manufacture is illustrated in Fig. 2. This is the outgrowth of various designs of machines for making embossing dies. Some of the buttons manufactured in these dies have matting designs done in fine lines, scrolls and other ornamentation, all of which must be produced by the die. In making dies for the manufacture of these various kinds of buttons, it is necessary to have a machine possessing a wide range of adjustment. In order to obtain the best results it is also important for the

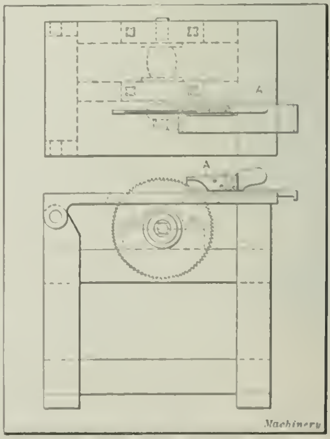

Fig. 10. Type of Saw used for cutting the Nuts up into Button Blanks

die to be finished as far as possible in a single setting. This can be done on the machine shown in Fig. 2 by using different forms of tool-holders, as shown in Fig. 8; and dies can be duplicated by keeping a record of the movements, as obtained by the indexes *H*, *K* and *L*. In operation, the table of the machine is worked back and forth by means of the handle *A*, and this movement, in connection with the cutting tool in the holder *E*, Fig. 8, constitutes the equivalent of a shaper. In this way fine lines are cut across the die-block. The spacing is controlled by the index *H*.

The feed is driven by the cam *I* on the main cam-shaft and can be regulated by moving the cover *F* forward or back in order to expose the required number of teeth on the ratchet wheel. When it is desired to disengage the feed, the cover *F* is set forward so that the pawl will ride over the face of the cover without engaging with the teeth. The dies produced on this machine are made from a fine grade of machine steel, although some shops have used very hard brass and obtained satisfactory results. The block from which the die is to be made is cut from bar stock and faced in the lathe, after which it is set up in a draw-in chuck *B* which is shown in detail in Fig. 8. This chuck has previously been located centrally on the table of the machine by inserting the plug *C* in the hole in the ram of the machine; this plug enters the chuck and locates it in position, after which it is securely bolted to the table. When the chuck has been centrally located, the readings of the indexes *H* and *L* in Fig. 2 should be recorded. If the die is to have fine lines cut on its surface, they can be produced in the manner previously described. The index *K* on the face of the chuck is used for cutting scrolls on the die and for other operations. The tool-holder *J*, Fig. 8, can be used with a fly-cutter, and tool-holder *G* can be employed for making cuts with the hand feed. The fine matting so often seen on buttons can be produced by machining the die with a matting tool of suitable form which is held in the tool-holder *D*. The die is cut flat and must be made to conform to the face of the button, which is usually convex. This is accomplished by turning down about 5/32 inch extra stock which is left for chucking purposes, leaving the die only 0.025 inch thick. This thin metal is then pressed over a form of the shape of the button that is required, as illustrated at *N* in Fig. 8.

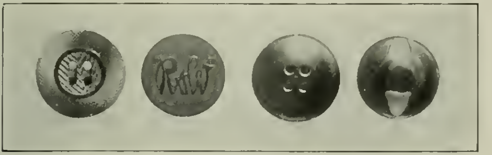
Fig. 11. Examples of "Vegetable Ivory" Buttons

The screw-operated press shown in Fig. 7 is also used in connection with a suitable die-block for making "spraying charts," as they are called, one of which is illustrated in Fig. 9. The charts are used for spraying dye onto the buttons. They are made of sheet brass which is punched with a series of holes, as shown in the illustration, after which it is soldered onto a cast-iron frame. The buttons to be sprayed with dye are placed on a board which is counterbored to receive their backs, and the charts are arranged over the buttons. The layout of the holes in the charts corresponds with the positions of pins in the board, thus bringing the buttons directly underneath the openings. Dye of a suitable color is then sprayed over the charts by means of an instrument somewhat similar to an artist's air-brush but larger in size, giving the buttons a mottled appearance.

TUBE MAKING IN A PUNCH PRESS*

PUNCHES AND DIES FOR PRODUCING AN AUTOMOBILE GASOLINE TANK FILLER

BY DOUGLAS T. HAMILTON†

The making of a small tube from sheet tin 0.01 inch thick, 15¾ inches long and ⅞ inch in diameter is quite a proposition. A tube two or three times larger in diameter and one-half the length would not be quite so difficult to make, as the increased length and correspondingly decreased diameter, of course, complicates the problem considerably. This tube, which is shown assembled with the funnel in Fig. 2, is used as a filler for a gasoline tank for an automobile, and the punches and dies for producing it were made by the Acklin Stamping Co., Toledo, Ohio. The tube part *A* of the filler is made from sheet tin, and is formed into tube shape in one operation in the punch press. Before the tube can be formed it is necessary to first trim the end of the strip to the shape shown at *B* in Fig. 3, and then crimp the edges as shown at *C* in order to produce the seam. As this illustration shows, the tube starts out with a flat sheet of metal 3¼ inch wide by 15⅞ inches long.

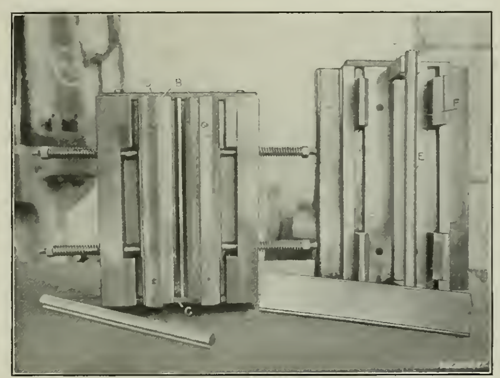

Fig. 1. Tube Bending Dies of Unusual Construction

The first operation after the sheet has been prepared by shearing is to trim the end to irregular shape in order to form an angle of 15 degrees. When the sheet is bent into tube form, then the two edges are turned or crimped as indicated at *B* and *C* in Fig. 3. This is accomplished in the die and punch shown to the left of the illustration Fig. 5, and is one of the operations that required considerable experimenting. As can be seen from this illustration, the die and punch are simply blocks of steel shaped to the form required on the blank. Both edges of the blank are formed in this one punch and die, there being two different impressions for accomplishing this purpose. The sheet, before and after crimping the edges, is shown at *A* and *B*. After the edges have been formed in the manner illustrated at *B*, to produce the seam, the next operation is the drawing up and forming of the tube. This is done in one operation, but to clearly illustrate the various steps, the important changes in shape are shown graphically in Fig. 3.

The punch and die used for forming this tube is shown in Figs. 1 and 4. Fig. 1 shows a view of the faces of both punch and die, while Fig. 4 shows a sectional view and illustrates the construction of these tools most clearly. The member *A*,

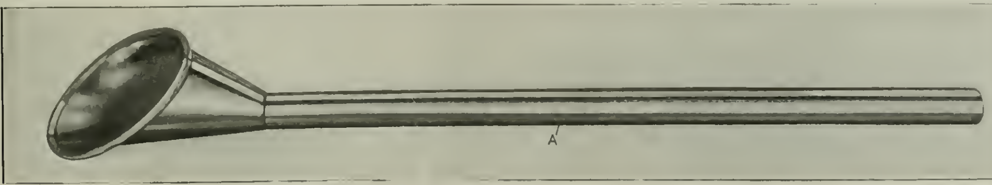

Fig. 2. Tube for an Automobile Tank Filler, made in the Punch Press

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* For additional information on punch and die work published in MACHINERY, see "Cluster Double-action Punches and Dies" in the December, 1913, number, and other articles there referred to.

† Associate Editor of MACHINERY.

known as the die, is held to the ram of the press and carries two sliding jaws or blocks *B*. These are held to the face of the die-holder by strips *C*, provided with tongues which fit in grooves on the sliding jaws of the die. The sheet of metal, when being formed, is placed in the grooves *D* of the jaws, and as the press is tripped the die descends, bringing the strip into contact with the arbor *E*, and bending it into V-shape as shown at *D* in Fig. 3. As the ram of the press continues to descend, the beveled faces of blocks *F*, Fig. 4, come into contact with the beveled edges of the sliding dies *B*, forcing them in against the tension of the springs and bending the strip into tube form as shown at *E* in Fig. 3.

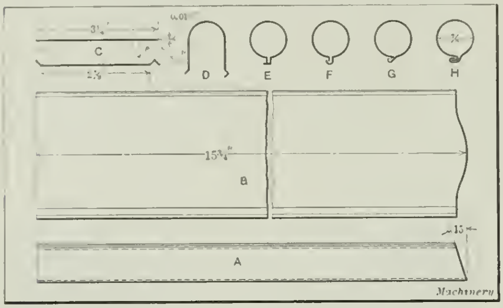

Fig. 3. Diagram showing Sequence of Bending and Forming Operations in producing the Tube in the Punch Press

Upon the continued downward movement of the ram the supports holding the arbor *E* recede, as they rest upon a spring pad located under the bolster, and the die-operating blocks *F* discontinue to act, so that the tube is confined between the circular faces of the dies, strip *G* and punch *H*, thus forming the tube into the shape shown at *F* in Fig. 3. Then as the ram of the press ascends, the tube is removed from the arbor by simply forcing down the post *I*, Fig. 1, which rests on the rubber pad, when the tube easily slips off the arbor.

All the working parts of both the die and punch are made from tool steel and the wearing parts are hardened. The last and final operation on this tube is the flattening of the seam. This is accomplished by a simple punch and die illustrated to the right in Fig. 5. The die in this case has a slight movement on the bed of the punch and is provided with two differently shaped projections. The formed tube is first placed so that the seam is located in one groove, and as the ram descends the projecting seam is bent over to an angle of 45 degrees, as shown at *G* in Fig. 3. The tube is then shifted to the other groove and the seam flattened as shown at *H*. While the seaming operations are being accomplished, the tube is held on the arbor *C*, shown in the punch, Fig. 5. The finished tube is shown at *D* in this illustration. While the punches and dies shown in the illustrations appear to be comparatively simple in construction, it required considerable experimenting to produce this job, because of the great length in proportion to the small diameter. However, it was successfully accomplished and the tube is certainly a nice piece of work.

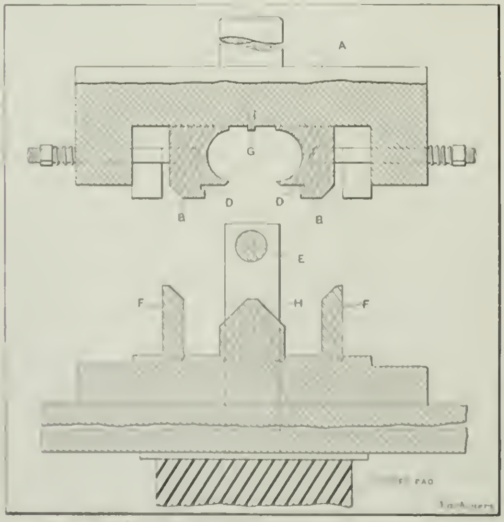

Fig. 4. Sectional Diagrammatic View showing Construction of Tube Forming Punches and Dies

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PUBLIC EMPLOYMENT OFFICES

The United States Commission on Industrial Relations, at Washington, has published a tentative plan of a national system of labor exchanges to cooperate with state and local public employment offices, and to regulate private employment agencies in interstate business. The proposed plan contains features drawn from the laws of various states and countries, and from correspondence with persons and organizations interested in this vital subject. Copies of the tentative proposals may be had by applying to the Commission on Industrial Relations, Southern Bldg., Washington, D. C., and it is requested by the commission that all persons having criticisms or suggestions to offer should submit them in writing to the commission. The proposed plans, as published, give details of the organization, defining the duties, powers and authority of the bureau and its method of carrying on its work. It also gives legislative rules relating to applicants and private employment agencies, fees, etc. The rules relating to the private employment offices are especially designed to prevent the frequent abuses which have sprung up in this business. All such employment agents are, according to the proposed plan, required to obtain a license, and the application for such license must be accompanied by a bond for a sum of $1000 as a guarantee that the applicant will conform to the rules and not violate any of the terms, conditions and requirements of the law. Licenses may be refused when the conditions set forth in the proposed plan warrant this, and they may also be revoked under certain conditions. Special rules are made with regard to the fees charged by these private employment agents.

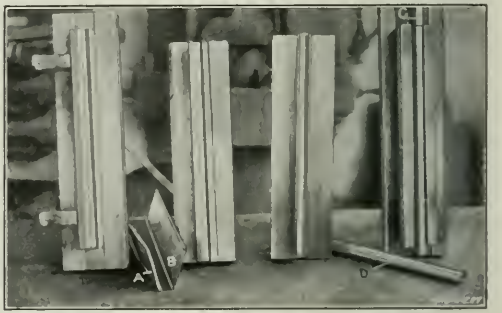

Fig. 5. Punches and Dies for bending Edges of Sheet and for flattening the Seam

Regulations are also contained for the management of the employment offices conducted by the bureau either directly or jointly with other authorities. It is expected that a great deal of interest will be taken in this matter, as it is of vital importance to employers as well as to employes that the employment agencies of the country be under more strict supervision and that their efficiency be increased through the supplementing of their services by a comprehensive system of national public employment offices.

* * *

The autumn meeting of the Iron & Steel Institute, London, England, which was to have been held in Paris, September 17-22, has been cancelled on account of the European War. The papers that were to be presented will be printed in advance as usual, and distributed to members. Discussion by correspondence is invited and the papers and discussions will be published in the next number of the *Journal*.

RAPID PISTON TURNING ON A DOUBLE-SPINDLE TURRET LATHE

One of the examples of rapid production turned out by the Jones & Lamson double-spindle turret lathe in the factory of the H. H. Franklin Mfg. Co., Syracuse, N. Y., is a piston finishing job. Fig. 1 shows the general character of this work and the way it is done; Fig. 2, the set-up on the turret lathe; and Figs. 3, 4, 5 and 6 the work done at each operation. The pistons are 3⅝ inches diameter and 5 inches long.

The pistons come to the turret lathe with the open end faced off ready to be held on the spindles of the lathe by connection through the wrist-pin holes, which have been drilled. After two pistons have been put in place on the machine, the outsides are rough-milled by the hollow-milling tools *A*, Fig. 3. These remove about 3/16 inch of metal, using for the purpose the four inserted high-speed steel cutters that may be seen in the line illustration and also in the general view, Fig. 1. The turret is now indexed, bringing the groove-roughing tools *B*, Fig. 4, into place. These in reality are circular forming tools having the groove-cutting sections spaced so that the three grooves are cut simultaneously and at the correct distance apart. The turret is indexed again, bringing the tools which may be seen in the foreground in Fig. 2 into play. These tools consist of the two pairs of tools *C* and *D*, Fig. 5; tools *C* start midway of the piston and tools *D* start at the front end, each turning half of the finishing cut for the diameter. This cut being taken, tools *E* are used in an inverted position for facing off the ends of the pistons to length. The last indexing of the tool turret is for the purpose of bringing the tools into play that are shown in use in Fig. 2. These are the finish-grooving tools which finish to size the ring grooves as well as the oil grooves. These tools are indicated at *F*, and at *G*, Fig. 6, are the centering tools for centering the piston. The diameter is held to a limit of 0.002 inch and the length to 0.005 inch. The pistons are turned out at the rate of ninety in ten hours. C. L. L.

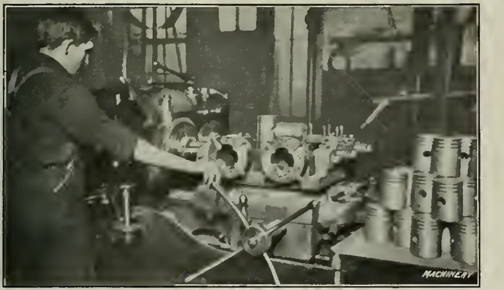

Fig. 1. Turning Pistons on a Jones & Lamson Double-spindle Flat Turret Lathe

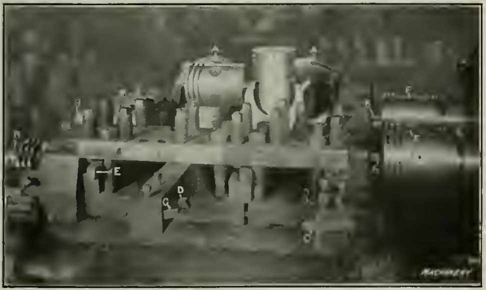

Fig. 2. Close-range View of the Tooling

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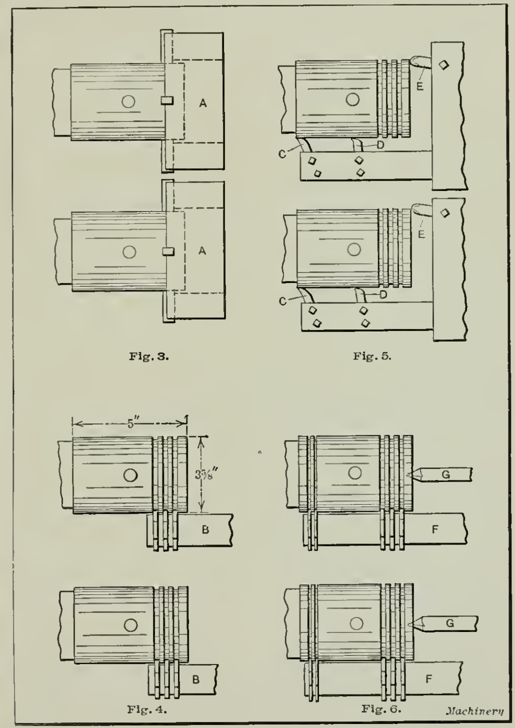
In a contemporary, we find the following paragraph: "In addition to other advantages offered, it is generally conceded that the hollow bar is stronger than the solid." Why not make them all hollow, then, and save the expense of metal altogether?

A MINE AT THE SAN FRANCISCO EXPOSITION

The United States Bureau of Mines has undertaken to construct, in cooperation with the mining industry and the manufacturers of mining machinery, a mine beneath the floor of the exposition building of mines and metallurgy at the San Francisco exposition. The entrance to the mine will be through the building and visitors will be attracted to it by being given portable mine lamps. They will then be lowered in a cage, while a panoramic effect of the strata lining the shaft will pass by them so rapidly as to produce the illusion of descending to a considerable depth. This method of producing the effect of a descent of several hundred feet when only lowering from one floor to the next was successfully employed at the exposition in Stockholm in 1897, where a mine exhibit similar to the one planned for the San Francisco exposition attracted great attention.

At the San Francisco Fair there will also be a motion picture room which visitors will pass in going from mine to mine, in which will be shown open workings which cannot be illustrated in the underground mines. Twice each day there will be an "explosion" or "fire" in some portion of the mine announced by telephone to the superintendent's office in the Bureau of Mines, on the "surface," and rescue men wearing breathing apparatus will enter the mines and bring out the "victims" who will be given first-aid treatment in an emergency hospital.



Figs. 3, 4, 5 and 6. Work done at Each Operation

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In a recent number of the *Daily Consular and Trade Reports*, Consul Samuel H. Shank, of Fiume, Hungary, strongly advises American exporters to take proper care of the foreign business coming their way. He states that many American firms are very slow as regards deliveries and that consuls who take pains to urge people to import American products are placed in a difficult position through the failure of the home firms to fill the orders in a reasonable time. This, says the consul, is no new story, but if it is often repeated it may eventually have the desired effect.

SPRING WINDING AND COILING*

VARIOUS METHODS OF WINDING AND COILING CONICAL, BARREL AND IRREGULAR SHAPED SPRINGS

BY DOUGLAS T. HAMILTON†

MANY ingenious methods and devices were employed for winding springs of irregular shapes prior to the invention of the now successful spring winding and coiling machines. Generally, the speed lathe was used for this work, with arbors of various types, as described in the following. It is a simple matter, of course, to wind a straight spring from wire, but an entirely different proposition to wind springs of the shapes shown in Fig. 1. In this case it will be seen that the diameter of the spring varies from end to end, so that the ordinary method of winding cannot be employed.

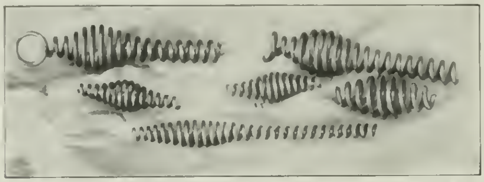

Fig. 1. Types of Irregular-shaped Springs wound on Arbors in the Lathe

Primitive Methods of Winding Irregular Shaped Springs

One of the first successful methods employed for winding irregular shaped springs of the type shown in Fig. 1 was to make an arbor as shown at *A* in Fig. 8. This was an ordinary arbor provided with a key-slot, around which babbitt metal was cast; the metal was faced off and held in place by a nut as illustrated. The babbitt was then turned to the shape of the spring desired, the spring wound around it, after which the babbitt was melted out to allow the spring to be removed. Of course this method was only employed where one or a few springs were desired, and would not have been satisfactory for winding a large number. The spring, when being wound, was guided on the arbor by the simple device illustrated in Fig. 4, which will be described later. It is possible to wind the spring on this arbor by cutting a helical groove of the pitch desired, but this presents considerable difficulty owing to the irregular shape of the arbor itself.

Another very simple but effective means of winding irregular shaped springs is by employing the arbor shown at *B* in Fig. 8. This is somewhat similar in construction to that shown at *A*, but instead of having a babbitt form, the form on which the spring is wound is composed of a series of washers. These washers are provided with key-slots before being put on the arbor and the latter is provided with a key to prevent the washers from turning. If a considerable number of springs is required, the washers are numbered consecutively so that they can be easily replaced in the proper order.

The outer contour of these washers is then machined to the required curve, and if the guide shown in Fig. 4 is not provided, a helical path is cut in the outer surface to serve as a guide for the wire. The spring is wound by starting from the left-hand end. After it has been completed, the nut is removed, the washers loosened up and the spring spread apart, allowing the washers to drop out between the convolutions of the wire. The washers are then assembled on the arbor in their proper order and are ready for action. The method just described is somewhat more satisfactory than that shown at *A* in Fig. 8, but it still leaves considerable to be desired when a large number of springs is to be wound. However, it must be admitted that considerable ingenuity was displayed in working up this simple but effective means of winding an irregular shaped spring.

A still more advanced and satisfactory means of winding irregular or barrel shaped springs on an arbor is illustrated at *C* in Fig. 8. To make this arbor a bar of stock large enough to be machined to the required size is centered on both ends and a cut is taken across it. Following this, a helical groove slightly greater in width than the diameter of the spring to be wound is cut from end to end, this groove having a circular bottom or root diameter, which of course must be smaller than the smallest diameter of the arbor. The next operation is to turn the contour of this arbor to the shape of the spring desired, after which it is ready for winding the spring.

To wind a spring on an arbor of this kind in the speed lathe, an attachment or device similar to that shown in Fig. 4 is necessary. This consists primarily of two brackets *A* which are fastened to the bed of the lathe; in the top of these is located a round guide bar *B*. Extending from the guide bar is an operating handle *C* which carries a guide *D*, the latter being held in place by a screw as illustrated. The handle must be a free sliding fit on the rod *B*. As a means for guiding the wire, the guide *D* is made in two forms as shown at *E* and *F*. The guide shown at *E* is used for guiding wire which is smaller in diameter than the width of the land on the arbor *C*, Fig. 8, whereas the guide shown at *F* is used for wire equal in width to the land on the arbor. By using a guide of this shape which straddles the projection on the arbor, it is unnecessary to cut grooves in the land of the arbor to guide the wire, as the guide serves the same purpose and is more effective.

Another type of irregular shaped spring and the arbor for winding it is shown in Fig. 5. This spring shown at *A* is generally used for wire handles in which the wire is rewound upon itself by using the arbor shown at *B*. This arbor, because of its shape, is held in a chuck when winding the spring. A groove *a*, as shown in the illustration, is cut practi-

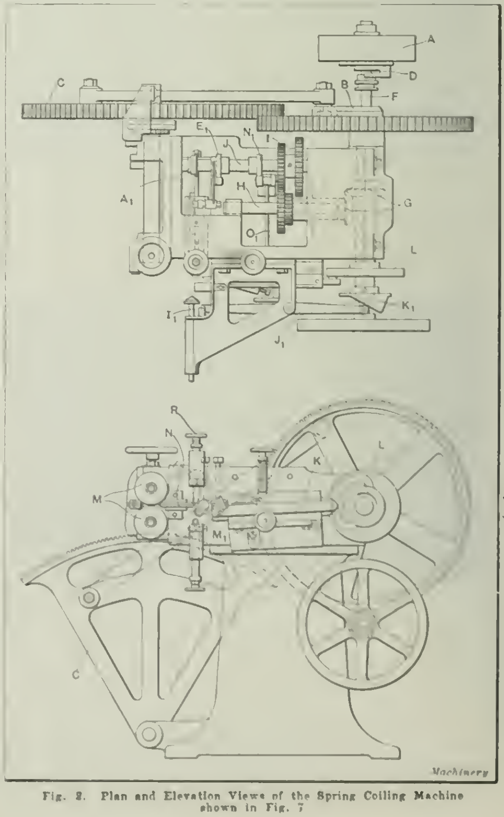

Fig. 2. Plan and Elevation Views of the Spring Coiling Machine shown in Fig. 7

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* For additional information on spring winding, see article entitled "Winding Piano Wire Tension Springs" and Data Sheet Supplement published in the April, 1913, number of MACHINERY.

† Associate Editor of MACHINERY.

cally the full length of the arbor slightly past the center. The wire to be wound is then laid in this groove and twisted around, a helical guiding groove having previously been provided on the circumference of the arbor. The spring can also be wound by gearing up an engine lathe to give the desired pitch and using a guide held in the toolpost. When the wire has been wound completely along the arbor and onto the part of the wire that is extending from the groove, the spring is removed by simply pulling it off. This is easily accomplished, as the largest diameter of the arbor is next to the chuck.

The terms spring winding and coiling in general trade usage denote two entirely distinct processes. In winding, the machine grips the wire and holds it firmly against the center arbor. The wire then commences to turn around the arbor as when winding in a lathe. The diameter of the spring in this case is determined by the size of the arbor and the tension given it while winding. In coiling springs, however, the action is entirely different. The wire is first forced into a circle by rolls or tools acting on the outside of the wire, and the forming of the spring does not depend entirely, in fact little at all, on the center arbor; in other words, the center arbor does not have to be of the same inside diameter as the coil of the spring to be wound. The following description applies only to the producing of springs by coiling, and covers two different types of machines used for this purpose.

The Hoefer Spring Coiling Machine

The spring coiling machine, plan and side elevation of which are shown in Fig. 3, was designed and patented by F. W. and A. G. Hoefer, of Freeport, Ill., in 1898. It comprises a mechanism for intermittently feeding the wire from a coil, a device for decreasing or increasing the pitch of the spring and a device for deflecting the wire from its normal path so as to form it into a spring of the desired shape. It also comprises a varying device for operating the deflector so that tapered, irregular or springs of any desired shape can be wound; in addition there is also a device for severing the wire when a spring has been completed.

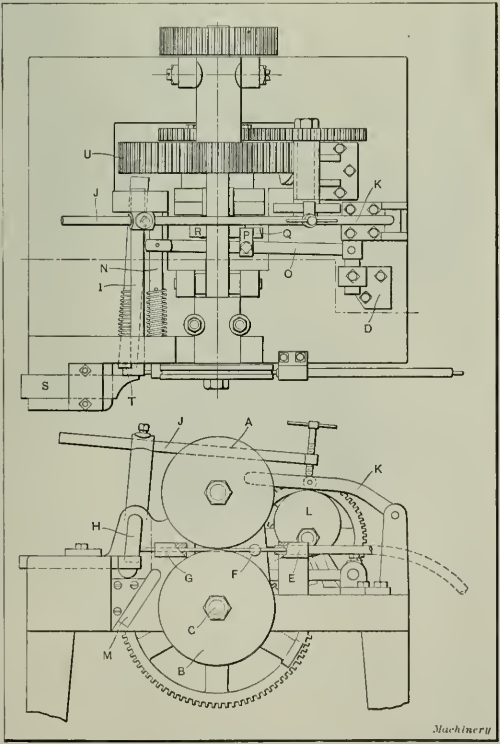

Fig. 3. Spring Coiling Machine patented in 1898 by F. W. and A. G. Hoefer

The wire is fed to the coiling devices by two grooved rolls *A* and *B*. The lower feed roll *B* is mounted on the stationary main shaft *C* of the machine, whereas the upper roll *A* is mounted on another shaft located above the main shaft and driven by gearing from it. The upper shaft is susceptible of oscillation so that it can be raised sufficiently to clear the feed roll *B* and thus interrupt the feeding of the wire. This movement is effected by means of a lever and roll which is operated by means of two cams mounted loosely on the main shaft and rotating independently of the shaft. The periphery of each of these cams is of varying radius and a portion is so made that it raises the roll sufficiently to depress the front end of the shaft and thus give a feeding movement to the wire. The remainder of the periphery of the cam is cut away, allowing the upper roll to release its grip on the wire and stop the feeding action. The two shafts carrying the rolls are geared in the correct ratio and in connection with the cams give the proper feeding movement to the machine.

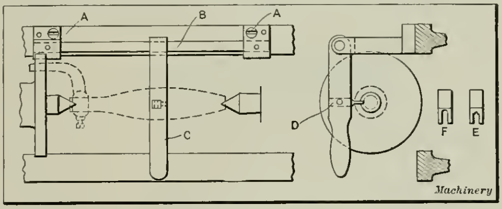

Fig. 4. Dividing or Spacing Devices used in winding Irregular-shaped Springs in the Lathe

The wire is conducted to the feeding rolls by means of two guides *E* and *F*, and after it leaves the rolls it is guided by a bushing *G*. As the wire leaves guide *G* it strikes a deflector *H* formed on the front end of the shaft *I*. This shaft is mounted in supports in the frame of the machine and is free to oscillate, so that its distance from the guide *G* can be varied at will; this is controlled by means of a cam as will be described later. The distance of the deflector from the front of guide *G* governs the diameter of the spring.

In order to give shaft *I* the desired amount of oscillation, it is provided with an extended arm, as shown in the lower view, in which a rod *J* is held. This rod carries on its opposite end an adjustable set-screw which bears on a lever *K*. Lever *K* is fulcrumed in a bracket on the machine and carries a roll that operates on cam *L*, the latter being formed to the correct shape to give the required movement to the deflector *H*. Of course for different types of springs, it is necessary to have cams of various shapes.

The spacing of the coils of the spring is effected by means of a spacer *M* which comprises the bent end of the rod *N*. Rod *N* is attached to lever *O* which is pivoted to a post that is adjustable in the bracket *D*; bracket *D* is adjustably held to the bed of the machine. Rod *O* carries a dog *P* which contacts with a cam lug *Q* that is a member of cam *R* on the main driving shaft. The spacer is held normally out of the operating position by means of a coil spring as illustrated. The lug on cam *R* is of such a length that it holds the spacing bar out long enough to complete one cycle of the machine or whatever portion of a cycle is required to complete the spring.

The cut-off arrangement consists of two knives *S* and *T*. Knife *S* is held in a groove in the machine base by a clamp as illustrated; knife *T* is adjustable in a groove in the machine bed and is kept in its backward position by means of a coil spring as illustrated. Knife *T* comprises a rod, against the rear end of which a cam on gear *U* comes in contact. This forces the knife out at the proper moment and severs the wire which lies against the cutting knife *S*. The various mechanisms of the machine are driven by gearing as illustrated, which, of course, is connected to a main driving shaft, operated from the overhead works by means of belting in the usual manner. The machine is automatic in operation and is generally fitted up so that one revolution of the large driving gear *U* completes the spring. All the various operating mechanisms that control the length and diameter of the spring are adjustable so that various lengths, diameters and shapes can be produced.

Other Machines for Coiling Irregular-shaped Springs

The preceding methods of winding irregular-shaped springs are only applicable to the making of a small number of springs, and could not be used satisfactorily for making springs commercially. Several interesting spring coiling machines, in addition to the Hoefer machine already described, have been developed for this work, but as they incorporate somewhat similar principles it has been thought advisable to describe only one of the latest types of spring coiling machines, two sizes of which are shown in Figs. 6 and 7. These machines are designed on the same principle, and are built by the Baird Machine Co., Bridgeport, Conn. Essentially, this machine consists of a means for controlling the diameter and pitch of the spring when coiling, and a cut-off mechanism for cutting off the wire to any desired length.

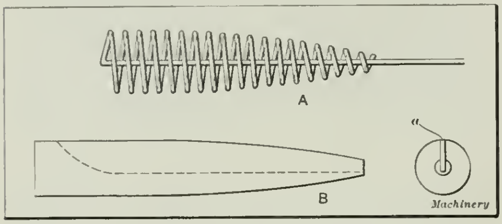

Fig. 5. One Type of Wire Handle and the Arbor used for winding it. Note how Wire is wound upon itself

General Construction of Spring Coiling Machines

Power for actuating the various movements of the machines shown in Figs. 6 and 7 is secured through a main driving pulley *A* which receives power from an overhead shaft. This pulley drives the eccentric plate *B* through a pinion and large gear as illustrated, and the latter is connected by a link to the segment gear *C*, which controls the feeding mechanism. The machine is stopped and started by means of a clutch *D* which is operated by the handle *E* shown in Fig. 7. The main driving shaft *F*, Fig. 2, through a pair of bevel gears *G*, drives an intermediate shaft *H*, which, through sliding gears *I*, operates the cam-shaft *J*, two speeds being secured. From this intermediate and main shaft the various feeding, diameter-controlling and cutting-off mechanisms are operated.

The Feeding Mechanism

The wire is fed into the machine by a pair of feeding rolls *M* which are held in a bracket and carried by shafts geared together. The lower shaft carries a ratchet wheel which is engaged by pawls carried by a disk, the latter being made integral with a pinion meshing with the segment gear *C*. From the main shaft power is transmitted through the segment gear and the mechanism outlined to the feeding rolls. The wire passes from the feeding rolls *M* to a guide *N* extending from the cap plates and goes directly from the guide to the coiling rolls or coiling tools that control the diameter, as will be described later.

The length of the wire for each spring is varied by changing the position of the link on the eccentric plate *B*. This link is connected to the plate by a stud that turns freely in the link and is provided with a T-head engaging with a corresponding groove in the plate. Changing the position of the link in relation to the axis of the plate determines the amount of oscillation of the segment gear *C*, and consequently the length of wire drawn in by the feeding rolls; adjusting the stud to the extremity of its outward movement produces the maximum length of wire that can be fed in at one revolution of the plate.

The operation of the feeding mechanism is as follows: When the segment gear *C* is moved toward the left, the pawls engage with the ratchet and impart a rotary movement to the pinion held on the lower feed roll shaft, and as both shafts are geared together, both rolls are rotated. Then when the segment gear is moved toward the right, the pawls slip over the teeth of the ratchet, thus imparting no rotary movement to the rolls. In order to prevent the possibility of the feeding rolls continuing to move forward by momentum after the forward movement of the segment gear has stopped, when the machine is working on light wire, and also to prevent any backward movement through the reaction of heavy wire, a friction device on the lower feed roll shaft is provided. This consists of clamping arms enclosing the feed roll shaft, which are drawn together by a set-screw, being kept from rotating with the shaft by a pin passing between them, engaging with a lug on the cap plate.

The Diameter Control

The diameter control, which is one of the most interesting features of this spring coiling machine, is shown in detail in Fig. 9. As the wire comes from the guide it strikes a roll *O*, and is deflected to the roll *P*; it is then picked up again by the roll *Q*. By this time the wire has been formed into circular shape. The coiling roll *O* is carried by a slide which can be moved longitudinally in a holder having a shank fitting in a socket which is held in place in the machine by a set-screw. The slide carrying the coiling roll is adjusted longitudinally in the holder by means of a screw attached to the operating handwheel *R*, Fig. 2.

It will be obvious that the coiling rolls or tools, no matter whether one or three are used, must each be adjusted in the proper relation to each other or to the arbor. To start with, there are three possible adjustments of the coiling roll *O*. The first is for diameter control, and is secured by adjusting the roll holder up or down in the slide; the second is for maintaining a certain relation between the center of the coils and the coiling roll, and this is obtained by rotating the holder *S* on the shank *T*; the third is for controlling the pitch of the spring, which will be described later.

Cam Control of the Coiling Roll

The adjustments previously described have to do only with the use of the coiling roll for making straight springs. In order to provide for making cone, barrel and other irregular-shaped springs in which the coils progressively increase or diminish in diameter, an automatic arrangement for varying the diameter of the coils is incorporated. This mechanism is operated from the cam A_1 on shaft *J*, Fig. 2, which it will be understood, has to be changed for each different type of spring that is to be wound. If, however, only the length or diameter is changed and not the shape, this same cam can be used by making the necessary adjustments previously described.

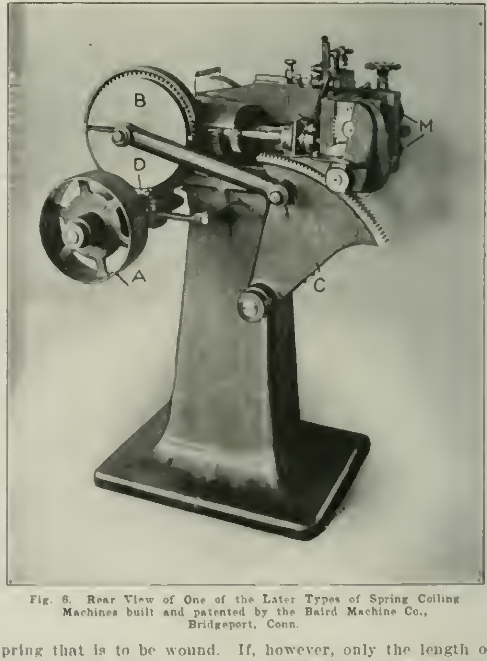

Fig. 6. Rear View of One of the Later Types of Spring Coiling Machines built and patented by the Baird Machine Co., Bridgeport, Conn.

In order to facilitate the removal and insertion of these cams they are made in halves (see Fig. 10), each part being supplied with a slot to receive a cap-screw that engages a collar rigidly secured to the shaft. In the making of barrel, cone and similar shaped springs, in order to permit free reciprocation of the slide carrying the rolls, the cap-screws must be loosened. This leaves the slides free to be controlled in their movement by connecting links and a bellcrank lever. One arm of the bellcrank lever carries a roll which engages with the periphery of the cam, whereas the other is adapted to engage in the slides. The adjustment of stud B_1 in the slot in the bellcrank lever C_1, Fig. 10, enables various sizes and lengths of cone and barrel springs to be wound; this also allows the use of different sizes of wire without changing the cam A_1, provided of course the style of spring is not changed. To change from winding left- to right-hand springs, the position of the rolls O and Q, Fig. 9, must be reversed from that shown by the full lines in Fig. 9, where a left-hand spring is being wound. To wind a right-hand spring the wire first contacts with roll Q and is deflected upward as shown by the dotted lines.

Pitch Control Mechanism

The pitch control mechanism is that part of the machine which regulates the distance in a longitudinal direction between the separate coils of the spring. This is effected by means of a pusher D_1, which reciprocates freely in the hole in the framework of the machine, and passes through a guide plate to preserve its proper alignment. The pusher is actuated from cam E_1 on shaft J, see Fig. 11. This cam engages with a roll F_1 carried by arm G_1, which is provided with a yoke at its inner end that fits over shaft J to hold the arm in position. The outer end of the arm is provided with a stud which is adjustable in a slot in the arm H_1 to increase or diminish the throw of the pusher. It will be noted that the operating face of the pusher D_1 is made convex in order to reduce the bearing surface on the wire.

In practice, the pusher is made broad enough to enable it to act upon the coils of varying diameter, and is changed when required. Adjustment of the outer end of the arm G_1 in the slot determines the amount that the coils are separated from each other, it being understood, of course, that the pusher bears upon the coil already formed and imparts a permanent bend to the wire, thus separating the coil against which it bears the required amount from the coil being formed. A change of cams E_1 is required for various types of springs, and these must be laid out accurately to produce the desired result. This mechanism, however, is adjustable, so that with the same cam quite a variety of springs can be made. It is only when a different type of spring is wanted that a change in the cam is required.

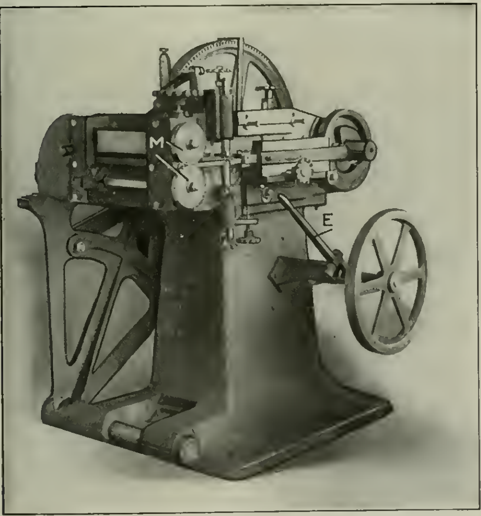

Fig. 7. Front View of Baird Spring Coiling Machine similar in Construction to that shown in Fig. 3 but of Larger Capacity

The Setting Mechanism

It is understood in the manufacture of all compression springs for accurate work that the springs are formed to a greater length than normal and therefore require to be "set," as the operation is termed, before they are ready for use: that is to say, the spring must receive what is termed an "initial set" or compression. This operation is ordinarily performed independently of the making of the spring in an arbor press. In this machine the set is accomplished before the spring is cut off. I_1, Fig. 2, shows the setting plunger which is made to reciprocate in a bracket, the latter being adjustable in the framework of the machine. The plunger is provided with a detachable head which is suitably shaped to pass within, and also to support circumferentially the outer coil of the spring, and is changed when required. The plunger is reciprocated by means of a lever J_1 which is pivoted to the bracket and is provided at one end with a roll that engages with the face cam K_1 on the shaft F. To provide for adjustment, the plunger I_1 carries a clamp to which a connecting link is fastened, this, in turn, being fastened to the lever J_1. To facilitate changing from large to small, right- and left-hand springs, a plate is interposed between the base of the bracket and the framework, which secures both brackets and plate to the frame by cap-screws.

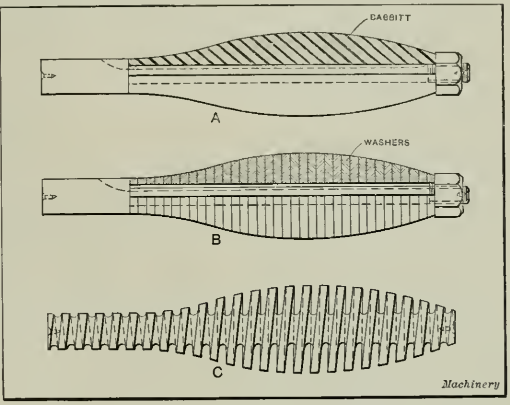

Fig. 8. Various Types of Arbors used for winding Irregular-shaped Springs in the Lathe

During the setting operation the attached end of the spring is supported by the coiling rolls, and it should therefore be understood that after the formation of each spring the feeding mechanism stops at the instant the setting operation takes place, after which the cut-off mechanism acts. As there is always more or less tendency for the spring to buckle in the setting operation, varying of course with the style and length of the spring, the bracket carrying the plunger is adjusted so as to place the axis of the plunger in proper alignment with the spring being operated upon. This should bring the axial line of the plunger parallel with, but slightly outside the axial line of the spring, which has the effect of making it impossible for the spring to buckle outward when subjected to the action of the setting plunger, and of giving it the tendency to buckle inward. To take the inward thrust, a plate is provided which partly encloses the spring and is adjustably secured to the bracket by means of a cap-screw.

The Cut-off Mechanism

The cut-off tool M_1 is adjustably secured to a slide K, Fig. 2, which reciprocates in a bracket. The slide is dovetailed into the bracket in which it slides and is provided with adjustable gibs to compensate for wear. At the rear end is a roll which engages with a groove in cam L located on shaft F, which actuates the movement of the cut-off slide. The cut-off die lies within the coils that are being made and acts with the cut-off tool in severing the wire. The shank of this die can be adjusted axially in order to place the cutting edge in the proper relation to the cut-off tool. The cut-off tool may be adjusted longitudinally with relation to the slide by means of a screw and pin which bears against the rear of the tool.

The Cut-off Control

The cut-off control is the mechanism which is brought into use in making some cone springs, and also in making some special irregular shaped springs requiring an amount of wire in excess of the nominal maximum length for which the machine is adapted. Certain types of cone springs are more easily made in the form of double cones, and the cutting-off operation is performed alternately at the large end of the two springs and at the small end of the two springs, or in other words the springs are formed alternately with the large and small end first. This necessitates a cutting-off operation to separate the large end of the two springs, followed by a cutting-off operation to separate the small ends of the two springs.

To illustrate the use of this cut-off control, supose it to be operating on a spring flattened at one end only and having, say, twice the maximum normal length for which the machine is adapted. In this way, all the flattening of the two springs would be done at one place; that is, if the spring required two end coils flattened, then the pitch changing cam could be arranged to coil the four ends or four coils close together. The cut-off would take place alternately in the center of these four closed coils, and of course in the center of the open coil, thus giving springs flattened at one end only.

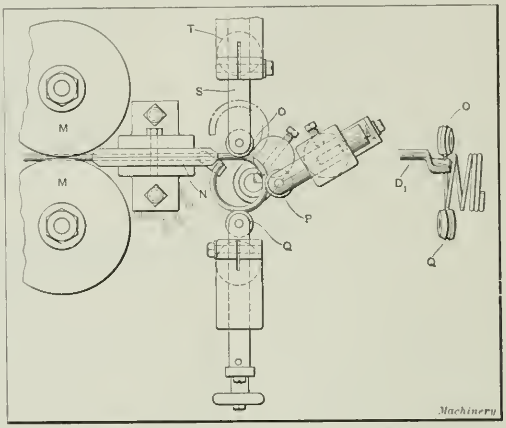

Fig. 9. Diagram illustrating Operation of the Coiling Mechanism

In both of the cases illustrated, it may be found that the position of the wire would not be entirely in front of the cutting knife when the time occurred to cut off, and that it may be necessary to move the cut-off knife a little in order to line up with the work. This is where the cut-off control comes into play, which changes the position of the holder or bracket that carries the slide and cut-off tool, the change being made automatically. To do this, the screws fastening the bracket in which the slide operates are loosened sufficiently to leave the bracket free to move laterally. The automatic movement of the holder is produced by means of cam N_1, Fig. 2, which engages with a roll held on an arm pivoted in a bracket, the latter being secured to the framework of the machine. This arm carries the controlling rod O_1, which passes through the framework to operate the cutting-off slide bracket.

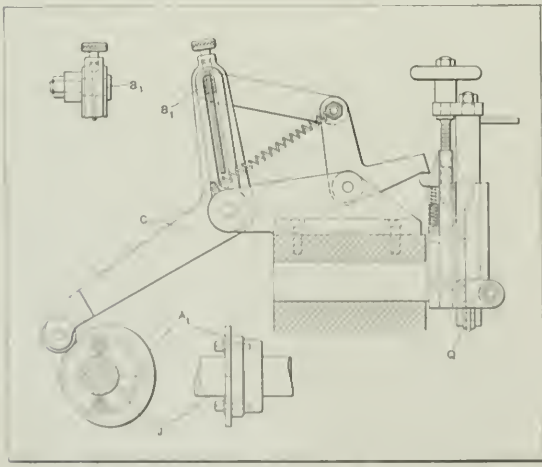

Fig 10 Diagram Illustrating Action of the Diameter Control Mechanism

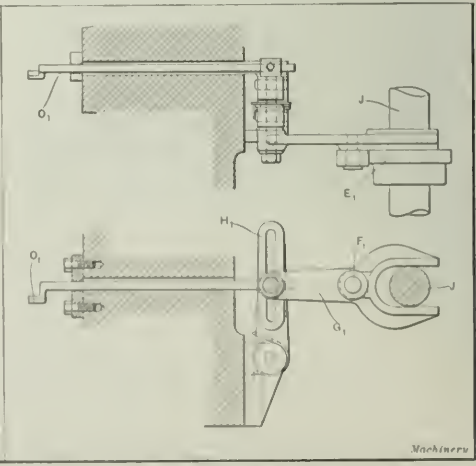

Fig 11. Diagram Illustrating Operation of Pitch Control Mechanism

* * *

Think out your work and work out your thoughts.

CRANKSHAFT FOR TWO-CYCLE INTERNAL COMBUSTION ENGINES*

BY D. O. BARRETT†

In the April, 1910, number of MACHINERY, the writer presented some formulas for crankshafts, applying to the four-cycle engine. Since that time, another engine has appeared on the market, the success of which is unquestioned, and which is rapidly replacing many of the engines using gasoline as a fuel. This is the two-stroke cycle oil engine. The formulas presented in the following will, of course, be equally applicable to the two-stroke cycle gas engine. The two-stroke cycle engine, having a power stroke for every revolution, is much smoother running than the four-cycle engine and produces more power for the same piston displacement. The production of power, however, is not double that of the four-cycle engine having the same cylinder dimensions, because the effective stroke is less than the actual stroke on account of the length of the ports in the cylinder wall. The scavenging is not as perfect as in the four-cycle engine where two extra strokes are employed to exhaust the burned gases and draw in a fresh charge.

Oil engines are liable to pre-ignitions and excessive internal pressures and must, therefore, have crankshafts of ample size to withstand the stresses imposed upon them. The following formulas are derived from actual practice and are based upon the results of an investigation into this particular field for a firm building this style of engine.

The general crankshaft formula has the following form:

$$\frac{B^2S}{2D^3} = C \qquad (1)$$

B = bore of cylinder in inches;
S = stroke of piston in inches;
D = diameter of crankshaft in inches;
C = a constant.

This formula is based on the fact that the force of the

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* See also MACHINERY, April, 1910, "The Calculation of Crankshafts for Internal Combustion Engines," and MACHINERY'S Reference Book No. 65, "Formulas and Data for Gas Engine Design," Chapter III, "Crankshafts for Internal Combustion Engines."

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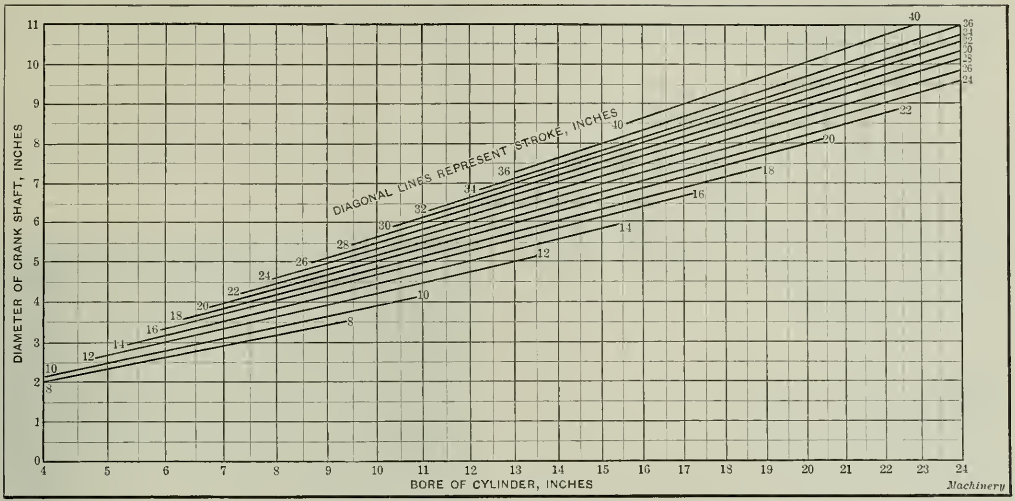

Fig. 1. Diagram for finding Shaft Diameter

explosion is proportional to the square of the bore, while the lever arm about which the force acts is equal to one-half the stroke. The resisting moment of the shaft is proportional to the cube of the diameter. Formula (1) may be reduced to the form:

$$D = \sqrt[3]{\frac{B^2S}{2C}}. \qquad (2)$$

The value of the constant in Equation (1) was determined from a large number of existing crankshafts as equal to 8. This was found to be an average representative value. By substituting this in Equation (2) and simplifying the expression, we have:

$$D = 0.4\sqrt[3]{B^2S}. \qquad (3)$$

Now, the stroke is usually expressed in terms of the bore, so that we may say that $S = a \times B$; then:

$$D = 0.4\,B\sqrt[3]{a}. \qquad (4)$$

Then, if $x = 0.4\sqrt[3]{a}$, we have $D = xB$.

The accompanying table shows the values of x for different values of a for various proportions of stroke to bore.

Fig. 1 shows a diagram by which the shaft diameter may be found directly without calculation. Locate the bore on the lower horizontal line, then follow a vertical line upward to the diagonal line representing the stroke, and from there follow a horizontal line to the left of the diagram where the diameter of the crankshaft is found. For example, an engine having a 12-inch bore and 18-inch stroke should have a shaft diameter of 5½ inches.

The length of the main bearings should be about twice the diameter of the shaft. The diameter of the crankpin is usually made about 1⅛ times the diameter of the shaft. The length of the pin may be less than its diameter and may be obtained from the formula:

$$L = \frac{0.22\,B^2}{d} \qquad (5)$$

in which

L = length of pin in inches;
B = bore of cylinder in inches;
d = diameter of pin in inches.

If Equation (5) gives a low value, the length of the pin is usually made practically equal to the diameter.

Crank Webs

The crank webs must not only be heavy enough to act as beams, in themselves, but must also be large enough so that the crank, when considered as a beam from end to end, will have a minimum distortion. When cranks are weak in this respect, the distortion is noted in the irregular motion or

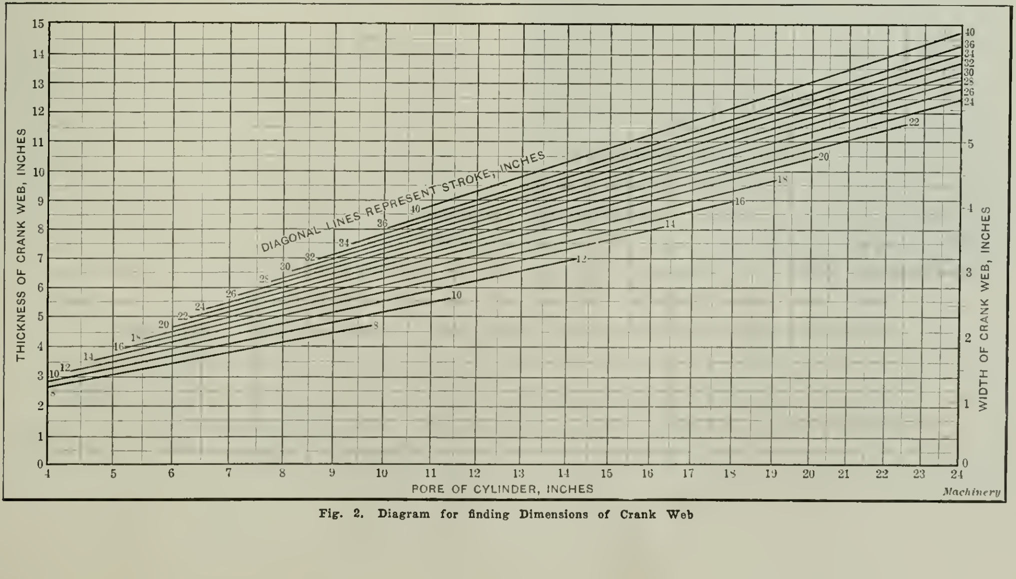

Fig. 2. Diagram for finding Dimensions of Crank Web

wobbling of the flywheels, and this is the cause of the breakage of many flywheels and shafts. Many cranks have webs thick enough in the direction of rotation, but too narrow in width. The ratio of thickness to width of web should be at least 2.2. The following equations for the crank-web dimensions give suitable proportions:

TABLE OF FACTORS x FOR VARIOUS VALUES OF a

a	x	a	x	a	x
0.9	0.386	1.2	0.425	1.5	0.458
1.0	0.400	1.3	0.436	1.6	0.468
1.1	0.413	1.4	0.448	1.7	0.477

Machinery

$$t = 0.52 \sqrt[3]{B^2 S} \qquad (6)$$

$$b = \frac{t}{2.2} \qquad (7)$$

in which

t = thickness of web in inches;
B = bore of cylinder in inches;
S = stroke of piston in inches;
b = width of web in inches.

The thickness of the web may also be expressed in terms of crankshaft diameter, since both are functions of the bore and stroke:

$$t = 1.3\,D. \qquad (8)$$

Fig. 2 shows a diagram for finding the dimensions of the web. It is used in the same manner as the one for the crankshaft diameters. After having followed the vertical line from the bore to the diagonal line for the stroke, the thickness of the web is found to the left of the diagram and the width to the right. For example, for an engine of 12-inch bore, 18-inch stroke, the thickness of the web would be about 7 1/8 inches and the width 3 1/4 inches.

* * *

MULTIPLE SLOT MILLING ATTACHMENT

An interesting attachment for milling T-slots in milling machine tables is used in the plant of the Rockford Milling Machine Co., Rockford, Ill. By the use of this attachment it is possible to complete the milling of the T-slots in one traverse of the table. Referring to Fig. 1, which shows a general view of the machine and attachment, it can be seen that this attachment carries three heads for holding the milling cutters, the latter being driven by a long helical gear meshing with bronze helical gears on the vertical milling spindle. The three milling heads are adjustable along the base of the attachment and are held in the desired position by clamping blocks and screws. There are three different positions of the slots in the various sizes of tables produced by this company, so the heads have three corresponding positions, and to locate them tapered pins are put in from the rear, fitting in the head, and are then, of course, clamped in position by means of the screws which bind on a tapered wedge.

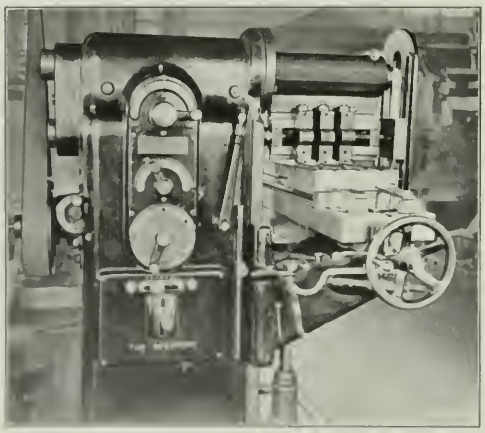

Fig. 1. Attachment fitted to a Rockford Milling Machine for milling Three T-slots at One Setting

In preparing the milling machine table for T-slotting, the three slots are first milled with a set of gang cutters, leaving about 1/16 inch on the side of the slot for finishing. The milling table is then taken to the machine shown in Fig. 1, where the T-slots are finished. The guiding portions of the slots are finally finished on a planer, which has been found to be the most accurate way of doing this work.

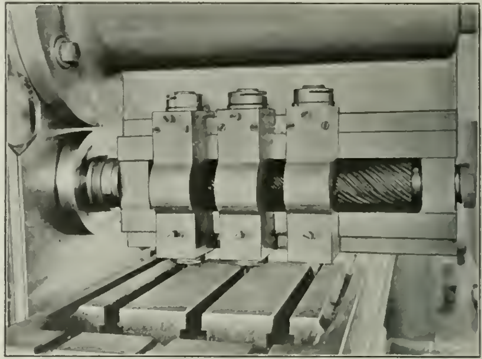

Fig. 2. Close View showing the T-slot Cutters and Attachment

The fixture itself is carried on the over-arm of the machine and is bolted to the flange of the column. It is also additionally supported from the knee by the bearing block shown, which is bronze bushed and is clamped to the supporting arm brace. This arrangement forms a very rigid support for the cutter-head, and enables the T-slots to be completed in one cut. On this particular table, which is 42 inches long, the T-slot is 1 inch wide and ½ inch deep. The actual time to cut three of these slots is fourteen minutes.

The end-milling cutters are provided with No. 7 Brown & Sharpe taper shanks, and are ground on the end after the taper has been ground so that all cutters stand out the same distance. The work is clamped to the table by means of V-blocks fitting on the under side of the table, and is located by a V-plate which fits over the vees of the under side of the milling machine table and is provided on its under surface with a tongue fitting in the T-slot on the regular table. This keeps the table parallel with the traverse of the milling machine table upon which the work is accomplished.

D. T. H.

* * *

Forged manganese bronze worms run with steel planer table racks and are used notwithstanding the comparatively high cost of the bronze. While the cost of the bronze is much higher than casehardened machinery steel, both as regards the rough forging—it being 28 to 30 cents a pound—and the labor of cutting, the final result is found superior by one machine tool builder who has tried both. He has been unable to caseharden large worms without distorting the threads and the walls of the hole. Grinding, of course, would correct the inequalities but it would remove most of the hard case and would be an expensive process. It is found cheaper to use a high-priced manganese bronze.

* * *

Tests made in France and reported in *Le Genie Civil* indicate that when holes are drilled and then reamed in soft steel, the metal between the holes increases on an average of nine per cent in its ultimate strength and twelve per cent in its elastic limit. This condition is explained as being due to the fact that the metal is compressed and thus offers a higher tensile resistance to rupture. Hence, if several holes are drilled, so as not to injure the material as in punching, the average tensile strength of the section across the holes per unit area of metal will be higher than before the holes were drilled.

DEVICES FOR PROTECTING MACHINE TOOL BEARINGS

METHODS OF EXCLUDING CHIPS AND GRIT, AND AVOIDING BRUISES CAUSED BY DROPPING TOOLS

BY JOSEPH HORNER*

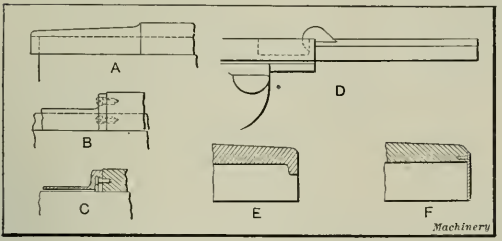

Fig. 1. Devices for protecting Slides of Lathes and Grinders

The protection of the sliding and running parts of machine tools is a subject to which more and more attention is being paid. The legitimate wear of rubbing surfaces when supplied with a film of lubricant, takes place at an extremely slow rate; but as soon as any foreign matter in the way of chips, grit, or grinding dust gains access, wear and scoring proceeds quite rapidly. The extent to which the presence of chips or gritty matter can be tolerated often depends on the class of machine and the work produced on it. A massive lathe, drill or other tool producing large chips does not suffer appreciably from having the chips drop on slideways because they cannot get between the working surfaces, nor would a moderate amount of small grit damage the slides to any great extent. In such a tool as a fine grinding machine, however, a very minute amount of dust or grit in the bearings or slides would materially affect the running and quickly ruin the bearings, while the accuracy and precision of operation would immediately suffer. From this it will be evident that the same degree of protection is not necessary in all cases, and many of the devices applied to grinding machines, for instance, would be out of place and superfluous on some other types of machine tools.

A vital difference between machines using cutting tools for the removal of metal in the form of chips, and those which employ grinding wheels, is that in the former there is usually no floating metal in the air (the case of cast iron dust being excepted) while in the latter the machine may be more or less enveloped in an atmosphere of fine dust which finds its way into every unprotected part. The difference is of vital importance when the question of protecting various bearings and slides is considered; and it is found essential in the best classes of grinding machines to arrange coverings of various kinds to guard against the possibility of dust entering any of the rubbing parts. For this reason, it is never advisable to operate grinding machines close to ordinary machine tools which are not so fully supplied with protective devices; the grinding department should be enclosed and separated from other departments. An exception occurs in many tool-rooms where various high-class tools, including grinders, are grouped together; but in this case, it will generally be found that the lathes and other machines are better equipped with means for the exclusion of dust than is usual with ordinary manufacturing tools. This is partly because grinding attachments are frequently employed on the slide-rests of fine lathes and so the bearings and slides are necessarily protected more completely than would otherwise be necessary.

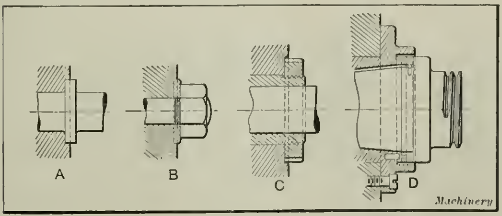

Fig. 2. Designs of Dustproof Washers and Adjusting Nuts

Another class of protection is that against damage done by having tools or the work dropped onto bearing surfaces, gears or other parts of the mechanism. Such protection is afforded, to a large extent, by the practice of guarding the gears and other parts to prevent injuring the workman; but where such guarding is not provided, special devices or modifications in construction are frequently made to render it impossible to touch an important bearing surface. It must be borne in mind that an operator is always tempted to lay a tool, spanner or piece of work temporarily upon some part of a machine, where its presence is undesirable or where damage may be caused if it falls off. Certain parts, such as slides, are sometimes built with rounded tops to discourage this practice; and some faces, including those with graduations, are sunk below the general level or protected with an overhanging lip, so that they can be seen but not touched.

A factor which assists in the protection of bearing surfaces against damage is that of arranging the lubricating systems for bearings and slides in such a manner that foreign matter is always carried outward by the flow of oil, and never has an opportunity of remaining long in a situation where it would cause scoring and wear. Where this practice is followed, any foreign matter is quickly removed, and is either trapped in shallow channels or is carried off to be separated from the oil in filtering. Nevertheless, clean oil is an essential for the lubrication of any class of slide or bearing, and care must be taken that the openings where the oil is fed in (in the absence of a pump system) do not afford any opportunity for dust or grit to enter when they are opened. The simple oil-hole is the worst offender in this respect, because it allows any matter surrounding the orifice to fall or be washed in with the oil. An oiler which stands up from the general level is much to be preferred, and its cover or cap should be arranged so that it may be opened and closed without tending to allow dust to fall, or be shaken or washed into the supply hole. The application of filtering pads or wicks laid in contact with the rubbing surfaces acts as a further precaution against the access of grit, because if properly fitted, a pad or wick absolutely prevents the transmission of any solid matter and nothing but clean oil reaches the bearing or slide.

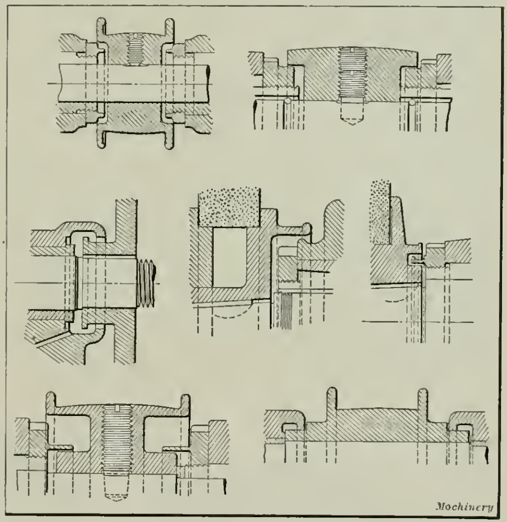

Fig. 3. Different Forms of Overlapping Constructions for protecting Shaft Bearings

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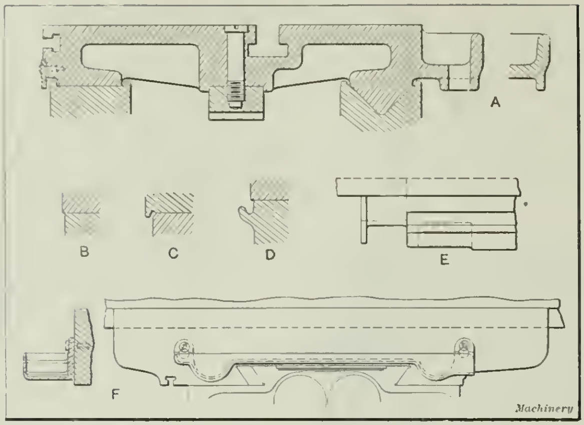

Fig. 4. Methods of excluding Dirty Oil and Fine Chips from the Slides

A distinction between the older practice and that of the last decade or so is noticeable in the extent to which protective devices are built into and embodied in the design and construction of the machines. In the older designs the protection of bearing surfaces was regarded as an unimportant detail and imperfect additions were made in the shape of sheet metal fittings, which frequently became detached from the machine and were not replaced. Now the universal tendency is to include such fittings in the form of castings and forgings, so that they must always be fully efficient from first to last, and can never fail except through being broken. And where separate plates or guards must of necessity be fitted, they are so arranged with screws and shoulders that displacement cannot happen without being at once apparent. The highest developments along this line are naturally observable in precision grinding machines, but the reaction upon other types of machine tools is noticeable. In some grinding machines the only loose protective fittings are those which have to slide or which must be easily detachable for oiling, inspection or to provide adjustment. And even in these instances, care is observed that the dust that accumulates around the apertures or upon the guard plates or covers cannot fall into the openings.

Protective devices may be classified roughly into four main types. (1) Those of a supplementary nature, attached with screws or by some other means, but otherwise stationary. (2) Those embodied in the design of castings or forgings and formed integral with them. (3) Those which slide over machine parts or telescope in conjunction with other guards. (4) Those of a flexible or a rolling nature, accommodating themselves to the movements of slides. There is much variety in regard to the design of each type of device—particularly in the first three classes—and in the following article, a selection of devices from various machines will be described to indicate the principles on which the devices are made, commencing with the simplest forms. The most primitive form of protective arrangement is that of laying boards upon a slide or bed, such as is often done with lathes to serve the double purpose of guarding the surfaces and of providing a place on which to lay a few tools and appliances. The boards are battened down to prevent them from moving laterally across the bed, and shallow ledges may be provided to retain the tools, etc. This practice is only feasible when the lathe is used for work which does not necessitate the full travel of the carriage, and is impracticable when a sliding and reverse movement takes place. But in many lathes and other machines, a saddle or base will perhaps have but a limited motion, or it may be clamped stationary for long periods, as in the case of wheel or tire lathes engaged on repetition work. Sheet steel or cast-iron covers are more durable and are preferable for wide slides or beds, such as those of large boring machines; the covers may or may not be bolted or hooked to the traveling slide.

The protection of the smaller slides, such as those of lathe slide-rests or of grinding machines, is a somewhat simpler matter as regards permanence of fitting, because the covers can be made the full length necessary to exclude chips or dust. It is simply a question of the choice of a cover cast integral with the upper sliding portion, or of a separate cover screwed or hooked in place. Fig. 1 illustrates the two alternatives, the cover shown at *A* being cast integral with the slide, and those shown at *B* and *C* screwed and hooked in place, respectively. The correct practice in these designs, as with the larger tables of some machines—particularly grinders—is to have the slide, including the end covers, of sufficient length to always keep the bearing surface protected. In the long tables of plain and universal grinding machines, it is sometimes the practice to cast the protective ends on, and sometimes to have them loose and bolted or hooked in place, as shown at *D*. A precaution observed in

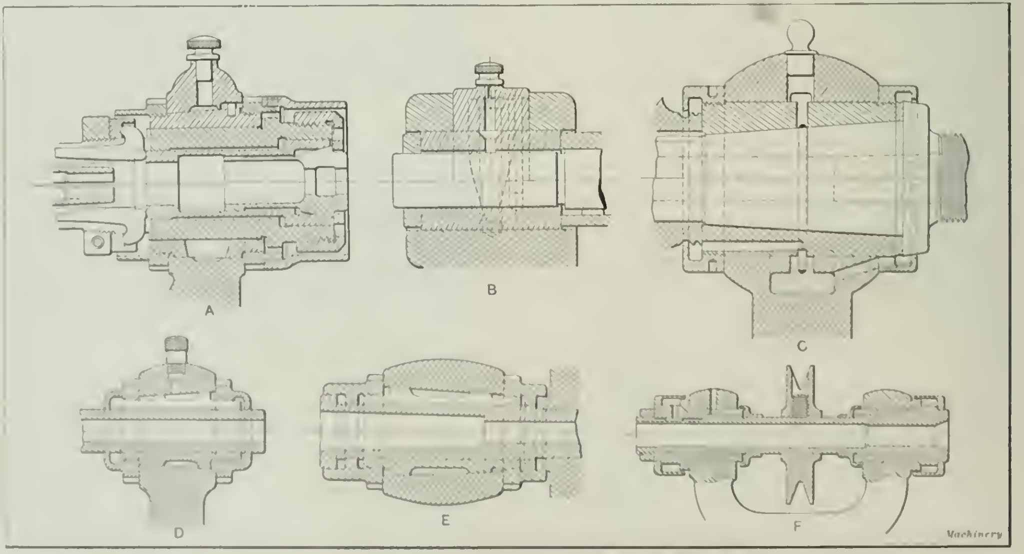

Fig. 5. Various Devices for excluding Dust and Grit from Shaft Bearings

the design of some covers is to form a slight lip or hanging flange at the end, so that any grit or dust mixed with oil or water which falls or is washed over the end will not creep along underneath the plate and so reach the bearing surface. A rib for this purpose is shown at *E*, together with the alternative method shown at *F*, which consists of a plate screwed onto the end of the cover.

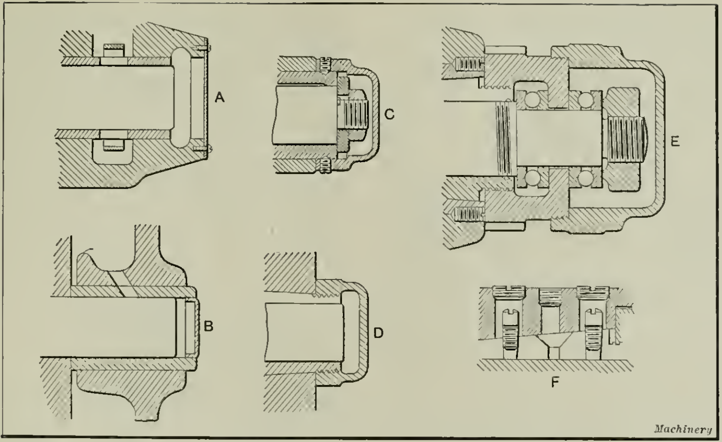

Fig. 6. End Covers for Shaft Bearings and Adjusting Nuts

The troughs or oil-lips which necessarily surround the tables and slides of machines using lubricant play an important part in the protection of slide-ways. They extend over the ways and prevent chips falling on them; but when the lip space is insufficient or the trough becomes choked, there is no guarantee against chips falling over the edge, and there is the risk of the finer chips sliding over the edge and working down onto the slide-way. Two devices may be adopted to prevent this contingency: one is to make the trough with a hanging lip on the bottom edge so that the cuttings must perforce fall clear of the slide-way; the other is to make the latter of slightly less width or diameter than the superimposed one. The cross-sectional view of the grinding machine table shown at *A* in Fig. 4 illustrates the advantage of a surrounding trough in preventing the access of dust to the ways of the bed beneath; and the detail shows how the continuation of the hanging lip prevents oil carrying grit or dust from creeping into the bearing. Milling machine tables are often cast in a similar manner, with a still stronger rib running around underneath, which is an important factor in stiffening the table. The way in which slides and circular tables of moderate dimensions are usually overhung is shown at *B*, *C* and *D*, the types being representative of practice on milling and on grinding machines. It will be seen that three variations are given—a plain finish, an underhung lip and an oil catching lip on the lower slide, the last-named type being necessary only when the dropping of oil and dust further down on the machine must be prevented. When faces such as these are submerged in oil, there is still provision for excluding dirt in the shape of a shallow groove running around to catch the sediment and retain it until the groove is cleaned out.

Many other examples of the protection of sliding or revolving surfaces by the adoption of overhanging sections are to be met with. A design in which a lip is cast on the end of a planer table to prevent the chips from falling onto the bed is shown at *E*, the sloping faces diverting them to right and left; the same device is used in some other kinds of tables to throw the chips away to a place where they are harmless. Or, as shown at *F*, a removable tray may be hitched over screws and used to prevent any fine chips from dropping onto the knee of a machine. The fact that inverted slides are nearly always used in machine tools helps to eliminate the risk of chips remaining on them, because the conditions are not favorable to the retention of the chips. Another fact in favor of the exclusion of foreign matter from the shoulders of very many bearings is that the rims of pulleys extend out to some distance on one side, and so nothing beyond floating dust can well gain access. In the case of vertical shafts, a method occasionally followed is to extend the bearing boss up around the hub of the pulley, acting as a sort of wall against the ingress of any foreign matter.

The protection of vertical revolving faces affords scope for much variety, regardless of whether the rotation occurs intermittently or continuously. Even in the case of heads, shoulders, or washers which may only need to be adjusted occasionally, it is preferable to guard them against falling or floating dust, or oil-sodden matter which slides down vertical faces. Sinking the shoulder or washer a short distance, as illustrated at *A* in Fig. 2, is effectual; and the same method is followed with adjusting nuts for bearings or other parts, as shown in the same illustration at *B* and *C*. The same result is attained by extending the front of a bearing box or bushing as shown at *D*. In any of these fittings, it is very difficult for dust to gain admittance because the oil which exudes continually from the bearing tends to carry undesirable matter away, even though it may have collected around the faces. When a pulley or the flange of a grinding wheel is adjacent to a bearing, advantage is generally taken

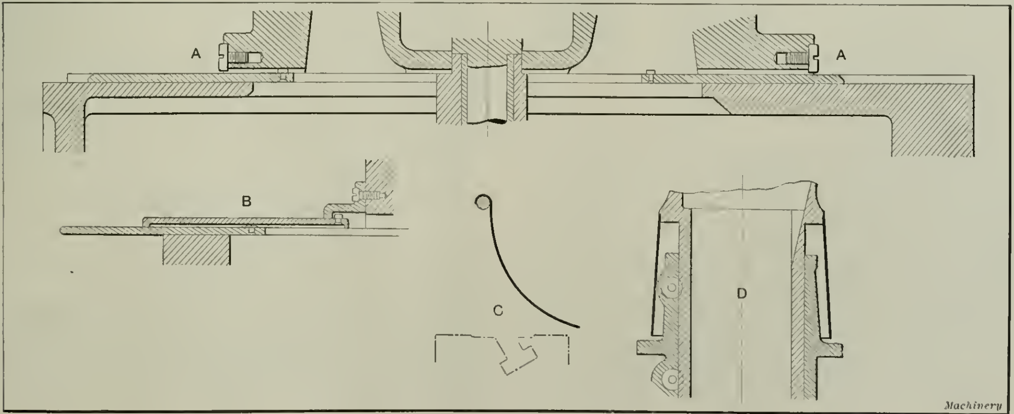

Fig. 7. Guard for Knee Slide and Two Types of Water Shield for Use on Grinders

of the fact to make an overlapping construction, either by arranging the pulley or flange to extend over a bushing or a nut of the bearing, or *vice versa*. Various examples of this kind are illustrated in Fig. 3; the employment of a beaded edge will be noticed in some of these designs, the purpose being to prevent oil and dirt creeping around to an under face, or the tendency to throw the matter outward by centrifugal force in cases where the bead is on a revolving member.

Nuts on the bearings of turret lathes and other machines are sometimes specially prolonged into a tube formation to cover a sliding part, an instance being seen at *A* in Fig. 5; it will also be seen that the chuck at the opposite side of the bearing is protected by a guard which is made to cover only a little more than half the upper part of the chuck and may be made with or without hanging sides which are carried straight down. Other devices fitted to running bearings are shown in this illustration at *B*, in which the width of the bearing box is less than that of the main casting; at *C* and *D*, where the adjusting nuts are flanged to nearly touch the rotating parts; and at *E*, where double security is offered by the construction because the nuts embrace the shoulders on the spindle and the boss of the pulley as well. Some designers prefer to fit flanged collars on the spindle, as shown at *F*, with the idea of throwing off the undesirable matter as the spindle revolves.

None of these devices absolutely guard against the entrance of foreign matter because a slight clearance must always be left between the running and the stationary members; but where a spindle is flush with the end of the bearing or projects only to a moderate extent, absolute protection is easily accomplished by using a covering cap or plate. In large bearings the use of a circular plate is frequently adopted, which is held to the end face with screws as shown at *A* in Fig. 6; or a stopper is lightly tapped into the bearing as shown at *B*. In smaller bearings, if a portion of the bushing extends, a cap can be fitted onto this bushing and locked with one or two screws as shown at *C*, and another device is to make the nut serve a double purpose, forming it with a capped end as shown at *D*. A cap supplementing the adjusting nut is occasionally more convenient when it becomes necessary to get at an end adjusting nut or screw without disturbing the bearing nut. A typical fitting of this kind, which is screwed on, is shown at *E*, while a plain push fit is made in other cases. Another variation of this device is to screw a protecting cap on and pass an adjusting set-screw with lock-nut attached through the cap, so that although the running bearing is guarded, adjustments can be made from the outside. To avoid the clogging up of the nuts with dust, cap-nuts are often utilized in place of ordinary open nuts, and if certain kinds of adjusting screws are sunk below a surface, it is best to protect them with short grub screws, the method being clearly shown at *F*.

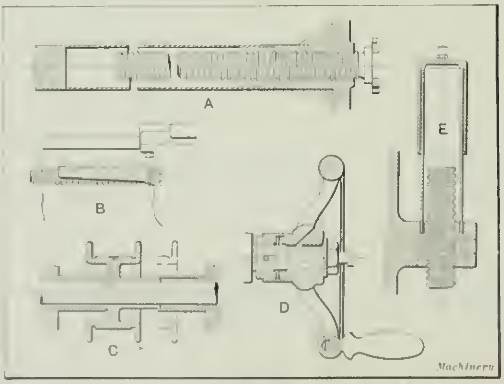

Fig. 8. Tubes for protecting Feed-screws, Splined Shafts and Clutches

The protection of the ways of tables and slides which run on horizontal beds is, as previously mentioned, usually taken care of by the overhang of the upper parts. But floating particles will find their way where falling chips cannot and it is essential in some types of grinding machine tables to have a trapping arrangement, made on the same principle as the overlapping flanges shown in preceding illustrations. An excellent example showing the method of fitting the tables of the Blanchard vertical surface grinders is shown by Fig. 9. Here a deep groove is formed on the under side of the table, and fits over a rim standing up from the carriage. Water or grit which may reach up under the table groove is checked by the slight ridge *A* and drops from this down one of the holes in the carriage and so to the settling pan in the base. A hanging strip to protect the carriage slideways will also be seen at *B*. Leather or felt pads provide a means of excluding chips from sliding ways or shaft bearings and are fitted to slides of lathes, milling machines and grinding machines and to certain shafts which cannot be guarded in any other way. An example of each type of fitting is seen at *C* and *D*, the former illustration showing a projecting guard with a felt attached to make contact with a bed slide, and the latter a double spring-closed felt packing at the end of a bearing through which a splined shaft slides.

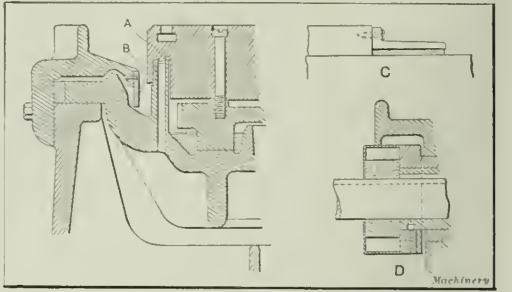

Fig. 9. Guards for Grinding Machine Tables and Felt Pads for Table Slides and Shaft Bearings

Feed-screws and adjusting-screws very often do not require special protective devices, on account of the fact that they lie within the beds and slides and are totally enclosed. If an end is exposed at intervals, this can be protected by a portion of the cover employed for protecting the slide; or a separate fitting in the shape of a tube may be applied as shown at *A* in Fig. 8. A partial protection, which is sufficient to prevent chips from falling on a screw, is shown at *B*; this device is commonly met with in screw-cutting lathes. If a shaft is exposed between two bearings, efficient protection may be afforded by fitting a tube over the intervening space. The application of two such pieces of tubing is represented at *C*, this arrangement being compulsory on account of the necessity for sliding the pulley and its spindle endwise to traverse a grinding wheel to and fro. The tubes fit close to the pulley bosses and so keep out dust. Another fitting representative of many other cases is that shown at *D*, consisting of a tube fixed on the hub of a handwheel, and of sufficient length to cover the teeth and part of the body of a clutch. Telescopic action may be desirable if the full length of a solid projecting tube is not permissible or would perhaps be unsightly. Three or four, or even more, sections of tube fitting one within another may cover a screw, or a simpler device like that illustrated at *E* may meet the requirements.

Flat or curved guards having a telescopic action are used on milling machines and grinding machines, the former for covering the knee opening, the latter for preventing water and grit from falling onto the slides or splashing outward. Fig. 7 shows at *A* how the steel guard strips are fitted in the top of a miller knee and pulled along by the action of a peg riveted in to make contact with a screw on the saddle. Double superimposed strips *B* are sometimes provided with pins and turned down edges to engage so that the plates will close up or draw out according to the position of the saddle, these being used when a single plate will not cover a space adequately. Some designs of plain and universal grinding machines do not require telescopic water-guards because the headstock and tailstock are not fitted like those of an ordinary lathe, *i. e.*, on a horizontal bed, but are set at an angle on ways which rise up at the rear, and a long solid cast-iron guard is formed in one piece with the ways. This guard is either curved, or made with two facets at an angle to secure the effect of catching the splash and throwing it downward and forward. The steady-rests are set at the back of the guard and reach over the top and down to the required location. But when the heads are mounted like those of a lathe, the guards are collapsible, being hung on a rail as shown at *C*, and hitched together with pins or turned down edges so that they always remain together when the heads are separated widely.

A system of slide protection which has been adopted to a very limited extent is the roller-blind device; this comprises a wide roller mounted at the end of a bed, and having a spring action to automatically wind it up. A waterproof or oilproof strip or blind is attached to the roller and at the other end to the moving slide. As the latter travels to and fro the blind is drawn out or wound up, thus keeping the slideways covered. The arrangement is applied to planing machines and to surface grinding machines. A way of producing the same result on much shorter slides, as those of cutter grinders, is to attach one end of a flap of canvas or other material to the fixed slide and the other end to the moving slide, having the flap of sufficient length to give the maximum movement each way. An example of the application of a canvas or other apron is shown at *D* hung down around the column of a cutter grinding machine to throw off the water, a principle which is applied in other cases where flexibility is essential. Some horizontal spindles, those on surface grinders being a case in point, are protected with a flexible waterproof tube which is sufficiently loose or baggy to allow of the maximum to minimum adjustments lengthwise, and still excludes all water and grit. The tube may be kept out to an approximately circular shape by a spiral coil of wire inside to prevent it from touching the revolving spindle or flange.

* * *

LINCOLN'S GETTYSBURG SPEECH BROUGHT UP TO DATE

The following parody of the famous Gettysburg speech was composed by Leon Rudski, safety clerk in the master mechanic's office of the upper and lower union mills, Carnegie Steel Co., Pittsburg, Pa.

> A few years ago our industries brought forth a new idea conceived by humanitarian obligations and dedicated to the workmen's welfare by promoting "safety first." Now we are engaged in a great effort testing whether this idea, or any idea so conceived and so dedicated can stand for all ages. We have about reached the summit in promoting welfare. We have come to a point where we have decided that this safety first movement built up and operated by the industries and supervised by the government, will continue to bring welfare to the workmen in the mills and happiness to their families at home. It is altogether fitting and proper that we should have so decided. But in a large sense, the men having the safety first movement at heart and who are looking toward the betterment of their homes will profit by the opportunities offered them. The present men who are struggling to perfect the safety first movement have dedicated to the workman a humanitarian purpose that commands the admiration and respect of all mankind. The world will little note nor long remember what we say here but it can never forget what they did here. It is for us who have not been crippled, to dedicate ourselves to the great movement before us, that we here highly resolve that the efforts of the safety men shall not be in vain, that this movement shall have a new birth, and that all good resolutions for the benefit of workmen shall not perish from our land.

* * *

The present tariff law provides that all measurements of wire, metal products, etc., passing through the U. S. Custom houses shall be expressed in decimals of an inch, with the exception of steel strips. The measurement of steel strips shall be by the American or Brown & Sharpe wire gage, this being fixed as the standard. Under previous tariff laws the Birmingham wire gage was the standard for metal products measurement.

IMPORTANT DETAILS IN SOUTH AMERICAN TRADE*

In the substantial increase in trade with South America which the immediate future promises it is highly desirable that American manufacturers should keep clearly in mind some of the cardinal points of difference between South American trade usages and those of this country. It has, for instance, been emphasized many times that the social feature, almost negligible in the United States, is an important factor in trade relations in Latin America. Business is conducted more slowly in general, correspondence and personal relations do not perhaps have so much of the "touch-and-go" character, and in all commercial transactions more stress is laid on both the forms and the spirit of courtesy than in the United States. Traveling salesmen will find that they will make more progress by taking their time in working up a personal acquaintance with the trade than by attempting, even with the most favorable terms to customers, to close a sale on the first visit; and a courteous letter, written in Spanish and directed especially to the person or firm addressed (in contrast to a circular or form letter), will probably prove far more valuable as an accompaniment of a catalogue and price list than the mere catalogue itself.

Necessity of Fair Treatment of South American Customers

It is to be emphasized also that fair treatment of the customer by the American manufacturer, from the beginning to the end of a commercial transaction, is of the highest importance. In the next year or two American goods will be likely to penetrate to every remote corner of Latin America where the wares of civilization are in demand at all. Dealers who have never thought of the United States as a possible source of supply for the articles they handle will be buying from American exporters, and many will learn for the first time the meaning of the label "Made in the United States." The custom of going to Europe for certain lines of goods has become so thoroughly established that many South American dealers have little idea that their supplies can be obtained in the United States at all. Under these circumstances dealers and consuming public alike will have their first opportunity to become acquainted with American wares of every description, and it is of the highest importance that the impressions they receive, not only as to the quality of the goods, but also as to fairness of treatment by American exporters, should be favorable.

The reputation which American tradesmen and American goods will acquire in the next year or so will probably last for a generation and will have an enormous influence on the future commercial relations between the two sections. Latin-American merchants, as a rule, do not lightly change from firm to firm in their purchasing of foreign goods, and when they become assured of fair treatment from a particular export house their trade is likely to go to that house indefinitely. Much the same thing is true of the nations from which they buy, and with American goods once firmly established and American exporters found to be courteous and trustworthy, the future for our trade in Latin America will be assured. The quality of American goods, so far as they are known, is in general very well liked in Latin America, and the advantage which this gives to American exporters should not be dissipated.

Importance of Following Packing and Marking Instructions

Consular reports have from time to time cited a number of points in the commercial intercourse between South America and the United States in criticism of American methods, and while these criticisms are probably justified now in much less degree than formerly, it will doubtless be as well to point out, for the sake of those new to the trade, a few of the matters concerning which American exporters should be particularly careful. Perhaps the greatest objection to American methods heretofore has been that detailed instructions concerning packing and marking of cases, bales, etc., have been disregarded, with considerable damage and delay as a result. This has been reiterated many times, and the effect of the criticism is to be seen in much-improved packing of American goods. In many ports on the east coast, and in practically all on the west coast, of South America, all goods have to be lightered to shore, and on landing are sometimes allowed to remain exposed to the weather for several days. The necessity for strong boxes and crates, well reinforced, is obvious. This subject has been discussed in detail in a publication "Packing for Export," issued by the Bureau of Foreign and Domestic Commerce and obtainable from the Superintendent of Documents, Government Printing Office, Washington, for 15 cents. Good clear marking, preferably with stencils, is of much greater importance than is generally realized, as the lack of these marks, or their failure to correspond to those in the invoice, often causes the goods to be held up in the customs for weeks and months. It is in many cases essential that the weight in kilograms shall be marked on the box, as the capacity of many of the cranes is limited. American exporters owe it to their customers to look carefully after these details, especially if the customer himself lays emphasis on the point, and they will find that attention to these matters will go far toward retaining the good will and trade of a customer once obtained.

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* From "Daily Consular and Trade Reports," August 28, 1914.

Substitution in Filling Orders—Failure to Follow Samples and Catalogues

Another unfair practice which is sometimes resorted to and which is particularly irritating to buyers is the substitution of one type of goods for another which has been specified in the order. The needs of customers in South America are very often peculiar to their district, and substituted goods are in many cases altogether useless. When it is remembered that it may take a month to send the original order, another month to have the goods shipped, a third to complain of the substitution or return the article substituted, and a fourth to get the article originally ordered, it will be seen that one instance of this kind will be likely to kill the chances of the particular manufacturer concerned for an indefinite period. In the same class of actions is the sending of goods which do not correspond to the sample or the catalogue description from which they were ordered. It is in nearly all cases a mistake to suppose that the manufacturer knows better what a customer wants than the customer himself, but this might be said to be particularly true in South and Central America, where most of the countries are mountainous and transportation offers special problems, and where the preferences of the people have been accentuated by long use of the same kind of goods. A firm that can be depended on to send the exact goods ordered will work at a big advantage in the Latin-American trade.

Encroachment on Field of Exclusive Agents

The granting of exclusive agencies and then the indiscriminate sale of products direct to all comers is an instance of unfairness that needs only to be mentioned to be condemned. There have been many complaints that exporting firms did not observe the terms of such arrangements, and have not only sold in the territory granted to an agency, but have after a while terminated the agreement and entered the trade direct after the preliminary work and expense had been borne by the local firm. Practices of this kind are, of course, not conducive to the establishing of permanent trade relations and will be avoided by farsighted concerns. It often happens, however, that an American firm offends in this respect while acting in perfect good faith. It grants an exclusive agency to a local concern in some country and then fills orders, in the regular course of business, from an export commission house that has customers in the same territory. Fairness to the local agent requires that this should be prevented, but the best method of procedure would probably be to have an understanding in regard to the matter before the agency is granted.

The Question of Credits

The matter of credits, however, does not come under the question of fair treatment, but is simply a detail of policy in which the American practice has differed from the European. Americans sell for cash, or on a credit of one to three months, Europeans allow three to nine months, or even longer. While there is considerable complaint that American goods cannot be obtained on as favorable terms as those from Europe, there are no charges of unfairness against Americans on this account. The difference has probably been due in large part to the smaller interest in and study of the market by Americans and the consequent lack of facilities for collecting accounts and financing shipments generally. With banks of their own nationality on the ground and in intimate touch with the commercial situation, and desirous of furthering the trade of their respective countries in every way, English and German exporters have felt safe in letting accounts run for a considerable period. American exporters, on the other hand, accustomed to a more rapid turnover and operating over a long distance, often through correspondence or foreign agencies, have not considered it wise to tie up their funds or extend credits to firms with which they were out of touch for long periods.

For all exporters who are new to the field, or who are operating through salesmen or correspondence merely, it would probably be as well to continue to use caution in the granting of credits. Financial conditions in many South American countries are not on so sound a foundation as in the United States; and it often happens, besides, that beginners in business who have small knowledge of trade or of their particular line do not hesitate to lay in a large stock of goods on credit without regard to future contingencies. The credit-information facilities in many countries such as Argentina and Uruguay are said to be as good as in the United States, but the factors affecting business are perhaps more numerous and different in character than those in the United States and this makes the granting of long credits without a knowledge of the country more or less a leap in the dark. The whole credit situation is best handled by a permanent agency of the exporter, which remains on the ground year after year, and knows not only the varying phases of the economic situation but the character and standing of the commercial firms to which they sell. Perhaps the best of all mediums for keeping in touch with the credit situation is the permanently established American branch house or agency, with Americans of experience in charge. A firm with such a representative can afford to grant credit terms to compete with those of Europe, and will probably find it advantageous to do so. But others would do as well to go slowly, and at any rate to lay down a general policy of extending credit only after thoroughly satisfying themselves, from a study of the many elements involved, as to the lengths to which they would be justified in going.

Appreciation of Fairness by Latin Americans

Other points will come up as the export trade develops which the careful American house will watch closely. The essential thing, of course, is to enter the trade with a desire to treat customers fairly as well as to insist on fair treatment in return. The old trade maxim "Let the buyer beware" is a doubtful policy under any circumstances, but particularly so in dealing with Latin-American merchants. They will be found to respond quickly to any evidence of a desire to act generously with them and are as keenly appreciative of fair dealing as any other people in the world. It should be further noted that even with the best intentions on both sides misunderstandings, due to different trade customs, are likely to arise and charges of bad faith should not be made hastily or without investigation. A thorough and detailed study of the elements that enter into South American trade will on that account be found of high importance to American exporters.

* * *

It is mentioned in a recent issue of the *Standard* (London, England) that London now has a woman consulting engineer with extensive workshop and testing-room experience. She is said to have conducted researches in the laboratory of a famous engineer and holds certificates of technical education from well-known technical colleges, covering the courses in general mechanical, electrical and automobile departments. It is further stated that this very engineering lady is vexed because no engineering society as yet has admitted her to membership. She, of course, is allowed to attend the meetings, and frequently does so, but vote—no!

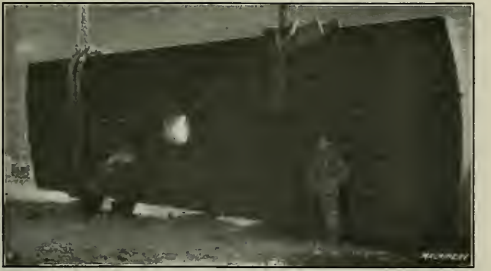

Fig. 2. Central Section of Table

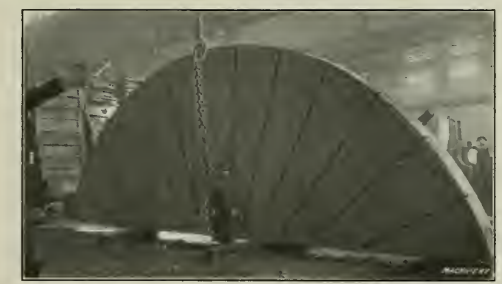

Fig. 3. One of the Outside Sections of Table

THE LARGEST BORING MILL EVER BUILT IN AMERICA

At the Brooklyn Navy Yard there has recently been completed the installation of the largest boring mill that has ever been built in this country. This mill was made by the Niles-Bement-Pond Co., at the Niles Works, Hamilton, Ohio. It swings 36 feet in diameter and has a capacity of 12 feet under the tools. The great swing of this machine is required for finishing the tracks of the immense turrets carrying the 14- and 16-inch guns of the new battleships. The mill will also be used for boring cylinders and machining the casings of the giant steam turbines for our war vessels. The significant feature about the size of this mill is that it is not of the so-called "extension" type, but it is a regular cross-rail machine with an actual swing of 36 feet 2 inches with the housings in a fixed position. An idea of the size and massiveness can be gained from the fact that the total weight, including the motors, is 665,000 pounds, or over 330 tons.

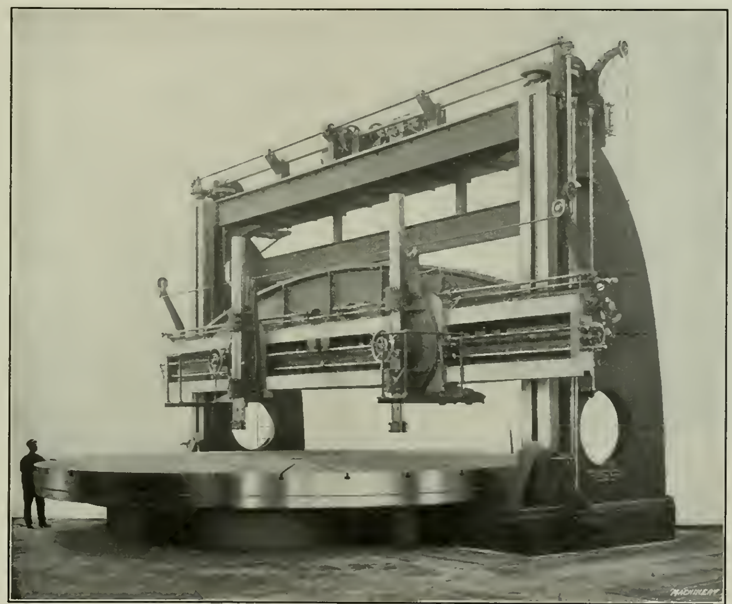

Fig. 1. Niles-Bement-Pond 36-foot Boring Mill—the Largest ever built in America

The table is designed to carry a weight of over 200,000 pounds. The extreme size of the table, which is 34 feet in diameter, made it necessary to cast it in three parts, the central and one side section being shown in Figs. 2 and 3. The three sections of the table weighed 225,000 pounds. The table is supported on conical rollers running in a circular track 24 feet in diameter, which is sunk in the bed. The rollers are of high carbon steel and fitted to the circular guide frames to insure alignment. In addition, the table rests in an annular adjustable bearing ring surrounding the central spindle. The bearing ring is adjusted vertically by steel screws. The spindle is centered in the bed by an adjustable conical bushing.

The table tracks and spindle have forced lubrication from a pump operated from the main driving motor, and the table is fitted with a spur gear 28 feet in diameter, which is a semi-steel casting, with teeth cut from the solid. It is driven by means of two forged steel pinions, placed on opposite sides of the mill. The main part of the bed is made in two sections, one of which is shown in Fig. 4, and there are two extensions attached to the main bed. The whole bed weighed 69,000 pounds and the section with the extensions, 48,600 pounds. The table tracks are rigidly supported by the vertical webs.

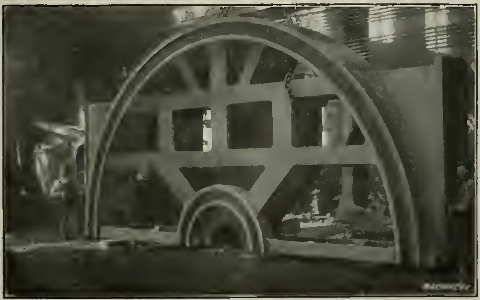

Fig. 4. One-half of Bed Casting showing Provision for Table Tracks

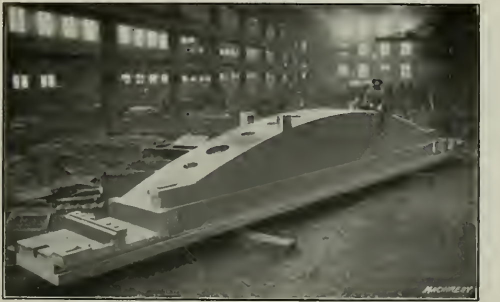

Fig. 5. Cross-rail of the Niles-Bement-Pond Boring Mill

The housings, as shown in Fig. 6, are box castings of massive construction, connected at the top by a heavy cross brace. Rigidity is further increased by a steel girder connecting the housings. Each housing weighed, in the rough, 32,000 pounds. The cross-rail, as shown in Fig. 5, is about 46 feet long and weighed 85,000 pounds in the rough. It is a box casting, and bolted to the top is a massive camber beam, the function of which is to stiffen the cross-rail and take up the sag due to the great weight of the cross-rail and the heads. The combined depth of the cross-rail and the camber beam is 8 feet.

The rail is raised and lowered by means of a 30-horsepower motor located on the top cross brace and connected to four elevating screws of large diameter working in bronze nuts. The cross-rail is fitted with two heads for boring and turning. The heads are right and left, so arranged that either can be moved to the center. They are provided with graduated swivels, with worm-gearing for setting them over to any angle on either side of the vertical of 30 degrees or less.

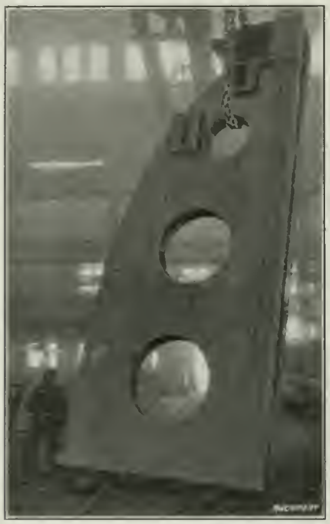

Fig. 6. One of the Housings

The heads and bars are provided with rapid power traverse, as well as hand movement for close adjustment. The rapid traverse is operated by a 10-horsepower motor located on the top brace. The control of these operations and also the engaging and disengaging of the feeds is from a platform attached to each head, upon which the operator stands. The operating levers are interlocking so that the rapid traverse cannot be engaged for one head until it is disengaged from the other, making it impossible for the operator on one head to accidentally move the opposite one.

Eight reversible power feeds are provided for the bars and are operative in a vertical or angular direction. The feeds for each head are entirely independent and positive. Means are provided by friction clutches to prevent the breakage of the feed gearing, should either bar or saddle encounter an obstruction. The main drive is by a 75-horsepower motor, and suitable speeds are provided for boring, turning and facing operations.

* * *

AUTOMOBILE SPRING WHEEL

The pneumatic tire, while one of the most perfect shock-absorbing devices known, is costly and likely to fail without warning. A great many mechanical contrivances have been invented to do away with the use of compressed air in motor tires, substituting therefor springs in various combinations. Some of these are ingenious and fairly effective. The best devices of this type are so constructed that all the springs in the radial members help support the load, no matter in what position relative to the load they may be.

The illustration Fig. 1 shows a motor car equipped with "Perfection" automobile spring wheels made by the Perfection Automobile Spring Co., Indianapolis, Ind. The wheels have traveled over five thousand miles and have been subjected to the most severe tests, one of which was crashing them against a curb at an angle of 15 degrees five hundred times to determine lateral strength.

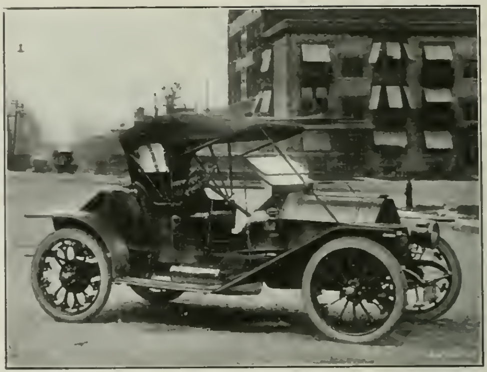

Fig. 1. Automobile fitted with "Perfection" Spring Wheels

The construction of the wheel is more clearly shown in Fig. 2. The spokes are composed of two flat special chrome-vanadium steel springs secured in the hub by wedge blocks, and are attached to the felloe by two links, the ends of the springs being curved outward in order to be attached to the links with the latter at right angles to the axis of the springs when in a normal position.

Radial movement of the hub relative to the felloe deflects the springs as indicated by the dotted lines. Lateral movement also deflects the springs, but sidewise; thus it is evident that all the spring spokes help support the load, and hence the load on each wheel is supported by twelve pairs of flat springs.

Of course no spring wheel of the rigid rim and solid rubber tire type can carry a load with as little shock as the best pneumatic tire. The unyielding form of the rim forbids this, but at moderate speeds, no doubt, spring wheel construction offers an acceptable substitute for the expensive pneumatic tire, especially for delivery wagons, light motor trucks and motor vehicles, in which dependability is a prime requisite.

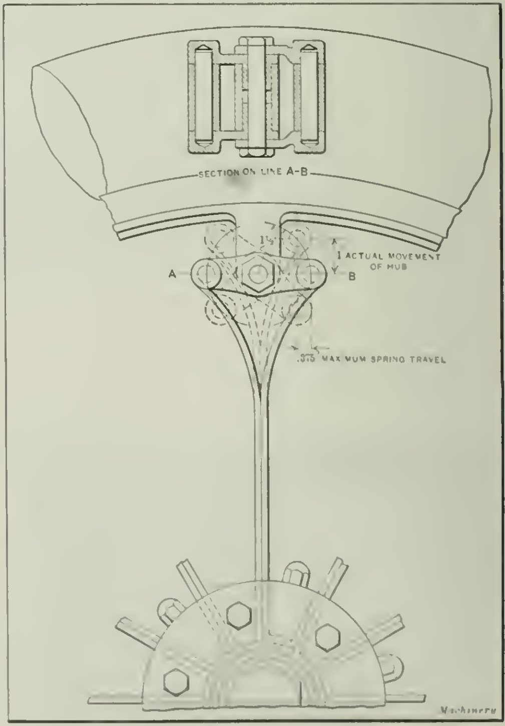

Fig. 2. Detail of Wheel showing Construction of Links, etc.

THE INFLUENCE OF CHIPS ON THE DESIGN OF TOOLS AND FIXTURES

ILLUSTRATED BY EXAMPLES SELECTED FROM VARIOUS FIELDS OF MACHINE OPERATION

BY ALBERT A. DOWD*

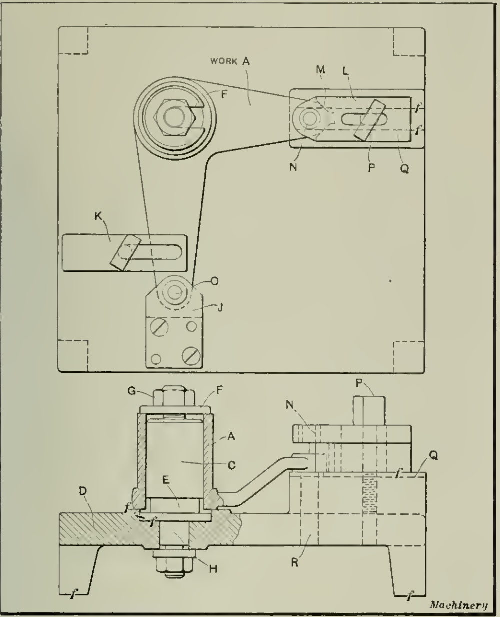

Fig. 1. Example of Drill Jig Design where Provisions for Chips are only partly considered

IN the design of all kinds of cutting tools, jigs, fixtures, and even machine tools, the chips produced by the cutting action have an influence which is of great importance. In these days when the amount of metal removed in a given time is so great in comparison with what it used to be, the importance of the matter is especially emphasized. In the design of machine tools of all kinds there are a number of points which may be traced back directly to the disposal of the chips, for example, the protection of running or sliding surfaces, such as the ways of a turret lathe. Some type of felt "wipers" are generally used for this purpose, as it is out of the question to arrange a permanent guard. When machines are used on cast-iron work some protection is greatly needed, as cast iron contains more or less sand which has an abrasive action and therefore causes excessive wear on moving parts. Cast-iron dust containing sand is nearly as destructive as emery. The writer has seen the ways of a turret lathe so badly worn when used in cast-iron chucking, that the depression could be easily seen and even felt with the fingers in some places. Felt wipers on the front end of the turret slide would have prevented a great deal of this trouble.

Gear guards are sometimes found necessary on account of flying chips, even when the gears are in a position which would not require guarding for the sake of the operator. Pans are now cast as a part of the machine bed in many cases, and adjustable guards are provided in addition, to catch chips and direct them into the pan. In the design of chucks and collets the influence of the chips is again apparent, for the chuck jaws are made of such lengths that they keep the scroll well covered under normal conditions, while collets are protected by their general construction. In milling machine construction the slide is well protected by its general design, as there are no exposed ways on which chips may find lodgment. The table, however, with its T-slots receives the chips, and provision for cleaning is therefore necessary. The slots, being open at both ends, may be easily brushed out. Table gears are in such a position that no trouble is possible here. Index heads for the milling machine have all their working parts well protected so that there is no danger of chip troubles on these mechanisms.

As cutting tools are the great producers of the chips in question, it is apparent that the matter of taking care of the chips must be carefully considered in their design. The flutes in a drill, for instance, are not made for ornamental purposes, but are a necessity in order to provide a path by which the chips may find their way out of the hole. Cutting angles of various tools, their clearance and their general shape all have to do with the making and disposal of chips. On steel work from the bar, when a roller turner is used, the angle of the cutting tool controls the form of the chip to a certain extent, and on heavy reductions of stock when a continuous spiral chip is formed, more or less clogging of the turning tool sometimes takes place. In order to prevent this trouble the Jones & Lamson Machine Co. brought out their chip-breaking turner a few years ago. Other types of tools are affected by the chips in one way or another, those working on internal surfaces being somewhat more susceptible than those used externally, on account of the difficulty of getting rid of the chips after they are made. Speaking generally, internal tools, such as boring-bars, which are to be used on steel work, require much more clearance for chips than those which are to be used on cast iron or other material having a short chip. Many a tool has proved a failure on account of insufficient chip clearance.

Jigs and Fixtures

There are several points in the design of jigs and fixtures for interchangeable work, which are of interest in their rela-

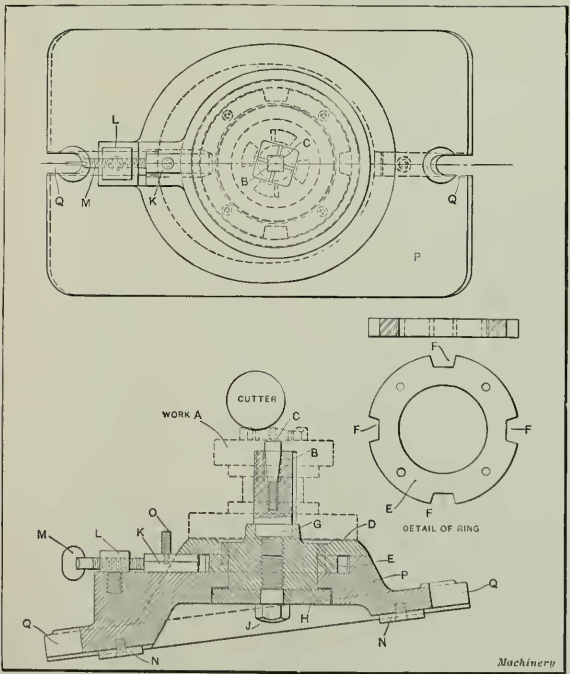

Fig. 2. Indexing Milling Fixture well guarded from Chips

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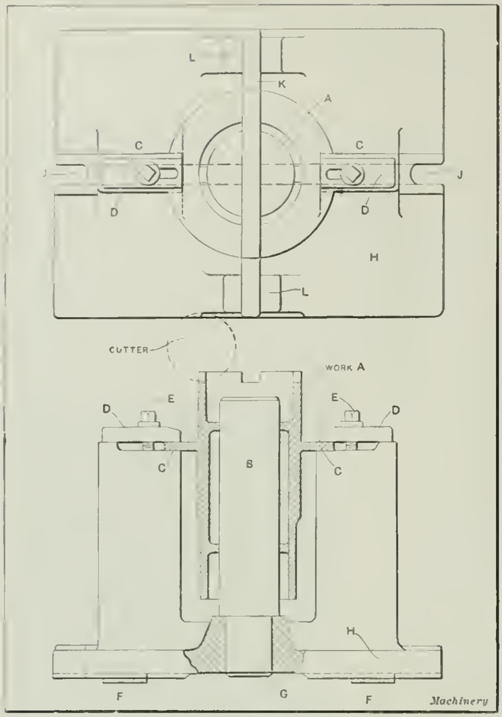


Fig. 3. Another Satisfactory Milling Fixture

tion to the chips; for example, locating points or surfaces should be so arranged that the presence of chips will not cause variations in the location of the work, and they should be easily accessible for cleaning; threaded clamp screws and other movable parts should be protected, as far as possible, in order to prevent trouble in operating; indexing fixtures should have the indexing parts so designed that there can be no chips at important points; openings should be made in the jig or fixture so that the accumulation of chips incident to the cutting operations can be quickly removed.

Fig. 1 shows two views of a drill jig for the bell-crank *A*. Prior to the operation performed in this jig, the piece has been chucked and the large hub turned, and the bosses have been faced. This example shows a peculiar inconsistency, in that the chips have been provided for in some portions and neglected in others. The casting is located on the stud *C* which fits the previously chucked hole in the work. This stud is shouldered at *H* and kept in place by the nut and washer shown. The U-washer *F*, in connection with the nut *G*, makes rapid removal easy. The shouldered portion of the locating stud sets slightly below the finished boss on which the hub of the casting rests, and is relieved at *E* in order to prevent chip troubles. As slight variations in center distances are permissible, the drilled hole at *N* is centered on the boss at the end of the bell-crank by mounting the bushing plate *M* on the sliding V-block *L* which is tongued to fit the slot *Q*, the thumb-screw *P* being used to lock the block in position. The other bushing *O* is fixed in plate *J* and a slotted clamp *K* holds the work down.

One of the peculiarities of this jig is the fact that although hole *R* has been made slightly oversize for the egress of chips formed in drilling the boss, no thought has been given to the trouble which might be caused by chips packing into the slot in the sliding block or the groove in which it travels. As a matter of fact the chips packed into the slot in such a way as to cause a great deal of annoyance, until the operator, who seemed to be of a more practical turn of mind than the tool designer, cut out a piece of tin to cover the slot, this helped the matter considerably. There was, however, no remedy for the packing in of small particles of metal under the block itself, except the removal of the sliding block from time to time to clean out thoroughly the groove in which it moved. Failure to take proper care of this matter caused angularity in the holes, due to the "cocking" of the block. This trouble was all caused by chips and could have been avoided by using a dovetailed block with a backing-up screw or something of a similar nature. It will be seen that in this particular case the tool designer's forethought took into consideration the location of the piece, but overlooked the production of chips in their relation to moving parts.

Provision for Chips in an Index Milling Fixture

In milling machine work the chips produced are inclined to be rather fine and are frequently very abundant, so that precautionary measures are of the greatest importance. A point which should not be overlooked is that a milling machine fixture is practically a part of the machine itself when it is in use, and therefore must be readily cleaned without removal from the table. Oftentimes a fixture is completely buried in chips and a designer should bear this continually in mind, so that proper precautions will be taken to avoid pockets, recesses, etc., which might be difficult to clean. In indexing fixtures special care must be taken so that there will be no inequalities of the indexing due to the presence of chips.

Fig. 2 shows an index milling fixture for an automobile clutch gear *A*, in which a square hole has been previously broached. The work done in this operation is the milling of the angles of the clutch teeth. The work is located on the

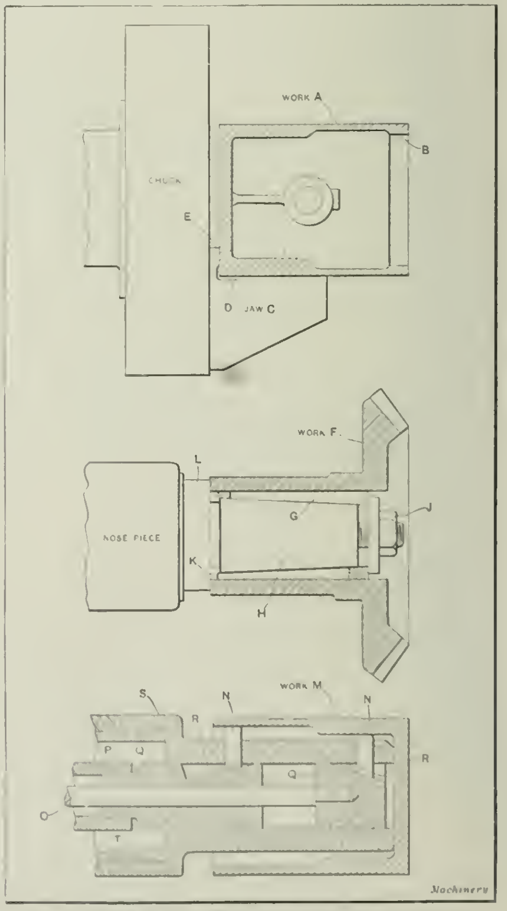


Fig. 4. Methods of holding Work in Horizontal Chucking Machines, showing Means for guarding against Chips

square stud *B* which is split in four places on its upper end and expanded by the tapered screw *C* in order to fill the hole and avoid any possibility of chatter which might be caused by a loosely fitting stud. The split feature also acts as a clamp. The stud is shouldered at *G* and screwed into the upper part of the indexing portion *D* on which the face of the larger gear rests. The index ring is screwed to the under side of this piece and the stem of part *D* extends down, having a bearing in base *P*, where it is secured by the collar and bolt *H* and *J*. The base is provided with keys *N* which fit the slots in the table, and slots *Q* for the holding-down bolts. The index ring (a detail of which is shown at the right of the illustration) is of steel and is provided with four angular slots *F*. The indexing bolt *K* is correspondingly tapered, and is tongued at the sides to fit the base. A pin *O* provides the means of withdrawal; it will be noted that the necessary movement is not sufficient to expose the angular point and thus allow chips to enter. Thorough protection is afforded both the index ring and bolt by the overhanging portion of the casting *D*. The bolt is forced into position by screw *M* acting in the swivel *L*. This fixture is an exceptionally good one, requiring very little care and having ample protection against chips.

Another Example of a Milling Fixture

The work shown at *A* in Fig. 3 is a steel hub which has been previously bored, reamed, turned and faced. The requirements for the milling operation are that the four slots must be milled at right angles to each other and perpendicular to the axis of the hub.

The base *H* of the fixture on which the work is held is provided with two keys *F* which fit the table T-slots in the usual manner, while slots *J* are used for the hold-down bolts. Stud *B*, on which the work is located, is shouldered at *G* and forced into the base. Chip troubles are here prevented by allowing a considerable amount of clearance between the lower end of the hub and the boss in which the stud is held. The fixture is also of very open construction, making cleaning easy, as all surfaces can be readily reached with a brush. The two uprights are a part of the base casting and are finished at *C* to receive the flange of the casting. Clamps *D* are set up by means of screws *E*. It will be readily seen that there is no chance for chip troubles on these surfaces on account of their accessibility. The indexing feature of this fixture is somewhat unusual, as no part of the fixture itself changes its position. After the cutter has cut the first two of the slots in the end of the hub, the clamps are loosened and the work is revolved on the stud until parallel *K*, guided by lugs *L*, can be pushed into position. The clamps are then set up lightly and the parallel removed, after which the clamps are set up tightly. This fixture is very satisfactory in every respect and is much less costly than an indexing fixture having a revolvable portion would have been.

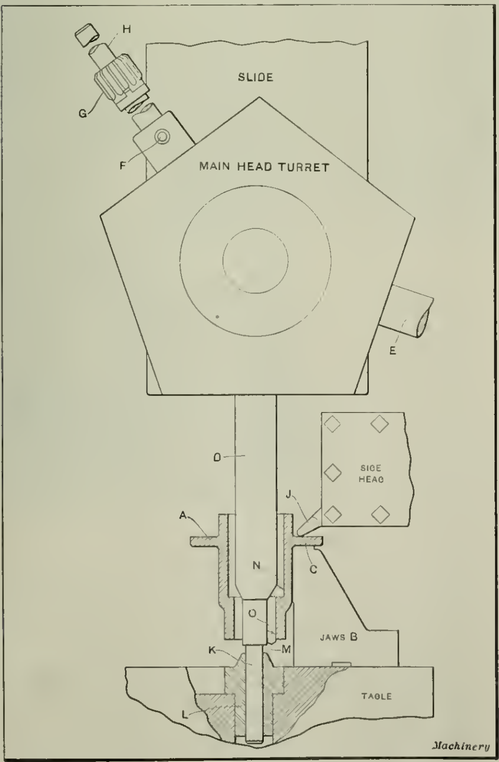


Fig. 5. Well designed Device for Vertical Turret Lathe Work

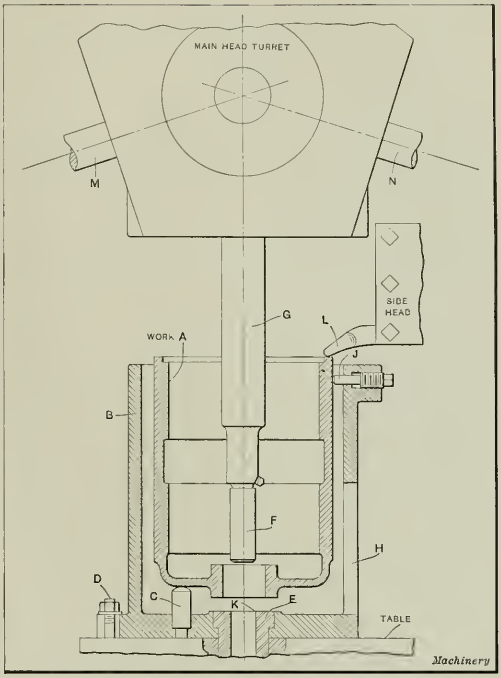


Fig. 6. Another Device for Vertical Turret Lathe where Due Regard has been given to Removal of Chips

Avoiding Chip Troubles in Chucking Work

In the machining of work in chucking machines, turret lathes and the like, there are fewer chances for chip troubles in the holding devices, because these are in motion and this has a tendency to throw the chips out of the way by the action of centrifugal force. Nevertheless, fine particles of sand from cast iron or steel and fine pieces of chips may cause considerable trouble unless proper precautions are taken.

The upper illustration in Fig. 4 shows an automobile piston *A* which has been previously machined on the outside. In this setting it is to be held by the outside surface and bored at *B*. It is held in the soft jaws *C* of a three-jawed chuck bored to receive it, a recess being cut at *D* so that locating troubles will be obviated. There is nothing unusual about this procedure, as it is common practice. A point in design which is frequently overlooked and which sometimes causes serious trouble is the tail *E* of the jaw. Unless this is made long enough to cover the operating scroll of the chuck perfectly, chips and dirt may find their way into the mechanism and do considerable damage. The writer has seen a chuck of this type with improperly designed jaws so badly clogged up with chips that it was impossible to use it until it had been taken apart and cleaned.

The work *F* shown in the middle illustration is a bevel gear which is to be machined on the angular faces. The split bushing *G* is forced back on the taper arbor *H* by the nut *J*. The arbor itself is held in a special nose piece on the spindle and has a shoulder *L* by which the longitudinal location of the work is insured. The relieved portion *K* of the arbor is of assistance in grinding the taper and also a precaution against dirt and chips. If used on cast-iron work, the split bushing should be taken off and thoroughly cleaned occasionally, as chips will find their way into the slots and between the bushing and the arbor, thus causing eccentricity. Troubles with expanding arbor inaccuracies may frequently be traced to this source.

The expanding-pin chuck shown in the lower part of Fig. 4 was designed for holding the piston *M* by the cored interior. Six radial pins *N* were dovetailed at their inner ends and were controlled by the dovetail slots *R* in the cams *Q* which were operated by the rod *O* and the sleeve *P*, respectively, from the rear end of the spindle. The body of the chuck *S* was screwed to the spindle as shown. This chuck is an excellent example of the troubles which may be caused by cast-iron dust, for although mechanically correct, its construction was such that particles of sand, fine chips and other foreign substances became wedged in the dovetails in such a way that its operation was seriously impaired. A leather washer in the open end helped matters considerably by preventing the dirt from getting into the mechanism. In several instances before this was done, the dovetail portion of the pins was broken off by the operator on account of the excessive power needed to operate the mechanism.

Avoiding Chip Troubles in Vertical Turret Lathe Work

In vertical turret lathe work much greater care must be used in the design of tools and fixtures than in horizontal work, as the chips naturally fall down onto the table or fixture. The table chuck on this type of machine is arranged with a set of permanent sub-jaws, lying flush with the table top and provided with a series of slots in which the upper jaws are fastened. T-slots in the permanent jaws permit quick and easy radial adjustment to approximate diameters. The scroll is well protected from chips, as the permanent jaws extend out to the edge of the table, there being a scroll controlled movement of about two inches which is sufficient to take care of any required condition.

When regular equipment and standard jaws are used there is no necessity for special precautions regarding chips, but when special tools and fixtures are used, considerable care must be taken in the design so that the devices can be easily cleaned. Movable clamps of all kinds must be so arranged that the falling chips will not clog and interfere with their use. Fig. 5 shows a hub at *A* which is to be bored, faced and turned on the upper end. The work is held in a set of special jaws *B* by the outside of the hub, the flange resting on the three points *C* on the upper parts of the jaws. In order to increase production it was desired to use multi-cutting bars as shown at *D*, and it was considered advisable to pilot the lower end of the bar in order to make it more rigid. A bushing *L* was fitted to the center hole of the table and was used as a guide for the pilot *K* of the boring-bar.

As any chips falling down and wedging around the bar would do a great deal of damage, the end *M* of the bushing was made conical, while the hole instead of being rounded or chamfered as is usually the case, was ground square and sharp. The result of this procedure was that the greater number of chips did not remain on top of the bushing, but fell to the table where they did no damage. The sharp corner in the hole did not permit any wedging action or drawing in of chips around the bar at this point. Another bar *E* used for finishing was piloted in the same manner, while the floating reamer *G* was hung loosely at *F* and piloted by the stem *H*. The side-head tools were used in connection with the boring- and reaming-bars as indicated by the tool *J*.

In vertical turret lathe work heavy castings are frequently machined which sometimes require the use of a pot of some sort as a holding device. In cases of this sort it is very important to provide means of cleaning, both because of the rapid accumulation of chips in a pot of this kind, and because of the necessity of keeping all locating points clean.

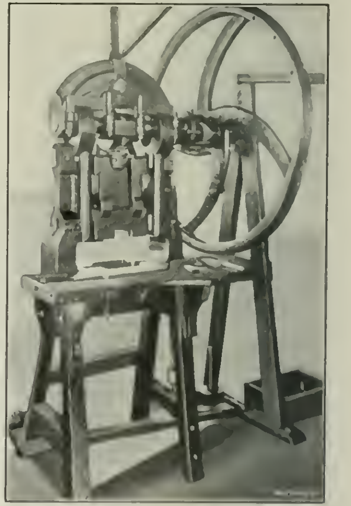
Fig. 6 is a good example of a piece of work *A* held in a pot casting *B*. This casting is centered on the table by means of the bushing *E* which fits the center hole, the fixture being held down by the bolts *D* in the table T-slots. The work rests on three points, these being pins *C* in the base of the fixture. Attention is called to the fact that the tops of these pins are rounded so that chips will not lodge there. A series of set-screws at top and bottom are arranged as shown at *J*. These set-screws are placed 120 degrees apart. It will be noted that the thread of the screws is entirely protected from chips and dirt, so that no trouble is experienced in operating, as might be the case if a regular set-screw were used with an unprotected thread. Two boring-bars and a reamer are piloted as in the preceding instance, these tools being indicated at *G*, *N* and *M*. The edge of hole *K* in the bushing is made sharp to receive the pilot *F* and the top of the bushing lies flat and flush with the fixture. There are three cored openings *H* in the walls of the pot, these being large enough to admit the hand of the operator, so that he can readily clean the locating points *C* and the bushing *E*, and free the entire interior of the fixture from chips without trouble.

The examples illustrated in this article have been chosen for their simplicity, in order to point out the importance of the subject even under the simplest conditions. In fixtures of a more complicated nature, the question of chips becomes even more important, but the same principles can be applied.

* * *

A PUNCH PRESS OF 1853

In the factory of the W. L. Gilbert Clock Co., Winsted, Conn., there is a punch press in everyday use that was built in 1853. The maker was A. Alfred, and the press was built in the town of Harwinton, Conn., a few miles from Torrington. The press does not differ greatly in general appearance from those made today, except for the large flywheel with which it is equipped. This was originally a handwheel and the side of the rim is fitted with holes so that handles may be put in, and the press operated by man-power. Later, the rim of the wheel was turned flat and the belt applied. Although the frame of the press is heavy, it has no cast-iron base and is supported on a wooden framework. An outboard bearing is provided for the right-hand end of the crankshaft, and this is also supported by a wooden framework.


A Punch Press built over Sixty Years Ago

In 1853 planing facilities were not very plentiful and it is probably for this reason that the guides or ways upon which the ram slides are made in separate pieces and held in position on the inside faces of the frame by tonguing them in rectangular holes. Each of the guides is adjustable by means of a taper square key that passes at right angles through the tongue, and by driving the keys in, the guides may be set closer together. Set-screws hold the guides in their adjusted positions. The clutch is operated by pressing the foot treadle in the usual way. This pulls out a pin that engages the heavy boss of the flywheel and thus causes the crankshaft to turn and the ram to descend. The approximate adjustment of the stroke of the press is secured by inserting large brass washers behind the adjusting screw, thus lengthening the ram. This press is still working every day at the Gilbert Clock Factory. C. L. L.

OPERATING AUTOMATIC SCREW MACHINES[*]

GENERAL DIRECTIONS FOR SETTING UP AND OPERATING MODEL "A" CLEVELAND AUTOMATICS

BY DOUGLAS T. HAMILTON[†]

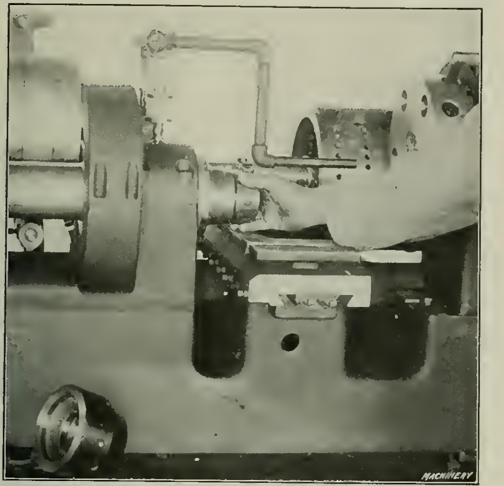


Fig. 1. The Spring Chuck is inserted by removing the Hood from the Nose of the Spindle

THE first step in setting up a Cleveland automatic screw machine is to decide on the best way of arranging the tools in relation to each other and to the work, and to select the types of tools best adapted to handle the part to be made. These points can best be illustrated by taking specific examples and drawing conclusions from them. This will be done in a following article. It is necessary, however, to first thoroughly understand the procedure in setting up the Cleveland automatic screw machine. Most of the work consists in adjusting cams, dogs and slides, etc., thus eliminating practically all calculations. To a large extent, it is simply a matter of adjusting the cams on the cross-slide drum, as well as the cams controlling the variable tool feed and the stock feed. This can be done much more easily on the machine than it can on paper because no cam cutting is necessary. Reference to Fig. 4, which shows diagrammatically the various members of the machine that require adjustment, will illustrate the points just mentioned. In the following, the method of setting up a Cleveland automatic will be treated in the order in which this work can be most satisfactorily handled.

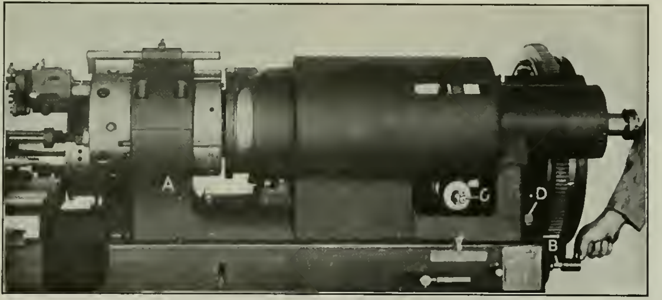


Fig. 2. The Turret Head is adjustable along the Bed to accommodate Various Lengths of Work and Tools held in the Turret

Changing the Chuck and Feed-shell

Assuming, for the sake of simplicity, that the machine has been torn down, that is, that all the tools and other equipment that has been used on previous jobs have been removed, the first step is to insert the chuck. This is being accomplished in Fig. 1. The hood on the nose of the spindle is first removed by a spanner wrench, and the chuck is then inserted, care being taken to remove all chips and heavy oil, which would retard its action. When the chuck is of the pad type, it is only necessary, of course, to remove the pads and replace them by those suited to the size of the stock that is to be handled. After putting the chuck in place, the feed-tube is then taken out and the desired size of shell or pads inserted. After putting the chuck and feed-tube in place, the chuck is then closed by hand and the cross-slide tools are placed in their approximate positions, allowing about 1/8 inch clearance between the front face of the chuck and the inner face of the cutting-off or forming tools.

Adjusting the Turret Head

Following the insertion of the chuck and feed-shell, the next move is to adjust the turret head *A* along the bed to accommodate the length of work to be turned. The operator is shown making this adjustment in Fig. 2 by means of the screw *B*. The turret should be advanced to full stroke, that is, to its extreme forward position, by means of shaft *C* operated by the same crank handle that adjusts screw *B*, and the turret tool having the greatest body length should be used in determining the position of the turret head on the bed. In making this adjustment, the clamping screws which fasten the turret head to the bed should be relieved; one of these screws is shown at *D* and the other is at the front end of the turret head underneath the bed. These should be securely tightened when the turret head is in the desired position.

Setting the Turret Tools

Turning our attention now to the turret, the first tool to be set is the gage stop. This is used for gaging the stock to the correct length and should be set in relation to the cut-off tool. The proper procedure is to measure from the outside face of the cut-off tool to the front face of the gage stop, when the turret *E*, Fig. 4, is advanced to its extreme forward position. All the other tools are then placed in the turret in their proper holes. In setting the turret tools, the exact length required for the job is secured by measuring from the face of the gage stop to the cutting tool, or

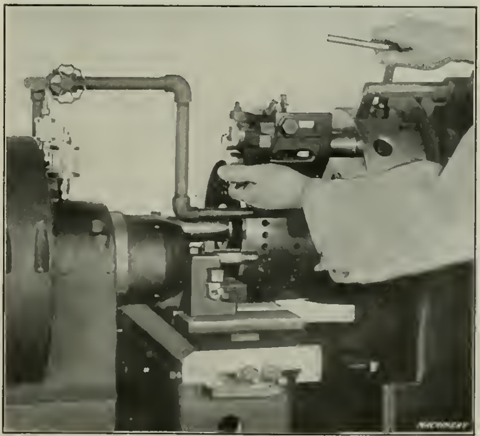


Fig. 3. The Operator locates the Box-tool in the Turret in an approximately Correct Position before tightening the Bolts

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[*] For previous articles on Cleveland automatic screw machine practice, see "Screw Machine Tool Equipment and Attachments," September, 1914; "Screw Machine Tool Equipment," 1 and 2, July and August, 1914; and articles referred to.

[†] Associate Editor of MACHINERY.

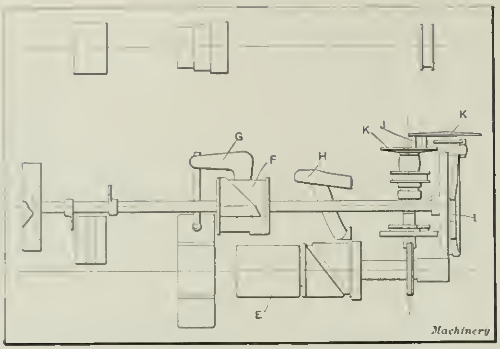


Fig. 4. Setting up the Cleveland Automatic consists principally in shifting Adjustable Cams, setting Dogs, etc.

from the outer face of the cut-off tool to the front edge of the cutting tool, with the turret advanced to its extreme forward position, as before. Fig. 3 shows an operator in the act of setting a box-tool. He first places the box-tool in the turret with the body in its correct relative position to the other tools for clearance; then he sets it lengthwise by means of a scale, as previously described, after which he tightens the clamping bolts which bear upon the shank of the tool. No attention is given to the final setting of the cutters in the box-tool until all the tools have been set in their proper relative positions.

Adjusting Cross-slide Operating Cams

The cams for operating the cross-slide are of curved segment form and are held on a drum *F* shown in Fig. 5. The procedure in setting these cams is to first advance the turret *E* to its full outward stroke and then bring the cross-slide by hand to the approximate position that the forming tool will occupy when it has finished taking a cut. The bellcrank lever *G* is then moved until the roll touches the flange of the cam drum, and a mark is made with a lead pencil, indicating the position of the roll on the surface of the drum. Then the machine is operated again by hand, rotating the drum about one-half turn, and the high point of the forming cam *H* is placed so that it coincides with the circumference of the circle previously outlined. The cam for operating the cut-off tool is located in the same manner, and is generally the last to be set.

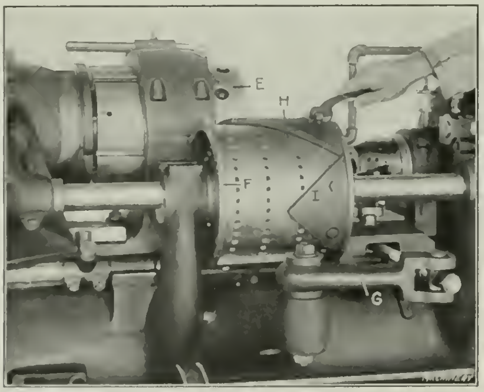


Fig. 5. The Cams on the Cross-slide Operating Drum are moved around into the Desired Position and then clamped by Cap-screws

The relief cams *I* (only one of which is shown) that draw the cross-slide to a central position after the forming and cut-off tools have finished their operations, are next adjusted. The cap-screws fastening these cams to the drum *F* are released, and the cams are shifted around so that the high points contact with the roll and hold the slide in the central position, after which the cams are clamped to the drum.

Fig. 6 shows the method of adjusting the cross-slide connecting-rod which controls the exact position of the cross-slide as required by the movement of the forming and cutting-off tools. Two adjusting nuts provided with individual locking-nuts are on this connecting-rod and these are adjusted back and forth in relation to the central pin in the bellcrank lever *G* in order to carry the slide to its exact position. After making this adjustment of the cross-slide, the machine should be turned one complete cycle by hand to insure the operator that each tool has been properly placed.

Making the Speed Changes

The next point that requires attention is the correct spindle speed to use. This, of course, is governed largely by the material that is to be operated upon, and to some extent by the tools that are to perform the operations. Fig. 7 illustrates the method of adjusting the belt-shifter dogs to obtain the different spindle speeds required to suit the tools that have just been placed in position. The operation of these belt-shifter dogs was clearly illustrated and described in a previous article. When a job is to be threaded with a spring or button die, or a tap is to be used, it is necessary to set these reversing dogs to reverse the spindle exactly at the time when the turret is at the full forward position. In

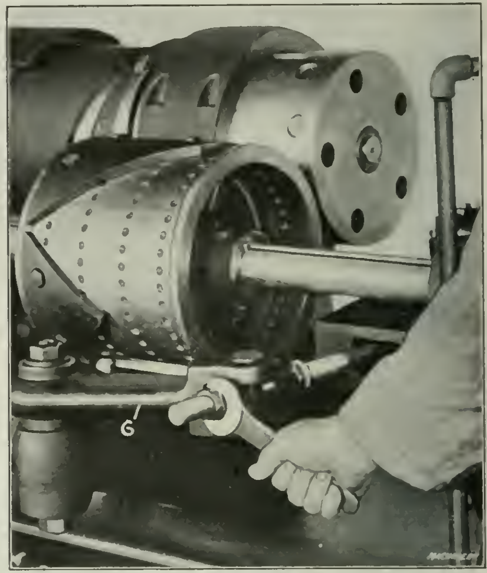


Fig. 6. The Adjusting Nuts on the Connecting-rod are for the Accurate Setting of the Cross-slide Tools

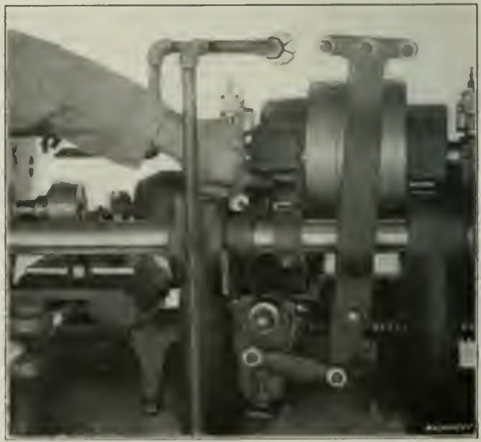


Fig. 7. Speed and Direction of Rotation of the Spindle is secured by adjusting the Belt-shifter Dogs

order to make this adjustment without danger of injuring the tap or die, the bar stock should be removed from the spindle, the turret advanced by hand to the extreme forward position and the belt-shifter dog set to reverse the spindle at this point; then the turret is backed up by hand and the power feed is thrown in, care being taken to observe whether the spindle reverses just as the turret starts on its backward motion. If the spindle reverses a little too soon or a little too late, the belt-shifter dog is adjusted slightly to correct the time of reverse. When it is seen that the spindle reverses exactly at the moment the turret starts on its backward stroke, the adjustment is correct, and the bar stock may then be replaced in the machine and the threading will operate correctly. No adjustment of this kind is necessary when self-opening dies or collapsing taps are used, as when the thread is finished the chasers clear the work and it is not necessary to reverse the spindle. There are several different combinations and arrangements of spindle drives possible on the Cleveland automatics, but these have all been described in a previous article.

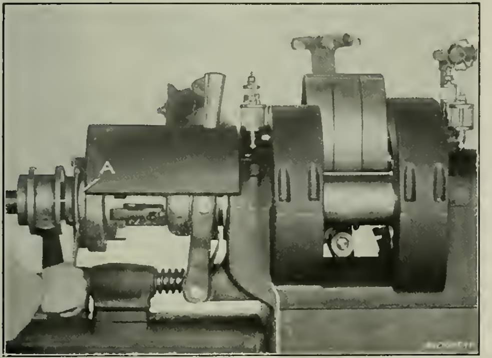


Fig. 8. The Grip of the Chuck on the Bar is governed by adjusting the Compression Collar Nut

Making Chucking and Feeding Adjustments

Assuming now that the tools have been set in approximately correct positions, the next step is to place the bar of stock in the spindle of the machine and adjust the chuck to its proper grip on the work. This is accomplished by means of an adjusting nut *A* shown in Fig. 8, which is located at the rear end of the spindle. In this illustration, the operator is shown turning the adjusting nut with the spanner wrench. Before adjusting this nut, it is necessary to release the binding nut *B* until compression nut *A* is released. Adjusting nut *A* is operated until the chuck has sufficient grip on the work to prevent it from being shifted by the action of the turning tools. When it is desired to tighten the grip of the chuck, the adjusting nut *A* is turned toward the right; turning it toward the left loosens the grip of the chuck. This direction is taken with the operator facing the spindle and standing at the front of the machine. When the correct adjustment of the chuck on the work is obtained, the binding nut *B* is tightened to lock the adjusting nut in position.

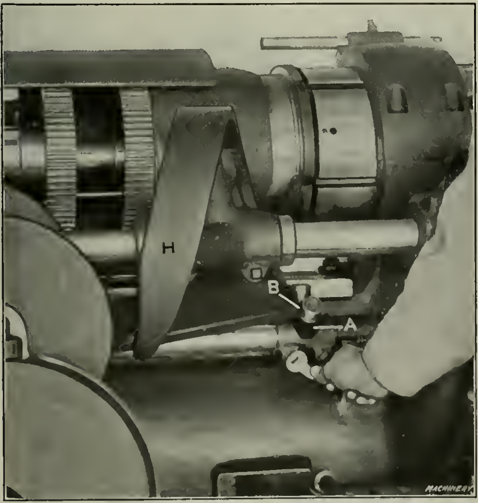


Fig. 9. The Stock Feeding Mechanism should be set to give a Greater Length of Feed than that actually required

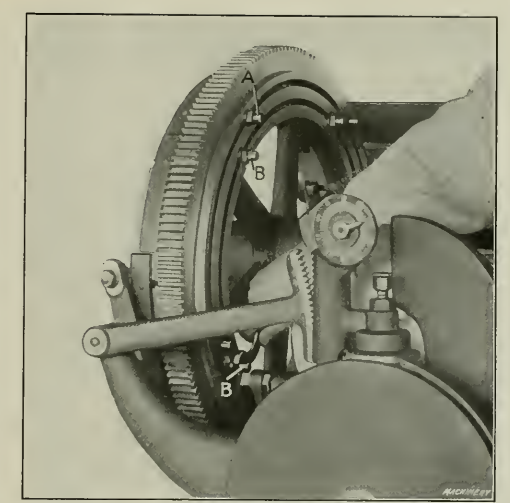


Fig. 10. Feed and Fast Idle Movements of the Tools are obtained by Shifter Pins which are Adjustable on the Regulating Drum

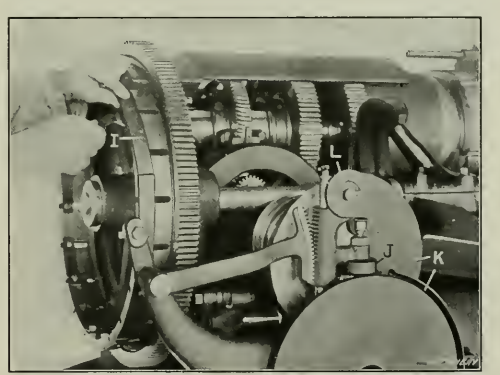


Fig. 11. A Wide Variation of Feed for the Turret and Cross-slide Tools is secured by Regulating Drum Segment Cams. These can be adjusted while the Machine is in Operation

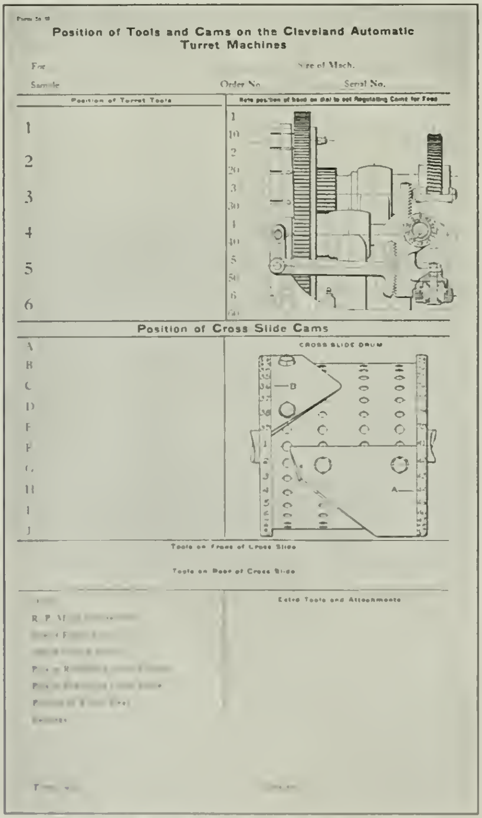
The next step is to set the stock-feeding mechanism so that the bar will be fed out to the correct distance. Fig. 9 shows the method of making this adjustment, which is secured by shifting the position of the stock feed-rod head *A* along the shaft so that cam *H* will engage with the roll *B* at a point that will feed the stock out to the desired length. The last 1/4-inch movement of the stock feed-rod should take place after the chuck is opened. This will give time for the spring chuck to open fully before the stock starts to feed to the gage stop. The stock feeding mechanism should be set to feed about 1/2 inch more than the job requires, and the gage stop in the turret will force the stock back to the desired length just as the chuck is closing on the bar.

Setting the Feed Shifting Pins

The feed on the Cleveland automatic is changed from the slow to the fast speed through a sliding clutch. This is secured by means of shifter pins *A* and *B* which are held in

T-slots in the rear face of the regulating drum, as shown in Fig. 10. In setting these feed shifter pins, each tool in the turret is advanced by hand, that is to say, the turret is advanced so that each tool is brought to within about 1/32 inch of where it should start to cut. Then the feed shifter pin *B* is moved around in the T-slot of the regulating drum and set to shift the clutch to the slow speed at this point. In the case of a tap or die, the tool should be brought to a position 1/4 inch from the face of the work. The feed shifter pins *A* in the outer T-slot of the regulating drum control the fast or idle movements of the machine, and should be set to shift the clutch into the fast speed at the completion of each tooling cut, whereas the pins *B* in the inner T-slot control the shifting of the clutch to the slow speed and are set to move the clutch at the point previously described.

One of the many important features of the Cleveland automatic is the regulating drum, which is used for securing separate feeds for each tool in the turret and on the cross-slide, the feed per revolution of the spindle being controlled by segment cams which can be adjusted while the machine is in operation. Fig. 11 shows the operator setting or adjusting the feed regulating cams *I*. These cams are attached to the flange of the regulating drum by means of two cap-screws. The flange of the drum is slotted to allow adjustment of the cams. By shifting the position of the cams, any desired feed can be secured for each individual tool. Moving them toward the outer edges decreases the feed, and in the opposite direction increases the feed. The edges of cams *I*, through the medium of a bellcrank lever, guide the position of roll *J* automatically up and down between the friction disks *K* which drive the turret drum and cam-shaft. This makes it possible to increase or decrease the tool feed as required, to suit the material being cut and the type of tools performing the operations.



Position of Tools and Cams on the Cleveland Automatic Turret Machines

For
Size of Mach.
Sample
Order No.
Serial No.

Position of Turret Tools

Note position of head on dial to set Regulating Cams for Feed

1
2
3
4
5
6

Position of Cross Slide Cams

A
B
C
D
E
F
G
H
I
J

Tools on Front of Cross Slide

Tools on Rear of Cross Slide

R. P. M.

Extra Tools and Attachments

1
10
2
20
3
30
4
40
5
50
6
60
CROSS SLIDE DRUM
B
A

Fig. 12. After a Job has once been set up, a Complete Record is made on this Sheet

The position of the pointer on indicator *L* determines the location of the feed regulating cams when setting up a job for the second time. The indicator is held on an arm moving up and down on a post; this arm receives its motion from the bellcrank lever which, in turn, is operated by the cams on the regulating drum. The position of the pointer is recorded on a record sheet shown in Fig. 12, which should be filled out before changing to other work and used as a guide for the operator when setting up the same job again. This record sheet shows the position of all adjustable cams (see Fig. 4) and gives all the necessary tooling data.

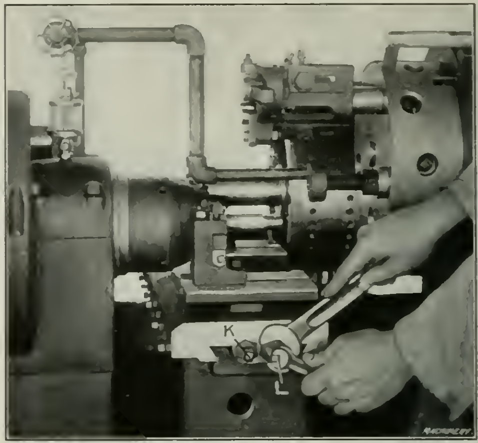


Fig. 13. Accurate Forming is secured by adjusting the Cross-slide Stop-screws

The positive stops for the front and rear of the cross-slide make extreme accuracy easily obtainable. In Fig. 13 the operator is adjusting the stop *L* which controls the tools held on the front of the cross-slide, and the rear tools are adjusted by stop *K*. These stops are in the center of the slide and control the exact position of the tools. The method of setting up outlined is that followed by expert operators of the Cleveland Automatic Machine Co. and is considered the most efficient practice.

* * *

PULLING POWER OF BELTS

Some time ago an item appeared in MACHINERY calling attention to the fact that the pulling power of belts may vary with weather conditions as much as 50 per cent, being less in damp weather. This statement was challenged in a later number, but, as a matter of fact, it may be stated on good authority to be true. In carrying out some tests with a drill press, an engineer once found it impossible to obtain uniform results owing to different belt tensions. In one case, for example, using a driving pulley about sixteen inches diameter with a vertical belt to a counter pulley of about the same diameter, with an oak-tanned belt, considerably used, the results indicated that at one time the driving power of the belt was not more than two-thirds of what it was at another time; in fact, in one instance, it was only one-half. In view of the result of this experiment, where the relative power delivered could be accurately determined, there seems to be no doubt about the statement as to the pulling power varying with the weather conditions. With chrome-tanned leather belts, the losses are much less than with oak-tanned belts. Another curious result found from these tests was that a new oak-tanned belt would pull only about 50 per cent of what an old belt would. Moreover, planer operators know that there is considerable trouble with planer belts, owing to weather conditions, as planers will not reverse as rapidly in damp weather as when the atmosphere is dry.

* * *

The locks of the Kaiser Wilhelm Canal in Germany, which is playing an important part in the naval strategy of the present war, are the largest in the world, being 72 feet longer and 38 feet wider than the locks of the Panama Canal.

EDGE RADIUS OF DRAWING DIES

BY FRITZ SPARKUHL*

C. H. Rowe of Milwaukee, Wis., contributed to MACHINERY for April, 1911, diagrams showing different edges of sheet metal drawing dies and invited a discussion of the method of determining their proportions. In reply, I offer the following formula for determining this edge radius, although the wide variation in the uniformity of the metal, its smoothness and ductility, and also the surface condition of the dies, the drawing velocity, the pressure of the blank-holder, etc., prohibit the guarantee of an accurate result. But the formula at least gives the means of ascertaining the smallest allowable edge radius, beyond which it is not advisable to go.

In Fig. 1 is illustrated the edge of a first-operation die with metal flowing around it, r being the radius and t the thickness of the metal. The length of outside fiber AB is:

$$L_1 = \frac{a}{360} \times 2\pi(r + t).$$

The length of the inside fiber CD is:

$$L_2 = \frac{a}{360} \times 2\pi r.$$

The length of the neutral fiber EF is:

$$L_n = \frac{a}{360} \times 2\pi \left(r + \frac{t}{2}\right)$$

Before passing over the drawing edge (that is with the blank in a flat condition) the length of these three fibers was:

$$L = \frac{a}{360} \times 2\pi \left(r + \frac{t}{2}\right)$$

This shows that the fiber AB is subject to tension, that CD is subject to compression, and that EF as the neutral fiber remains unchanged. The difference $L_1 - L_2$ gives us the total displacement C of the metal as:

$$C = \frac{a}{360} \times 2\pi(r + t - r) = \frac{a}{360} \times 2\pi t.$$

As the angle is 90 degrees we have:

$$C = \frac{90}{360} \times 2\pi t = 1.57t.$$

In Fig. 2 are shown the edges of a redrawing die with an angle of 45 degrees. Considering the first edge, we see that the fibers have an original length:

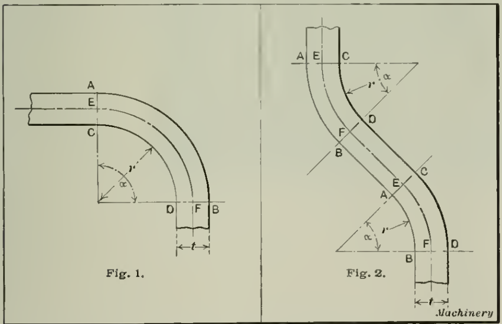


Fig. 1. Fig. 2.

Figs. 1 and 2. Diagrams showing Edges of a First-operation Die and a Redrawing Die

$$L = \frac{a}{360} \times 2\pi \left(r + \frac{t}{2}\right)$$

After the first drawing operation, the length of the outside fibers AB is:

$$L_1 = \frac{a}{360} \times 2\pi(r + t).$$

Similarly, the length of the inside fiber CD is:

$$L_2 = \frac{a}{360} \times 2\pi r.$$

In passing to the next drawing edge, the fibers AB will be compressed and the fibers CD elongated, while the fibers EF remain the same in both cases. Both angles equal 45 degrees; therefore, the compression *versus* tension condition is neutralized and no displacement of the metal has taken place after it has passed over the second edge. The local displacement will be:

$$C = \frac{a}{360} \times 2\pi(r + t - r) = \frac{a}{360} \times 2\pi t.$$

With $a = 45$ degrees, we have:

$$C = \frac{45}{360} \times 2\pi t = 0.785t.$$

We see that the severest test of the metal to be drawn occurs in the first operation with a displacement which amounts to $C = 1.57t$. The specific elongation is:

$$E = \frac{\frac{a}{360} \times 2\pi\,(r + t) - \frac{a}{360} \times 2\pi \left(r + \frac{t}{2}\right)}{\frac{a}{360} \times 2\pi \left(r + \frac{t}{2}\right)}.$$

The preceding equation is readily simplified to the form:

$$E = \frac{t}{2r + t}.$$

Solving this equation for the value of r we get:

$$r = t\left(\frac{1 - E}{2E}\right)$$

For tin plate E has a value of from 10 to 20 per cent, and using one or the other of these values we get:

$$r = t\left(\frac{1 - 0.1}{2 \times 0.1}\right) = 4.5t$$

$$r = t\left(\frac{1 - 0.2}{2 \times 0.2}\right) = 2t$$

The value obtained with this formula is too close to the breaking point; therefore, we make $E = 5$ to 7 per cent, and with this safe assumption we find that r has a value of $6.6t$ to $9.5t$. This result shows that the tentative rule $r = 6t$ should be perfectly safe, although it may be advisable to raise this value to $r = 10t$, thus avoiding danger of tearing, as the metal is not always uniform. Another vital point in laying out dimensions for drawing dies is to provide the proper clearance between punch and die. The least possible clearance between these two members is evidently twice the thickness of the metal.

Let d_1 = diameter of drawing die;
d_2 = diameter of drawing punch;
d_3 = diameter of redrawing die;
d_4 = diameter of redrawing punch;
t = thickness of metal.

Expressed mathematically, using the preceding symbols, we have:

$$d_1 = d_2 + 2t \qquad (1)$$

$$d_3 = d_4 + 2t \qquad (2)$$

But experiments have proved that the thickness of the metal increases from 10 to 20 per cent during the drawing process, and therefore an additional clearance has to be allowed, thus changing Formulas (1) and (2) to

$$d_1 = d_2 + 2(1.1 \text{ to } 1.2)t \qquad (3)$$

$$d_3 = d_4 + 2(1.1 \text{ to } 1.2)t \qquad (4)$$

A third factor to be considered is the friction between the punch and the metal, and the die and the metal. It is good practice to allow another additional clearance of $0.2t$ to $0.4t$, thus bringing Formulas (3) and (4) to their final forms as:

$$d_1 = d_2 + 2(1.1 \text{ to } 1.2)t + 2(0.2 \text{ to } 0.4)t = d_2 + 2.6t \text{ to } 3.2t \qquad (5)$$

$$d_3 = d_4 + 2(1.1 \text{ to } 1.2)t + 2(0.2 \text{ to } 0.4)t = d_4 + 2.6t \text{ to } 3.2t \qquad (6)$$

It is not advisable to go below these values, as the friction with its constant wear would affect the life of the tools and also necessitate an unnecessary increase of the operating power. On the other hand, if too much clearance is given, the shell will come out more of a conical than a cylindrical shape, full of wrinkles which cannot be "ironed" out by the redrawing dies, as is well known by every mechanic who has to do with this class of work. It is obvious that to produce satisfactory results, all parts of the dies that come in contact with the metal have to be in a perfectly smooth and well lubricated condition.

* * *

Little things are great to little men.

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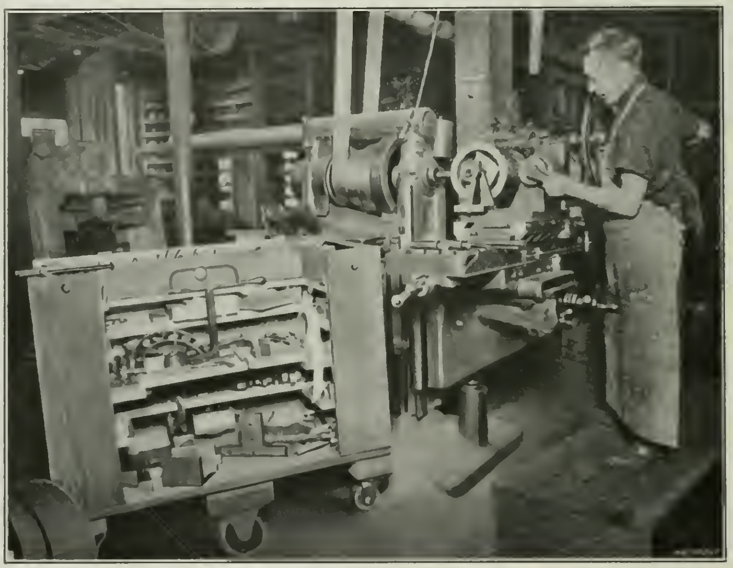
* Address: 212 Weequahic Ave., Newark, N. J.

LABOR-SAVING METHOD OF SETTING UP WORK

The American Machine & Foundry Co., 346 Carroll St., Brooklyn, N. Y., builds a great variety of high-grade special machinery. As there are not a great number of parts to be made at a time, different tools have to be set up on the machines at frequent intervals, and in order to dispense with the use of high-priced labor, as far as possible, a somewhat unusual method of procedure has been adopted. When the order and blueprints for any given job come to the foreman of the department in which the work is to be done, they give the required information in regard to the tools to be used. Instead of having the man who is to do the actual work go to the storeroom and get the required jigs, tools, etc., for handling the operation, special men styled "set-up men" bring out the necessary equipment and set it up on the machine ready for the use of less experienced employes who operate the machine to produce the required number of pieces. After the set-up man has made the machine ready for use, he makes the first piece of the series, and this piece is then sent to the inspection department where it is carefully gone over to see that it meets all requirements of accuracy, finish, etc. When this first piece has been found satisfactory, the tools on the machine can be depended upon to produce the remainder of the pieces within the required limits of accuracy, and the set-up man then O. K.'s the machine and turns it over to the foreman, who, in turn, assigns any man that may be out of work to operate it.



Set-up Man preparing a Machine for milling Barrel Cams—Note Portable Tool Cabinet and Fixture on Machine

After the operator has finished his work he removes none of the tools, but leaves the machine in exactly the same condition that he found it. The set-up man then goes back and removes the equipment and returns it to the storeroom. The set-up man is a storeroom employe and is held responsible for the tools which he takes out. In setting up a machine for any given operation, he makes a list of all the tools that are required and leaves it at the machine, so that the foreman and operator have a record of the tools which have been put out for their use. The set-up man keeps a carbon copy of this list in the storeroom, which he uses to check up the equipment when he tears down the machine. This method requires the use of a considerably higher number of machines than would otherwise be necessary, but experience has shown that the saving which is made possible through the use of cheaper labor pays very satisfactory dividends on the investment in additional equipment.

An apparently trivial feature in the application of this method, but one which really plays an important part in the efficient operation of the plant, consists of having an unusually large number of assistant foremen for the number of men employed in each department. This is made necessary by the fact that a great variety of work is constantly being handled, and as a result the inexperienced operators require quite a lot of instruction. During periods when the factory is not very busy the assistant foremen become set-up men and set-up men, in turn, are put to work as machine operators. If it is necessary to let any men go, the inexperienced machine operators who can easily be replaced are laid off. The valuable feature of this plan is that it keeps the set-up men and the assistant foremen closely in touch with the actual routine of producing the work, so that they are at all times in a position to give the best possible service in setting up the machines or instructing the operators in the best way to run them.

Each set-up man is provided with a cabinet mounted on a truck, which contains all the necessary tools, bolts, gages, etc., for use in setting up the classes of work handled in his department. The accompanying illustration shows a set-up man engaged in preparing a milling machine for cutting barrel cams. The arrangement of the tool cabinet will be readily understood from the illustration, and it may be mentioned that each cabinet is provided with a hinged cover which is locked in place every night to prevent the theft of tools. The fixture shown on the milling machine will doubtless prove interesting to some readers. It consists of a transformer which is used for milling a left-hand barrel cam from a right-hand master cam of the same form. In certain machines built by the American Machine & Foundry Co., both right- and left-hand cams of this type are required, and the use of this fixture does away with the necessity of making two master cams. The fixture itself is very simple. It consists of an arbor on which the master cam is mounted, this cam controlling the movement of the cam which is to be cut, in the usual way. In order to get a left-hand spiral in the cam which is being cut from the right-hand spiral in the master cam, the arbors on which the work and the master cam are mounted are connected by two pairs of worm-gears, one of which is right-hand and the other left-hand, the gears being similar in other respects. In this way the necessary transformation of the spiral from right-hand to left-hand is secured.

To facilitate the rapidity with which tools can be set up on the tables of milling machines, etc., a tool known as a T-plate has been developed and found to give very satisfactory results. One of these plates, which is somewhat similar to a small thick T-square, will be seen on the lower shelf of the cabinet. It is arranged with a slot in both the leg and cross bar, into which a guide strip can be secured by means of screws. This guide strip fits into one of the T-slots in the table of the machine. When held in this position, the T-plate is very convenient for either setting a fixture parallel to the table or squaring it up with the table, according to the requirements of individual cases.

The machines built by this company are principally of the type controlled by automatic mechanisms which enable cheap classes of labor to be employed to run them. A noteworthy point is the wide application of different forms of cams. In certain of the machines, plate cams, edge cams and barrel cams are employed. Rarely, if ever, have all of these three forms of cams been employed in a single train of mechanism.

E. K. H.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

PRECISION METHOD OF MEASURING ANGLES

We had to make several hundred of the parts shown at *A* in Fig. 1. The first one completed was brought, in compliance with the rule, to the inspector, who inserted two disks in the slot, and measured the distance between their centers. This method, entirely suitable for one piece, was manifestly much too slow to use where a large number had to be inspected, and some curiosity as to the means that would be adopted arose in the minds of the inspector's neighbors. In his battered old chest he was known to have a fine and valuable collection of tools, from which he had often drawn some previously unknown to his shopmates, especially convenient for some job on hand, and reputed to be of his own design and construction.

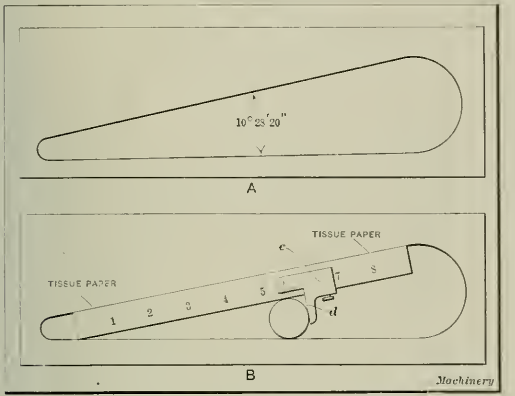


Fig. 1. (A) Work having Angular Slot. (B) Method of accurately testing Angle

In the present instance he produced from its depths a steel scale graduated in hundredths, a 1-inch disk from his micrometer case, and the attachment *c* shown applied to the scale at *B*.

This remotely resembled the attachment on the familiar Brown & Sharpe hook-rule, and, like it, was clamped to the scale by a split taper bolt. The zero mark is 0.500 inch from the side *d* against which the disk rests, and to the right of the zero are lines 0.009 inch apart. By this vernier and the 0.010-inch divisions on the scale, the setting of the disk can be made to 0.001 inch. Setting it at 5.456 inches he had a protractor of even greater accuracy than the work demanded, with which, aided by strips of tissue paper, the inspection was easily and rapidly completed by simply placing the protractor inside the angular opening as the illustration indicates.

All that is necessary in order to determine the setting for any angle within the range of this protractor is to find half the cotangent of half the desired angle. For instance, if the angle is 8 degrees, we set the zero of the attachment 7.150 inches from the end of the scale, as this dimension equals half the cotangent of 4 degrees. As the attachment can be used on a scale of any length, it is convenient in many places where a vernier protractor cannot be employed. As to its accuracy, if it were set 0.001 inch wrong—which is inconceivable—the angle would not, it is true, be 10° 28′ 20″, but the error would be less than eight seconds. In making the attachment, the vernier graduation was etched, the tool having first received a coating of asphaltum varnish, through which the lines were scratched with a height gage.

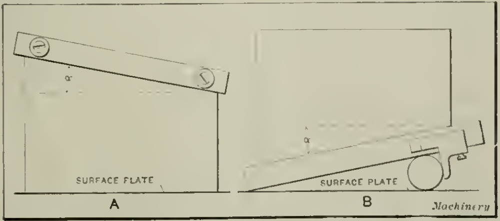


Fig. 2. (A) Testing Angle by Means of Sine-bar. (B) Quicker Method of testing Same Piece

Another kind of work for which this form of protractor is convenient is illustrated in Fig. 2. The pieces shown are to have the angle α inspected. Hundreds had been inspected by the method shown at *A*, which involves, for every piece, clamping first the work and then the sine-bar, and then, with a height gage, measuring to the top of each button of the sine-bar. When using the protractor (see sketch *B*) it is clamped in place once for all and each piece, in turn, is clamped over it, and the indicator is used (no height gage or actual measurement is required) to test the parallelism of the top of the work with the surface plate. The saving of time equals nearly two-thirds that necessary when using the sine-bar.

New London, N. H. GUY H. GARDNER

DESIGN AND CONSTRUCTION OF ELLIPTICAL GEAR PATTERNS

While much has been written upon the design of elliptical gearing, most of the methods require the use of so much mathematics that the average mechanic lacks the courage to apply the rules to actual practice, and for this reason one of the very best and cheapest of all quick-return motions for shapers, presses and punching machines has never come into popular use. It is the intention of the writer to show that little, if any, mathematical treatment is required when the gears are to be cast from patterns, and that the making of these patterns is a very simple matter which may be done by any patternmaker with the tools ordinarily found in the pattern shop.

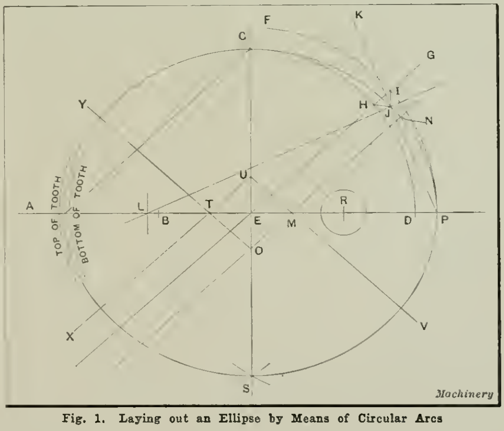


Fig. 1. Laying out an Ellipse by Means of Circular Arcs

It may be well to first define the three principal terms peculiar to an elliptical gear. They are as follows:

The major axis of the gear is its longest pitch diameter.

The minor axis of the gear is its shortest pitch diameter.

The focus is the point within the gear about which it revolves.

Referring to Fig. 1, the major axis *AP* is equal to the distance between the centers of the shafts on which the gears are to run. The hub of the gear is placed at one of the foci *B* of the ellipse. The positions of the foci *B* and *R* are determined by the ratio of quick return desired; that is, the foci points *B* and *R* should be so placed that the distance *PR* is in the same ratio to *AR* as the given quick-return motion desired in the gearing. For example, in a gear the major axis of which is 8 inches a given quick-return motion of 1 to 3 is desired; then *PR* would equal 2 inches and *AR* would equal 6 inches, because 2 : 6 = 1 : 3.

Having determined the major axis and foci of an elliptical gear, the length of the minor axis may now be found by using one of the foci *B* or *R* as a center, and, with a radius equal to one-half the major axis, cutting the line of the minor axis at *C* and *S*. When the minor axis has been found, proceed as follows to construct the ellipse: With the point *E*, where the major and minor axes intersect, as a center and a radius equal to *EC* draw arc *CD*; then with *EP* as a radius draw arc *PF*. Now draw a line *AC* as shown, and through *E* draw a line *EG* parallel to *AC*.

From the intersection of the line *EG* with the arcs *CD* and *PF* as shown at points *H* and *I* draw lines parallel to the axes of the ellipse which will intersect at point *J*. Draw line *PK* through *J*, and at *J* erect a perpendicular to line *PK*, intersecting the major axis at *L*. Next bisect *LP*, thus obtaining point *M*. Through *M* draw a line *MN* parallel to *AC*, intersecting the minor axis at *O*; lay off *ET* and *EU* equal to *EM* and *EO*, respectively, and draw *UMV*, *UTX* and *OTY*. Now, using *M* as a center and a radius equal to *MP* draw arc *NPV*. Then from center *U*, with a radius equal to *US*, draw arc *VSX*. From center *T*, with a radius equal to *TA*, draw arc *XAY*, and from center *O*, with a radius equal to *OC*, draw arc *YCN*. It will be found, if the work has been carefully done, that all the arcs match, giving a true ellipse.

Having obtained the pitch line of the gear in the manner described, the completion of the pattern by the forming of the teeth must next be considered. The following method has been selected because of its simplicity and the fact that no special jigs or tools are necessary in making the master pattern. The pitch of the tooth must first be decided. In the case just considered 8 diametral pitch was selected. The distance of the top and bottom of the tooth from the pitch line is now laid off on the drawing and shown by arcs drawn parallel to the pitch line from the centers *M*, *O*, *T* and *U*. The line of the top and bottom of the tooth being drawn as directed, the teeth may now be spaced off on the pitch circle. The simplest method for doing this is to use the dividers, which should be set at one-fourth the circular pitch of the tooth. This may be obtained by dividing 3.1416 by four times the diametral pitch of the gear. For example if the diametral pitch is 8, then $\frac{3.1416}{8 \times 4}$ equals one-fourth of the circular pitch. This distance being found, set the dividers to it and follow the outline of the pitch circle very carefully, marking every fourth step.

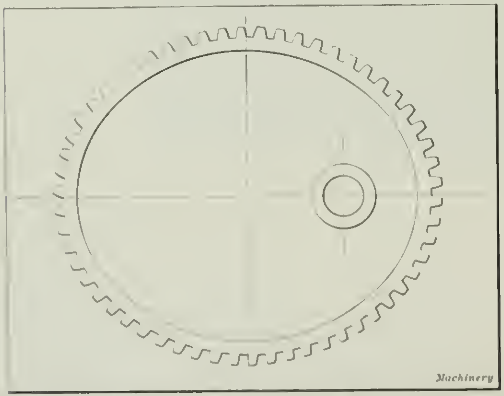


Fig. 2. Relative Position of Teeth and Axes in an Elliptical Gear with Even Number of Teeth

By using steps of one-fourth the circular pitch as recommended, the pitch line may be more closely followed and at the same time the width of the tooth and space, as well as their center lines, will be obtained. It is now a simple matter with a radius of suitable length to lay out the teeth which should be made with a simple curve, the same as commonly used on plain cast gears. This curve may be closely approximated by using a radius equal to one-fourth of *OC*.

If it is found after spacing the teeth that their number is even, the teeth must be located with relation to the major axis as shown in Fig. 2, but if the number of teeth be odd, then the major axis must bisect a space and a tooth as shown in Fig. 3. This is necessary in order that the two gears shall mesh. It is evident that when the teeth are spaced by dividers, the spacing will not generally come out exact at the first trial. The spacing must then be increased or decreased slightly until the perimeter of the ellipse is found to be evenly divided.

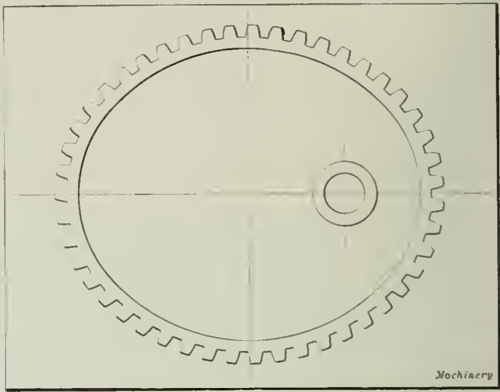


Fig. 3. Relative Position of Teeth and Axes when Number of Teeth is Odd

It would, of course, be possible to obtain the approximate length of the perimeter by one of the empirical formulas found in handbooks for this purpose, and to find the number of teeth by dividing the circular pitch into the length of the perimeter; but as the result thus obtained would still only be approximate, trial spacing with dividers would still be necessary, and little would be gained by this procedure. Hence, the method outlined above is more practical than any in which the mathematical treatment is used.

The number and location of the teeth having been determined, it now becomes necessary to form the tooth. This may be done in two ways. If no other means are convenient, the teeth may be cut directly into the pattern by hand, using an ordinary chisel and following the exact outline of the tooth as laid out in the pattern. This method, while entirely practical, is quite slow and tedious, and where possible the following method is recommended. Having found the center line of the teeth on the pitch circle, project it to the base or root circle of the pattern, marking each point distinctly. Now cut away everything above the root circle and finish the pattern carefully to this line. Next, from a straight piece of clear grained hard wood cut a rack on an ordinary gear-cutting machine. This rack should have at least as many teeth of the same size and pitch as are required for the elliptical gear. These teeth when finished should be cut free from the rack and fastened to the elliptical gear pattern blank with wire brads and hot glue, spacing them as shown by the points previously projected to the root circle. After the glue has had time to set and the teeth are securely fastened, wax fillets should be put in and the pattern blackened and finished as customary with all master patterns, after which iron patterns should be cast from it.

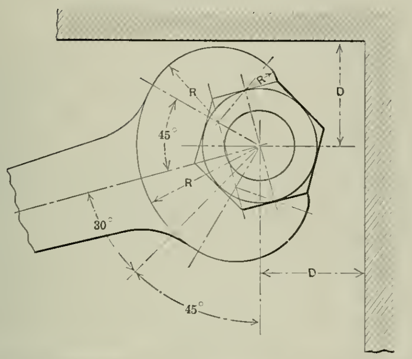
It is advisable before putting too much labor into the iron patterns to prove their accuracy by placing them on gear centers and allowing them to run together. If ordinary care has been used there should be no serious trouble, but if they seem to bind a little at certain points, these may be eased off with a file. On the whole, however, the patterns will be found entirely satisfactory and will give good smooth running gears.

Alfred Brown

WRENCH CLEARANCE TABLE

In looking over the June number of Machinery I noticed a table of clearance dimensions for bolts and wrenches. They agree fairly well with my practice. A table which I find of considerable value is for bolts in a corner. It is there that so many draftsmen place the bolts just as close to the wall as when it is straight away. This means trouble and expense in the shop and bad language when it comes to taking apart and re-assembling the machine. The dimensions given in the table permit of swinging the wrench through an angle of slightly over 60 degrees. For the convenience of determining through what angle a wrench will swing, a method of laying out a wrench for any size nut is shown by the illustration which should be self explanatory to any draftsman.

TABLE OF WRENCH CLEARANCES



Bolt Diameter	Clearance D	Bolt Diameter	Clearance D	Bolt Diameter	Clearance D
1/2	7/8	1 1/4	1 7/8	2 3/4	3 3/4
5/8	1	1 1/2	2 3/16	3	4 1/8
3/4	1 3/16	1 3/4	2 1/2	3 1/4	4 1/4
7/8	1 3/8	2	2 13/16	3 1/2	4 3/4
1	1 1/2	2 1/4	3 1/8	4	5 3/8
1 1/8	1 11/16	2 1/2	3 1/2	..	..

Machinery

J. L. Kay

REAL EFFICIENCY IN MANUFACTURING

At one time it was, no doubt, considered that there was more money in the manufacture of parts of machine tools than of the whole machine, and in days gone by the manufacturer—not only of machine tools, but of any article subject to wear and tear—figured that the greater part of his profit was to be made in supplying repair parts. These parts were purposely made of special size or shape, so that the buyer of the original article would be forced to apply to the maker when it became necessary to make replacements. Furthermore, the manufacturer honestly believed that by making as many of the parts of his machine as possible in his own shop, his total production cost would be kept low. Hence his disinclination to buy any supplies on the outside.

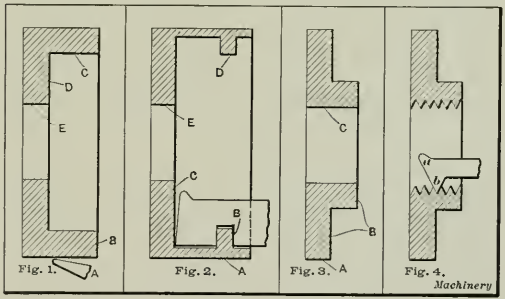
In the case of a well-known piano, the producers made a point of the fact that everything that went into the instrument, even to the smallest screw, was made in their own plant. This was, no doubt, the practice with a great many manufacturers, the idea being to impress upon the buyer their willingness to stand back of every part of their product. However, the advertising of recent years has changed all this, and we now let it be known that into our product goes this part made by Smith or that piece made by Blank & Co., because our customers have been educated by these gentlemen in the same manner as by ourselves, that is, through advertising, and we must accede to the demand that has been created. As one writer aptly says, "real efficiency can only be obtained by taking the best from all sources."

Jersey City, N. J. H. D. Murphy

USING THE REVERSE SPEED

Why not use the reverse speed as well as the forward speed in machining work? While reading the article by Albert A. Dowd in the March number of Machinery entitled, "Design and Construction of Boring Tools," I recalled a number of jobs upon which several operations were performed without requiring the work to be re-set. Different tools would ordinarily have been necessary for these operations. The work referred to was done on a Hendey-Norton 12-inch lathe. The first piece to be machined was a simple casting of the form shown in Fig. 1. To avoid wasting time in changing tools, the following method of procedure was adopted. A plain round-nose tool was used, and the surfaces *A* and *B* were machined with the usual forward motion of the lathe, while the surfaces *C*, *D* and *E* were machined with the lathe running in the reverse direction. The advantage of handling the job in this way was that, in addition to the saving of time, it was possible after once setting the tool for each operation and knowing its position on the cross-feed index, to machine subsequent pieces without having to make frequent measurements to obtain the required size, as would otherwise have been necessary.

The following method was employed in machining the piece shown in Fig. 2. The forming tool was used to machine the surfaces *A*, *B* and *C* with the lathe running in the usual direction. The surfaces *D* and *E* were then finished with the lathe reversed. Figs. 3 and 4 show a job which required the face of the casting and the threaded hole to be perpendicular to each other. The tool shown in Fig. 4 was used, the edge *a* of this tool being employed for turning and facing, while the edge *b* was used for cutting the internal thread. The surfaces *A* and *B* were turned with the lathe running in the usual direction. The hole *C* was bored with the lathe reversed, after which the internal thread was cut as shown in Fig. 4.



Figs. 1 to 4. Examples of Work on which Reverse Speed was used to Advantage

Elgin, Ill. F. R. Dexter

GRINDING AND LAPPING SMALL WORK

All mechanics experienced in fine work will no doubt agree on one point, *viz.*, that the grinding and lapping of the locating holes and pins in all hardened plates is a necessity for accuracy. It is the purpose of this article to present to the readers of Machinery useful information gathered from years of practical experience with this class of work.

The lap shown at *A*, Fig. 1, is used for grinding holes. It is made of drill rod and has a taper shank which fits the grinder spindle. The end should be recessed, as shown, and the lapping portion *a* should be narrow, as it cuts more free and clean than a wide end. Fig. 2 shows a rack-and-pinion device for rolling diamond dust into small laps. This was invented by E. D. Cooke (a designer of fine tools) with whose permission it is used in this article. The lap is charged as follows: Place a very small amount of the diamond dust, mixed with sperm oil, on the lap, place the lap between the two hardened steel pieces *A* and *B*, turn the handle *C* back and forth, thus rolling the diamond powder into the steel lap. The feed-screw *D* should be lowered carefully so as not to bear too tightly on the lap. Test the lap with the finger nail and if it has a gritty feeling it is properly charged. Use coarse diamond for roughing and fine dust for finishing.

Before beginning to grind a hole be sure the lap runs true; an eccentric lap is a slow and poor grinder. Keep all laps sharp, *i. e.*, well charged with diamond dust. After a lap has been used for some time, it is advisable to make a new one, as after continued use the lap becomes too hard to take the diamond readily. Do not try to crowd a lap, for that will spoil it and make a bell-mouthed hole. In order to tell when a lap is cutting use some kind of a "listener." Have the lap enough smaller than the hole to prevent excessive friction. Let the work revolve forward at low speed and the lap backward at high speed.

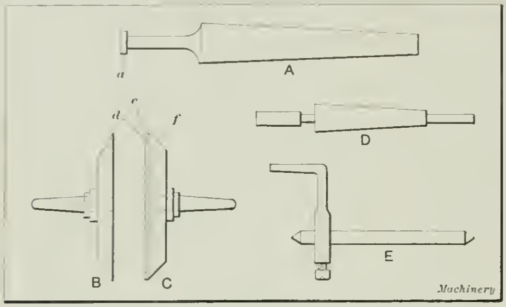


Fig. 1. Different Forms of Laps—Examples of Small Precision Work

When grinding it is well to use an automatic feed. The illustration Fig. 3 shows one of the writer's design that is both simple and effective. It is composed of the following parts: A sheet steel extension *A* to fit the T-slot in the sliderest; a binding screw *B;* a cam *C* attached to a vertical shaft which is rotated through worm-gearing by belt pulley *D;* and a grinder spindle *E*. This feeding mechanism is adjustable in every direction. On large laps use a sponge saturated with oil, and when using inside laps have a tin guard to stop flying oil.

At *B*, Fig. 1, is shown a diamond lap used for grinding V-slots, to make a slot central on round work. When doing work of this kind, grind one side at a time, indexing half way round for each operation.

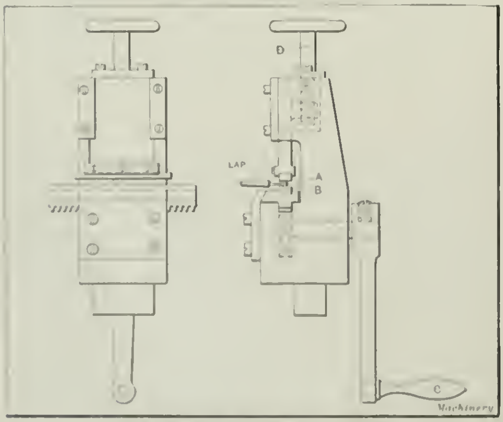


Fig. 2. Machine for charging Circular Laps

At *C* is shown a similar lap with three grinding points *d*, *e* and *f*. When lapping small holes, use a long piece of steel wire with a taper of about 0.0003 inch to one inch, as it will lap rapidly and effectively. When grinding and lapping do not allow loose diamond on the laps, as it will make holes bell-mouthed. For bearing holes, lap with emery. For combination pins where the taper and straight portions must be true with each other, as shown at *D*, Fig. 1, the use of a stop is very helpful. One stop is used for the taper and the other for the straight part.

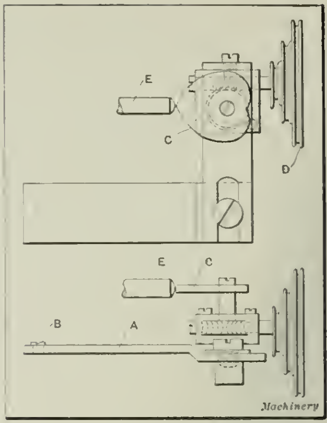


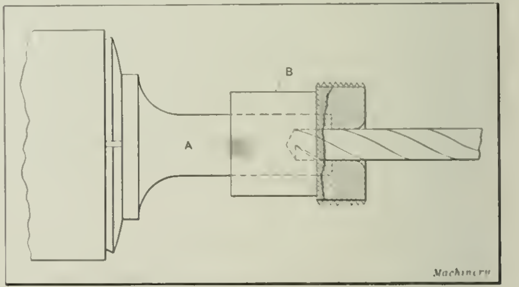
Fig. 3. Automatic Feeding Mechanism for Diamond Lap

When grinding pins on centers, point the ends as shown at *E*, and mount the work between a pair of dead female centers. When regular centers are used, always lap out the holes after hardening to insure their being round. When grinding long slender pins, the work should be steadied in the middle.

Elgin, Ill. Eben Lea

A CENTERING BUSHING

A simple device for centering rough work in the hand turret lathe is that illustrated in the accompanying line engraving. It is only intended for use in manufacturing small lots of work where more complicated methods would be too expensive. The work is indicated at *A*, and assuming that a hole is to be drilled from the end, the drill is started by slipping the centering bushing *B* over the end of the work, either after rough-milling or before. With this bushing in place, the drill may be entered with the surety that it will be in the center of the work even though the piece is not held exactly true in the chuck. After the drill has been started, the slip bushing *B* is removed and the drilling carried on independently. The purpose of the centering bushing is to provide a means for starting a drill in the center of the work, without first having to make the work run exactly true.

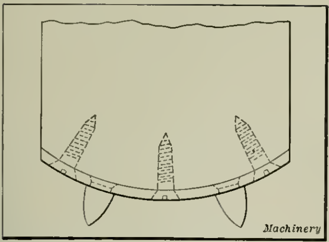


Centering a Drill with Relation to Outside of Work

C. L. L.

SPIKES ON LADDER FEET

An article discussing the subject of spikes on ladder feet was published in the November, 1913, number. This was of considerable interest to the writer, so he took up the problem and after studying it for some time decided to use a different class of spike from those described in the article referred to. The only objection to the type of spikes formerly described, is that they might prove somewhat dan-



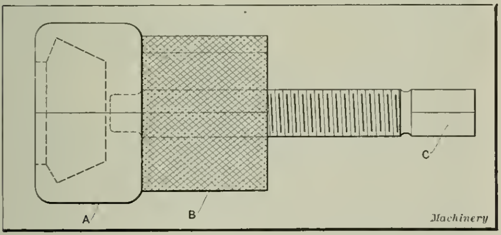
Spikes for Ladder Feet to prevent Ladder from slipping

gerous on account of their length. The probability of letting the ladder down on your foot is not great, although it is quite possible that such a thing may happen, and with long spikes a more or less serious accident would be the probable result. It was on this account that the writer decided to adopt the form of spikes shown in the accompanying illustration. These are only one-half inch long and are made of 3/8 inch round steel riveted into a plate 1 by 1/8 inch in cross-section, which is secured to the foot of the ladder by three screws. The position of these short spikes makes them as effective as longer spikes placed at the center of the foot of the ladder. Experience has shown that a perfectly firm grip on a wooden floor is secured, and yet the spikes project such a short distance that they can scarcely do any serious damage to the man handling the ladder, no matter how careless he may be.

Christchurch, New Zealand **John Peddie**

PULLING SMALL BEVEL GEARS OFF SHAFTS

The accompanying illustration shows a handy device for removing small bevel gears from shafts on which they are a pressed fit. The body *A* of the tool is made in two parts which are recessed to fit over the gear to be removed. The knurled bushing *B* holds the two parts of the body *A* together, and each half of the body is threaded to form a seat for the driving screw *C*. The split body *A* can thus be placed over the gear, after which the bushing *B* is slipped on to hold the two halves of the body together. Then by turning the screw *C* so that its end presses against the end of the shaft, the gear is easily pulled off. The split construction also affords a simple means of allowing the screw *C* to be set to approximately the required position at the same time as the two halves of the body are placed over the gear, thus avoiding loss of time in turning the screw in the nut.



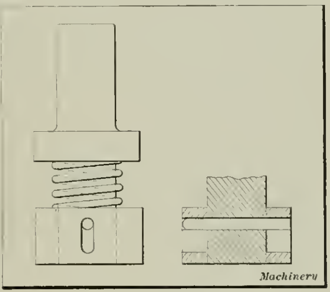
Device for pulling Small Bevel Gears off Shafts

M. W. W.

METHOD OF MAKING SLEEVE-RETAINING PINS

Sleeves similar to the one shown in the accompanying illustration are used in punch press departments for stripping work from the punches, the sleeve being actuated by a suitable spring. When such a sleeve is used on a piercing or sizing punch, a pin is driven into a hole in the punch. An elongated hole is provided in the sleeve, so that the sleeve has the required amount of play in either direction before its movement is checked by the pin. It frequently happens that the ends of these pins are made exactly the same shape, and as the pin is slightly tapered this makes it difficult for the tool setter to know which way the pin must be driven in order to remove it, when it is necessary to take off the sleeve to sharpen the punch. The best way to remove the pin is to place the punch end-wise in a vise, so that the sleeve is pushed up from the pin, thus relieving it of the spring pressure. The pin can then be easily driven out.

The writer has found that a convenient way of overcoming the difficulty in regard to which way to drive out the pin is to make the small end of the pin rounding, this end being left a trifle under the outer surface of the sleeve. The pin is hardened and drawn to a blue color. Its length is such that when the flat end of the pin is driven down flush with the sleeve, the rounded end is just below the surface, as previously mentioned. The pin should be driven in from the end at which the hole was started, as the hole is slightly larger at this end than it is at the end where the drill came through. Where these pins are used, it is a good plan to supply the tool setter with a set of various sizes of hardened pins which he can use to advantage in driving out pins of this kind. The ends of the pin do not become flattened after repeated use, as the pin is hardened to avoid this difficulty. This method of making pins can also be used to advantage in various other classes of work where it is occasionally necessary to remove the pins.



Method of making a Sleeve-retaining Pin which shows the Proper End to knock out

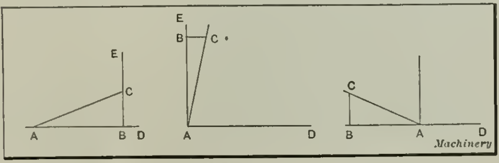
Waterbury, Conn. **Charles Doescher**

ACCURATE METHOD OF LAYING OUT ANGLES

The majority of drafting tables are so constructed that it is necessary to use a protractor when an angle is required that cannot be laid out with a 45- or 60-degree triangle. An angle laid out with a protractor is usually inaccurate because the divisions are small and a slight error in the setting is magnified on a long line. It is the purpose of this article to describe an accurate method of obtaining any angle without using a protractor.

By this method, the natural tangent of the angle is employed instead of the angle itself. As a table of natural tangents is available in every drafting-room, there is really no reason why this method should not come into general use. The procedure is as follows: From the point at which the vertex of the angle will be located, lay off 10 inches along one of the sides of the required angle, and erect a perpendicular to this line from the point so located. From the foot of this perpendicular measure a distance along the perpendicular equal to the natural tangent of the required angle multiplied by 10. Connect the point thus located with the vertex, and the included angle is the angle required. It is desirable to reduce the angle to one of less than 45 degrees by the use of an auxiliary reference line, as will be illustrated in a later paragraph. If the sides of the angle are very long, it is advisable to measure a distance of 20 inches from the given line instead of 10, and lay off a distance of 20 times the tangent of the required angle on the perpendicular.

Let us now consider three applications of this method: Suppose the problem is to draw a line at the point *A* in Fig. 1, making an angle of 26 degrees 10 minutes with the line *AD*. Lay off *AB* equal to 10 inches, and erect a perpendicular



Figs. 1 to 3. Three Methods of laying out Angles

BE at the point B. Ten times the tangent of 26 degrees 10 minutes equals 4.91. Lay off 4.91 inches on BE; this is the distance BC. Then connect the points A and C and the angle BAC is 26 degrees 10 minutes.

As the tangent of an angle increases rapidly as the angle approaches 90 degrees, it is advisable to modify the procedure slightly for angles larger than 45 degrees. Let us draw a line making an angle of 78 degrees 30 minutes with the line AD at the point A in Fig. 2. Erect a perpendicular AE at the point A and lay off AB equal to 10 inches. Subtract 78 degrees 30 minutes from 90 degrees, giving 11 degrees 30 minutes. At the point B erect a perpendicular and on this perpendicular lay off BC equal to ten times the tangent of 11 degrees 30 minutes, which is 2.034. Connect the points A and C; then the angle CAD is 78 degrees 30 minutes, as required. This method is applicable to angles between 45 and 135 degrees.

For angles greater than 135 degrees it is desirable to use the supplement of the angle. Let us draw a line making an angle of 160 degrees 40 minutes with the line AD in Fig. 3. At the point A lay off AB equal to 10 inches. Next subtract 160 degrees 40 minutes from 180 degrees to find the supplement of the required angle. This is 19 degrees 20 minutes. Erect a perpendicular to AB at the point B and lay off BC equal to 3.51 inches, which is ten times the tangent of 19 degrees 20 minutes. Connect the points A and C, and the angle CAD is the required angle of 160 degrees 40 minutes. This method is commended for angles between 135 and 225 degrees.

Newark, N. J. H. A. Freeman

PLANING A BLOCK SQUARE

When most apprentices are given their first die-block to plane, they simply set it up in the shaper vise and plane side after side until all of the sides are finished. The result is a block with six rhomboidal sides, not one of which is square with another. As the apprentice is the mechanic of the next generation and as he frequently completes his time without learning the proper way of doing this work, the result is that many machinists follow the same method of procedure and produce decidedly unsatisfactory results.

The first and most important point to observe in planing a block of this kind is to plane the widest surface first. A wide, flat block should always have the widest face planed first. When the block is nearly cubical in form this is not so important, although it is always the best plan because it gets one into the habit of doing the work right. A brief explanation in connection with the accompanying illustrations will prove of assistance in showing what to do after the first surface has been planed. Let A, B, C, D, E and F represent the six sides of a block, and the letters G and H represent the fixed jaw and the base of the shaper vise.

The method of procedure is as follows: With the block set centrally in the vise as illustrated in Fig. 1, plane side A; then present this side to the fixed jaw G and plane side B. Next set the block with side A against the jaw G and side B in contact with the base H of the vise, and plane side C. Then set the block with side A in contact with the base H and plane side D. This leaves only the sides E and F to be finished. Fig. 3 gives an exaggerated idea of the wrong way to plane these sides, for if the side E is finished in this manner, the side F not being square with the sides A and D, the block will not be accurate.

The proper way to plane the sides E and F is illustrated in Fig. 2. The block is set up in the same position that it occupied when the side D was planed, except that instead of being central between the jaws, it is brought over so that the side E will project so that it can be planed down. If the graduations on the swivel of the vise are inaccurate to such an extent that the jaws will not be at right angles with the stroke of the shaper ram, this may be corrected as shown by the lines I, J and K in Fig. 2, which represent strokes of the shaper ram. If with the side A in contact with the base H of the vise, the stroke of the shaper planes side E as indicated by the line K, by completely turning the block over so that the side D is in contact with the base H, another line of action will be formed at K owing to the inaccuracy of the swivel; but the original line K will occupy the position shown at I. By changing the swivel until both lines coincide as shown at J, this error is eliminated. In order to determine the coincidence of the lines J, an intermediate or connecting line must be made on the side B or C, at the time that the block is turned over. When this result has been obtained, side E is planed, after which the block is turned over and set up to plane the side F. When this method is followed a perfect die-block or box-jig will be produced.

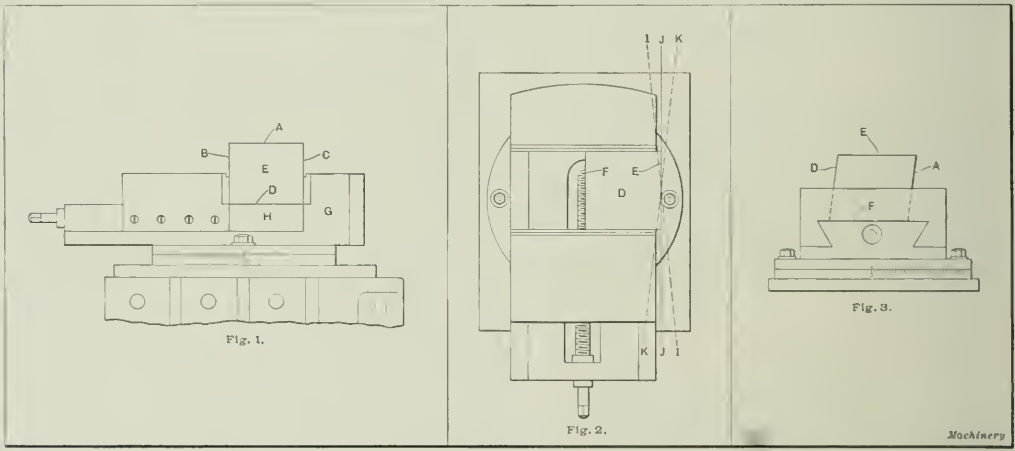


Fig. 1. Fig. 2. Fig. 3.

Figs. 1 to 3. Diagrams Illustrating Method of Procedure in planing Block absolutely Square

Stonington, Conn. M. T. Leahy

INDEXING ATTACHMENTS FOR RACK MILLING

I have frequently been interested in reading descriptions of various methods for cutting racks on the milling machine, but have never seen a table published which gives the necessary data for cutting accurate racks of various diametral pitches. The usual tables are merely approximate for the required circular pitch, and while these do very well for the average classes of work, they are useless where absolute accuracy is required. I recently had to cut a rack for use on a dividing machine and for handling this work it was necessary to devise an accurate method. In preparing for this job, I compiled the table published in connection with this article, which gives the settings for use in cutting all diametral pitches from 3 to 48.

MILLING MACHINE SETTINGS FOR CUTTING ACCURATE RACK TEETH

Diametral Pitch	Circular Pitch, Inches	Gear on Screw	Gear on Locking Disk	Angle	
				Degrees	Minutes
3	1.0472	26	109	2	21
3½	0.8976	20	72	4	11
4	0.7854	21	66	1	37
5	0.6283	34	86	6	29
6	0.5236	38	80	5	50
7	0.4488	36	65	6	8
8	0.3927	42	66	1	36
9	0.3491	40	56	4	7
10	0.3142	50	63	4	5
11	0.2856	49	56	1	36
12	0.2618	62	65	2	43
13	0.2417	49	48	9	16
14	0.2244	72	65	6	9
15	0.2094	50	42	4	20
16	0.1964	62	49	6	16
18	0.1745	50	35	4	20
20	0.1571	63	40	8	13
22	0.1428	52	30	8	4
24	0.1309	51	27	8	29
26	0.1208	90	44	8	5
28	0.1122	75	34	8	7
30	0.1047	100	42	4	20
32	0.0982	86	34	6	30
36	0.0873	90	32	10	51
40	0.0785	75	24	11	7
48	0 0655	90	24	10	44

Machinery

In order to explain the use of this table (in handling the work on a universal milling machine) let us suppose that a rack is required with 30 teeth of 16 diametral pitch, or 0.19635 inch circular pitch.

30 × 0.19635 = 5.8905 inches = length of thirty teeth.

The most suitable change gears available for this purpose were wheels with 48 and 60 teeth, respectively. Placing the 48-tooth gear on the table screw and the 60-tooth gear on the locking disk, and revolving the latter thirty times, gives a table traverse of 6.000 inches, which is too long by 0.1095 inch or 0.00365 inch per tooth. The work is held in a swivel vise, and to correct for this error in the table traverse, the milling machine table is first swung to the angle given in the table for a 16-diametral pitch rack, after which the vise is swung through a corresponding angle in the opposite direction; *i. e.*, 6 degrees 16 minutes, which brings the work back at right angles with the arbor. After completing this setting, if the locking disk is rotated thirty times, it will be found that the traverse amounts to exactly 5.8905 inches, which is the required distance for cutting thirty teeth of 16 diametral pitch. The same is found true of all pitches given in the table.

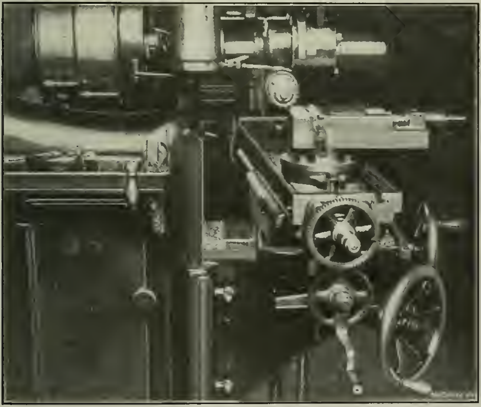


Fig. 1. Universal Milling Machine Attachment for Use in cutting Accurate Racks

A brief consideration of this method of setting will make it clear. When the table is set at an angle, the traverse obtained by the gearing, multiplied by the cosine of the angle at which the table is set, gives the traverse of the work on a line at right angles to the spindle. One of the features of this attachment is that it may be easily fastened to the table of any universal milling machine. Referring to the illustration, it will be seen that the attachment consists of a bracket fastened to one end of the table, and that the table is entirely unobstructed. The locking disk is grooved to receive a round pin, and is attached to an adjustable stud on the bracket; the handle which revolves the disk is mounted on the same stud. The pin enters the groove in the disk and helps the operator in keeping accurate account of the number of revolutions.

Ebrane

[The writer states that his table was compiled owing to inability to find a table of milling machine settings for cutting accurate rack teeth. Had he referred to the index table for the rack cutting indexing attachment for the Brown & Sharpe milling machine, he would have found a very satisfactory reference for this purpose. The error of the teeth cut with this attachment, and using the settings in the table referred to, amounts to only from 0.0001 to 0.0004 inch.—Editor.]

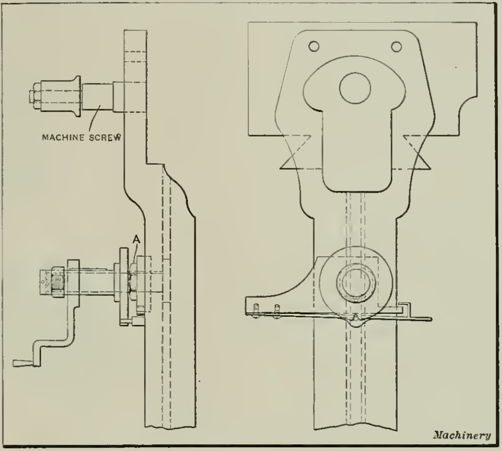
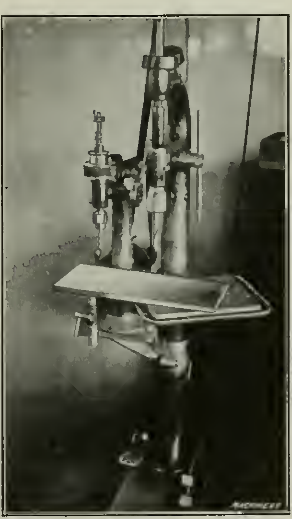


Fig. 2. Design of Attachment showing Arrangement of Locking Disk and Pin

MULTIPLE DRILLING WITH A SINGLE SPINDLE MACHINE

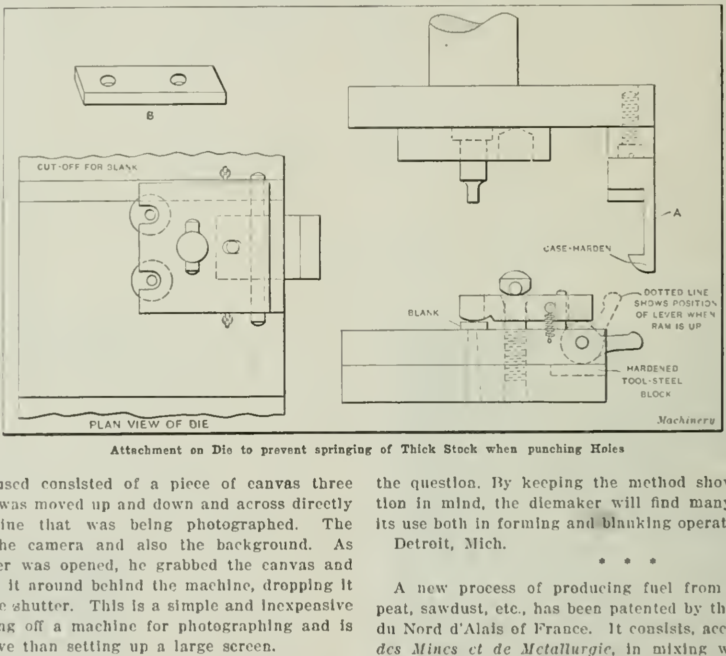
It was required to drill and ream two holes in several thousand castings, one of the holes being 3/16 inch in diameter by ¼ inch long and the other 7/16 inch in diameter by 1 inch long. Of course a jig was made to secure rapid and accurate production, but it was foreseen that at the time when the castings would be ready the only machine available would be a single-spindle sensitive drill press. The use of this machine would mean four chuckings of each piece and tying up the machine for a long time.

The writer finally hit upon the following scheme. A light bench drill was available and this machine was mounted at the side ot the larger drill press and used for drilling and reaming the 3/16-



Setting up a Bench Drill on a Single Spindle Drill Press for Multiple Work inch hole. To do this, an auxiliary table was made for the drill press; the surface of this table was accurately planed, after which it was bored and split to fit onto the column of the larger machine. A second hole was bored part way through the auxiliary table to receive the base of the bench drill and locate it in the desired position. The auxiliary table was then adjusted to such a height on the column of the drill press that the tables of the two machines were exactly level. The arrangement will be readily understood from the illustration, where it also will be noticed that a planed iron plate was provided to afford an unbroken surface for the jig to rest upon.

The entire lot of castings was first drilled. Reamers were then put in the machines and the holes finished. Two holes were drilled and two holes were also reamed at each setting of the work. Finished spots on the castings made it possible to relocate the work rapidly and accurately. The rate of production secured by this method was all that could be desired, and the method made it possible to handle the work without congestion or tying up any of the machines in the shop for a long period of time. In addition, the auxiliary table is now available for other classes of work that may come up in future and that can be handled in the same way.


B
CUT-OFF FOR BLANK
PLAN VIEW OF DIE
A
CASE-HARDEN
BLANK
DOTTED LINE SHOWS POSITION OF LEVER WHEN RAM IS UP
HARDENED TOOL-STEEL BLOCK
Machinery

Attachment on Die to prevent springing of Thick Stock when punching Holes

The photograph from which the illustration was made may prove of interest to those who have wished for some satisfactory background for use in shop photography. This photograph was taken with an inexpensive camera, the time of exposure being two minutes. The background used consisted of a piece of canvas three feet square which was moved up and down and across directly behind the machine that was being photographed. The writer operated the camera and also the background. As soon as the shutter was opened, he grabbed the canvas and proceeded to move it around behind the machine, dropping it in time to close the shutter. This is a simple and inexpensive method of screening off a machine for photographing and is much less expensive than setting up a large screen.

Middletown, N. Y. D. A. Hampson

PUNCHING HOLES IN THICK STOCK

When punching holes in stock say 3/16 inch thick or greater, the stock tends to curl due to the pressure of the punches being localized. This is especially true when the holes are to be nearly straight through, as this necessitates a somewhat closer fit between the punch and die than is good practice. With proper clearance, or rather, with customary clearance, between punch and die, the holes punched are, at the upper surface, a trifle larger in diameter than the punch; the hole gradually tapers to a diameter as large as the die and sometimes the stock breaks and the punching is actually larger than the die. This causes disastrous results unless the die has a wall heavy enough to withstand the pressure required to force the over-sized punching through it.

The accompanying illustration shows a very good method of eliminating the springing of the blank. This scheme can also be employed to hold various blanks while performing bending operations. As will be noted the clamping and releasing mechanism is actuated by the arm *A*. Assume that a blank is desired as shown at *B* and that the holes in this blank must be nearly straight. If an ordinary piercing and cutting-off die were employed, the blanks would receive a "set" directly around each pierced hole, causing the blank to curl. This results in many broken punches, especially if the stripper happens to be on a slight angle with the plane of the die. This set is caused by the stock surrounding the punches being free to move, and it is obvious that if stock is rigidly held in contact with a level die surface, although the same pressure of the punches is exerted on a blank, there will be very little curl due to the inability of the stock to receive the set which holds the blank in a curved position. What is meant by the term "set," will be more apparent if we consider a piece of steel gripped in a vise. We can bend the steel back and forth for a short distance only, *i. e.*, inside the elasticity limit and the steel will return to the same position each time, but if we bend steel a trifle too far it receives a permanent set and remains fixed.

This clamping device will be found excellent when used in conjunction with forming operations. Every diemaker aims to have the die at hand perform as many operations at each stroke as is consistent with good practice and without making the cost of the die prohibitive. A spring pad on the punch is often employed (equipped with very stiff springs), the pad producing one or more forming operations; as the ram of the press continues to descend the spring pad recedes and the forming punch performs its function. But when the stock is heavy the spring-pad scheme is out of the question. By keeping the method shown in the illustration in mind, the diemaker will find many opportunities for its use both in forming and blanking operations.

Detroit, Mich. F. E. Shailor

* * *

A new process of producing fuel from coal dust, lignite, peat, sawdust, etc., has been patented by the Societe Houillere du Nord d'Alais of France. It consists, according to the *Echo des Mines et de Metallurgie*, in mixing with the small material a colloidal substance such as the starches or the flour resulting from the grinding of rice, etc. The mixture thus obtained is compressed and the resulting briquettes submitted to an intensive drying, which hardens them and renders them capable of withstanding the action of water for a long time without disintegration. As an example the following is given: Dry ground rice in the proportion of 2½ per cent by weight is mixed with 97½ per cent of anthracite dust; hot water or steam is injected into the mixture in order to transform the flour into a pasty mass, which is kneaded before passing into the press. The briquettes are then dried three or four hours at 200 to 400 degrees F.

* * *

It is stated on the authority of the *Birmingham Daily Post* that during the Liége bombardment the Germans destroyed the Ougrée-Marihaye Steel Works near Liége, and also partly demolished the Cockerill works at Seraing. The Cockerill works employed 10,000 men and among other lines have won great fame in the manufacture of armor plate and fortification material. The Ougrée-Marihaye Steel Works employed 12,000 men.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

H. P. TOWNSEND AUTOMATIC SCREW MACHINES

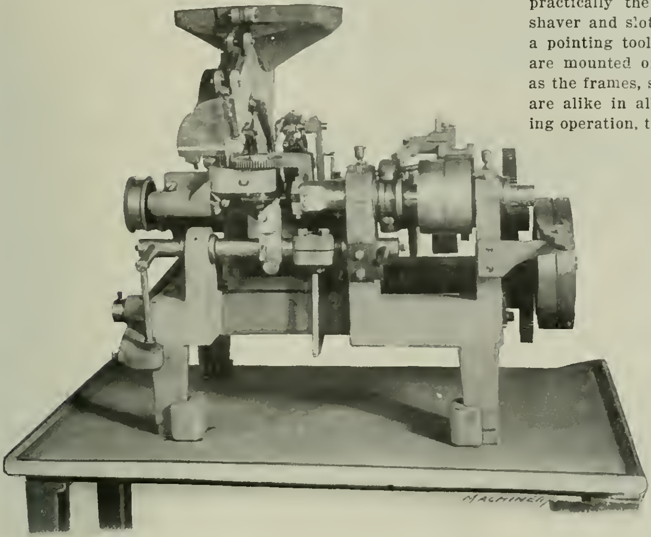


Fig. 1. H. P. Townsend Screw Shaving and Slotting Machine

The development of the automatic screw machines described in the following, for working on headed blanks that are fed to the machine from a hopper, has been made possible by the progress which has been made in cold-heading. When it is necessary to turn blanks to form the heads, the amount of material wasted is frequently greater than that retained in the product, thus making the cost of material excessively high. The use of headed blanks avoids this waste, and those who have had experience with cold-heading, find that it may be applied for producing work of innumerable forms, and that the results obtained are highly satisfactory.

Primarily, the machines are intended for manufacturing common gimlet point wood-screws. In making wood-screws, after the blanks have been made in a heading machine, the first machine to be used is for shaving and slotting the heads; and the second machine is for pointing and threading. The shaver and slotter shown in Fig. 1, unlike those now in use, has only one spindle which revolves for the turning or shaving of the head and stops automatically when this operation is completed; it is locked rigidly in position while the sawing operation takes place. After this, the spindle starts again and the turning tool is again presented to the head to take off the burr left by the saw. It will be noticed that this machine is provided with a tool-bar which rocks the tool against the work for ordinary turning operations. This tool-bar and its operating levers are known as the turning mechanism and can be used in connection with or independently of the sawing mechanism; or the sawing mechanism may be used independently of the turning mechanism, so that this machine, in itself, can be used as a shaver and slotter, for plain shaving or for plain slotting.

The second machine used in making wood-screws is the pointer and threader illustrated in Fig. 2. In this machine practically the same turning mechanism is used as in the shaver and slotter, and the sawing mechanism is replaced by a pointing tool. Both the saw mechanism and pointing tool are mounted on the same bearing and can be interchanged, as the frames, spindles, back-rest bracket, and feed mechanism are alike in all of the machines in the line. In the threading operation, the tool-bar not only feeds in to secure the depth ot cut, but it reciprocates longitudinally at the proper speed for cutting threads of any desired pitch, passing over the screw as many times as required. It will be noticed that in this machine the turning mechanism is adapted to move sideways and therefore constitutes a threading or turning mechanism, plain turning being done in the same manner as on an ordinary lathe. The pointing mechanism, being independent of the threading mechanism, can be used for plain pointing, omitting the threading operation, or the threading mechanism can be utilized for plain threading or turning, omitting the pointing mechanism, so that this machine also constitutes three separate machines: for pointing and threading, plain pointing and plain turning, and plain turning or threading. A drilling attachment is also provided, which can be applied to the frame without changing the general mechanism, and this drilling attachment can be used alone, in combination with either the plain form turning device or with the threading or longitudinal device, so that one machine can be used for plain drilling, or it can be conveniently made into a combination forming and drilling machine or a combination drilling and

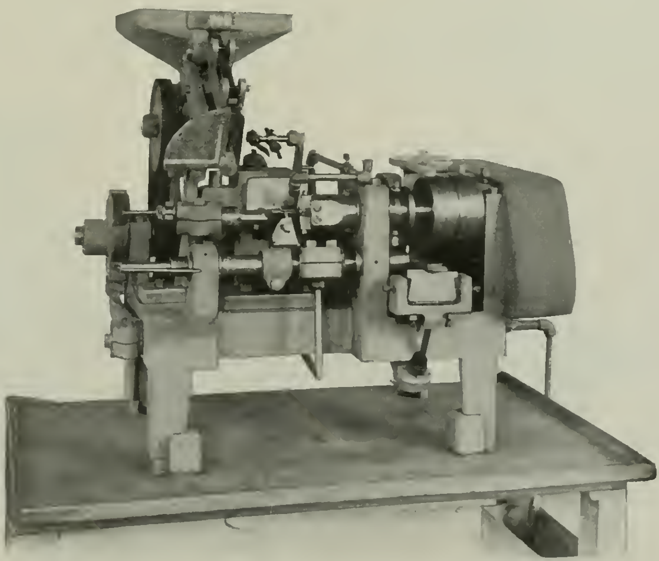


Fig. 2. H. P. Townsend Screw Pointing and Threading Machine

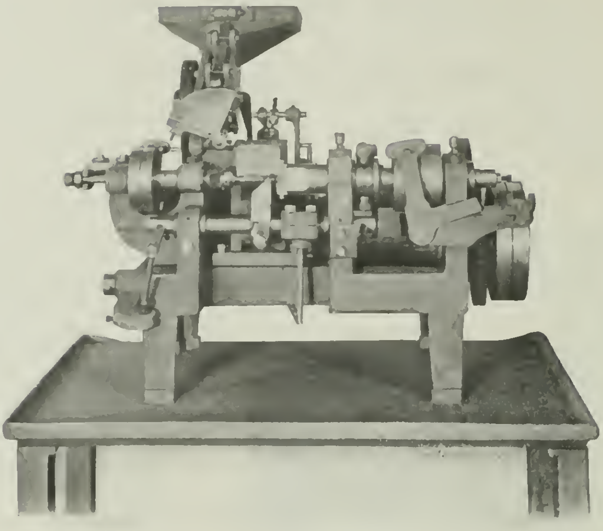


Fig. 3. Townsend Screw Machine tooled up for Drilling and Turning Operations

threading machine. This attachment is shown in Fig. 3.

The drill mechanism, by a slight change in the spindle and in the spindle operating levers, forms a tapping or die threading device, the levers being adapted to start and stop the tapping spindle. This device can be used alone or if the operation is to be that of tapping, it can be combined with the forming mechanism, which gives possibilities on the same machine of plain tapping or die threading and combined tapping and forming. This application is shown in Fig. 4. The general construction and appearance of these machines is very much alike, so that one operator can easily understand all of the different machines. By leaving off the feed mechanism and applying a rod feed to the spindle, the machine can be utilized for turning, drilling and cutting off small pins, studs, etc. In all these machines the spindle revolves. In another application of the saw mechanism for plain slotting, the spindle does not revolve and on this machine it is possible to use two saws on the saw spindle for flatting or slabbing off two sides of a blank; also, an index device can be applied for indexing the spindle 90 degrees so that the saws may be brought up to flatten two sides of the blank and then withdrawn while the spindle is turned 90 degrees and the saws are again brought into action, forming a square on the blank. This index may also be used to mill a hexagon shape. The machine illustrated in Fig. 5 is equipped in this way.

In all the machines, the feed mechanism can be changed to feed the blanks either point first or head first so that all of the operations can be performed on either end of a blank. These machines can be provided with pans, legs, and an oil system so that they may be used singly or in a battery, as desired. Unlike the machines of this class now in use, they drive from overhead, keeping the belts free from grease and leaving the under side of the machine clear for storage. An innovation on this type of machine is the tight and loose pulley on the spindle, with the belt shifter which enables the operator to conveniently turn the machine by power when trying out the tools, thus starting and stopping at will. Where it is possible, the machines are provided with an interlocking belt shifting mechanism so that the machine cannot be started unless the spindle is revolving, thereby preventing the breakage of tools, which would be the case if the spindle were not turning so that the tools could perform their cutting functions. All the adjustments on the machines are directly in front, where the operator can easily reach them. This is an especially valuable feature in the shaving and slotting machine which, in the old type in common use, has the saw mechanism on the back so that the operator has to walk around the line of machines in making adjustments.

A peculiar and valuable feature in connection with the saw mechanism is an arrangement for compensating for irregularities in the saw. This arrangement causes the saw to cut all the way around instead of just on the high teeth. This same arrangement prevents the breakage of saws to a great extent by allowing any tooth which catches or clogs to relieve itself before it will break. Usually the saws will get dull instead of breaking. Fig. 6 shows a variety of operations that can be performed on headed blanks, the heavy lines showing where the metal has been removed. It will be seen that these machines are not limited to standard screws but

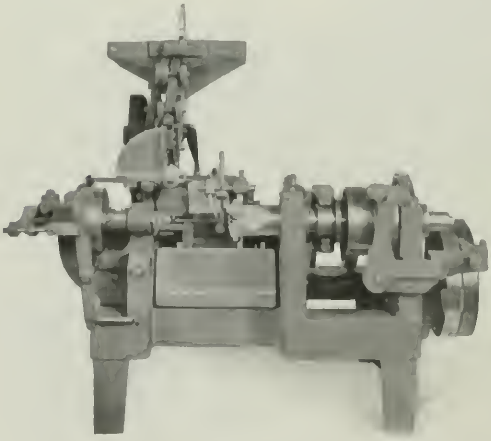


Fig. 4. Machine equipped for handling Tapping Operations

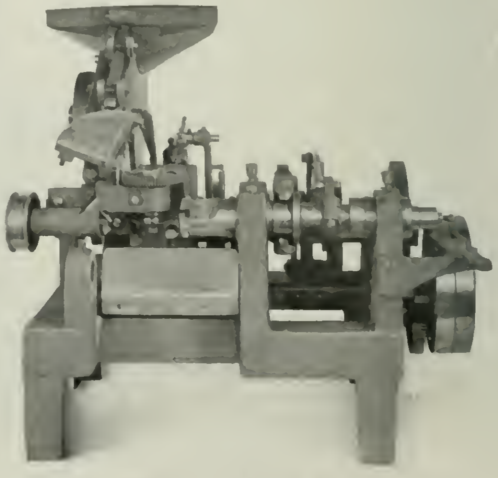


Fig. 5. Application of Two Saws for Squaring Operations

are capable of performing any kind of metal cutting operation on either end of any blank that can be fed from a hopper. The feed mechanism is novel in its construction and it is possible to feed many blanks which cannot be fed in any other hopper feed mechanism; one notable record it achieved was continuous running for thirty-two hours without missing a blank. The machines are useful in performing secondary operations on numerous screw machine parts as well as on blanks which have been headed from wire. These machines have recently been placed on the market by the H. P. Townsend Mfg. Co., Hartford, Conn.

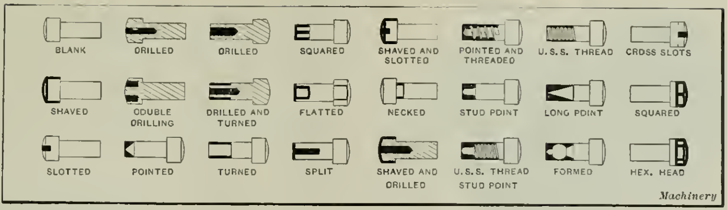


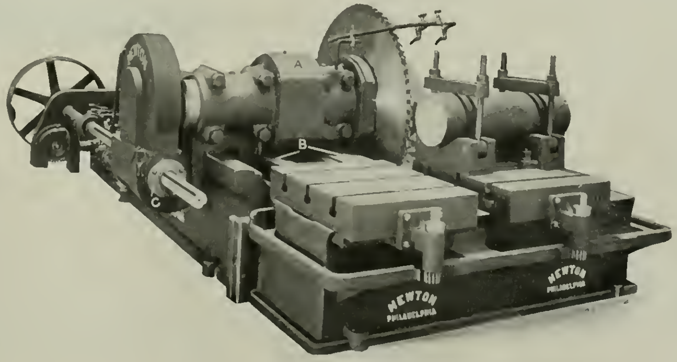
Fig. 6. Examples of Work done on Townsend Automatic Screw Machine

NEWTON COLD SAW

The accompanying illustration shows a cold metal saw which constitutes a recent addition to the line of machines built by the Newton Machine Tool Works, Inc., Philadelphia, Pa. One of the important features of this machine is the entirely enclosed driving spindle gear and pinion which provides for the operation of these members in grease; the gear case is shown at *A*. Another feature of the machine consists of the incorporation of narrow guide bearings *B* which decrease the friction between the saddle and ways to a minimum. The adjustable thrust bearing *C* with auxiliary bushings to prevent the escape of oil and to preserve the fixed bushings from contact with the splines, is another noteworthy point in the construction. Care has been taken to limit the overhang of the saw blade beyond the shears to a minimum.

It will be seen that the machine is provided with duplicate work-tables which can be adjusted independently or in unison as desired. Both V- and arch-clamps are provided for holding the work. The spindle is extended and fitted with spacing washers which enable any desired distance to be obtained between the saw blades when two blades are used at the same time. This distance between the blades can be adjusted by increments of ⅛ inch. The spindle is supported at both ends and revolves in bronze bushed capped bearings. The teeth of the driving pinion are cut from the solid shaft and the driving worm-wheel is cut from a solid bronze casting. The feed is obtained from a gear-box which affords six changes without the removal of gears, and the saddle has fast power traverse in both directions. Adjustable and safety release is provided for all motions in the extreme positions.

The machine may be equipped with either one or two saw blades 44 inches in diameter, which gives a capacity for cutting through oblong billets 20 inches high by 10 inches wide. Round stock up to 13 inches in diameter and square stock up to 12 by 12 inches can be cut. Larger sections can be cut by turning the stock. The illustration shows a machine equipped with one blade and with the spindle extended out beyond this blade. Where a second blade is used, it is mounted on this spindle extension, the two blades being used for working simultaneously on such pieces as open-end locomotive rods, etc. This cold saw is of exceptionally heavy construction and is particularly adapted for handling heavy forge work and other classes of work where a machine of unusually heavy construction is required.



Newton Cold Saw designed for handling Heavy Forge Work

AMERICAN ELECTRIC GRINDER

The American Electric Grinder Co., Chicago, Ill., is the manufacturer of the self-contained, double-end, motor-driven grinder which forms the subject of this article. This machine is particularly adapted for heavy classes of foundry grinding and similar work. The important feature of the construction lies in the fact that the motor is built around the grinding wheel shaft, the arrangement being such that repairs to the motor may be made without requiring the machine to be dismantled. To provide the maximum rigidity, the base of the grinder from the center of the wheel spindle down is a single heavy casting, and the spindle is made from 35 to 40 point carbon steel and ground accurately to size. In the standard machines, the spindle is mounted in Hyatt roller bearings, but ball bearings may be substituted if desired.

Fig. 1 shows a general view of the machine and Fig. 2 shows the arrangement of the motor drive in some detail. The motor armature is assembled on a spider, through which the wheel spindle is forced at 500 pounds pressure. Should it become necessary to re-wind or repair the armature, it is not necessary to remove the armature from the machine. For this purpose, the upper half of the field ring *A* is in the form of a separate casting hinged to the base, and may be raised to the position shown, in order to give access to the armature. The lower half of the field ring is cast integral with the base of the grinder. The brush holders *B* and the pole pieces *C*, including the wiring, may be lifted up out of the way, and when this has been done, the armature may easily be repaired without removing it from the machine. The electrical connections are so arranged that they do not have to be broken while working on the armature.

The electrical controlling apparatus used on the machine is provided by the Electric Controller & Mfg. Co., of Cleveland, Ohio. The switchboard is located inside the base of the grinder where it is readily accessible by opening the door shown in Fig. 1. The push buttons *D* are used for starting and stopping the motor and a rheostat is provided for regulating the speed to compensate for the change in size of the wheels, which results from trimming. It will be seen that about three-quarters of the wheels are covered by cast-iron shields, and the outer plate of each of these shields is hinged at the back and locked by two bolts at the front. This enables either plate to be swung back, as shown in Fig. 1, making the replacement of wheels a very easy matter. In addition to covering the wheel, it will be noticed that the guard covers the nut at each end of the spindle so that the possibility of accidents through the operator's clothing becoming caught is eliminated.

The work-rests are made in two pieces

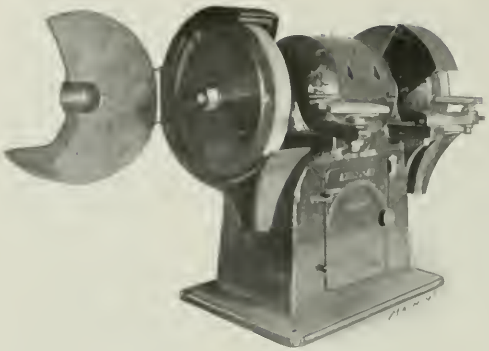


Fig. 1. American Electric Grinder showing Arrangement of Wheel Guards

and bolted together. Whenever the used section of the rest becomes worn, a new plate may be easily bolted to the support, extra plates for this purpose being provided with the machine. The heavy foundry size of this type of grinder requires a 5-horsepower motor to drive it and is suitable for running at from 800 to 1200 revolutions per minute. Wheels 24 inches in diameter by 3 inches face width are used. Without the wheels, this machine has a weight of approximately 2900 pounds. The same type of grinder is also made in several different sizes, the smallest of which carries wheels 10 inches in diameter by 1 inch face width; and the largest, wheels 42 inches in diameter by 6 inches face width.

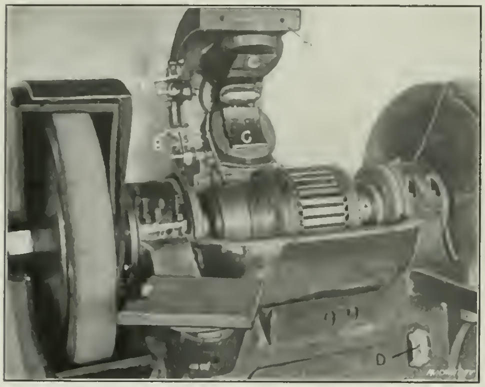
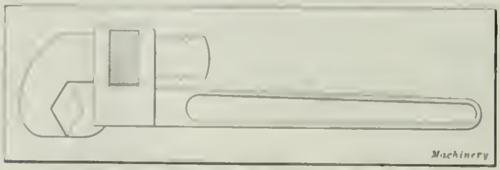


Fig. 2. Arrangement of Driving Motor

"WALCO" HEX WRENCH

The "Walco" hex wrench is manufactured by the Walworth Mfg. Co., Boston, Mass., and is particularly adapted for removing valve bonnets and turning other hexagonal parts. Every engineer or user of valves will appreciate the value of this tool. Valve bonnets are made up in a factory where special wrenches are used, and if it becomes necessary for the user to remove a bonnet by means of a monkey wrench or "Stillson" wrench, the hexagons are almost certain to be damaged.

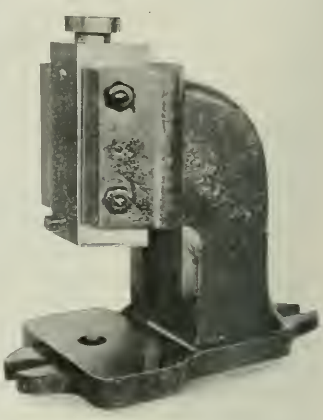
Reference to the illustration will make it evident that the "Walco" hex wrench grips four sides of the hexagon where an ordinary monkey wrench only grips two sides. Using this new wrench, it is possible to remove valves or cocks from a pipe line without injuring their finished surfaces. This wrench is made of high-grade tool steel.



The "Walco" Hex Wrench for Pipe-fitting and General Work

OPTICAL TOOL CO.'S SUB-PRESS

The Optical Tool Co., Providence, R. I., has recently brought out a sub-press intended for carrying fine dies that must be kept in permanent alignment. The principal distinction that this press has over others is the shape of the plunger. This, in section, resembles a triangle with the apex cut off. The plunger is made of steel and runs in cast-iron bearings; the adjusting gib is also of cast iron, so that the wearing surfaces are steel to cast iron. With this sub-press there is less chance for extensive wear developing, and adjustments may be made very quickly. The frame of the sub-press is of open construction at the back so that stock may be fed either sideways through the dies or from the back.

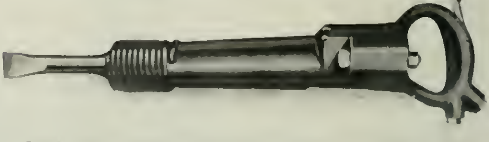


Sub-press for operating Fine Dies that must be kept in Permanent Alignment

"LITTLE DAVID" RIVET "BUSTER"

In making riveted joints it frequently becomes necessary to remove one or more rivets, and for this purpose a hammer and cold chisel are often used to knock off the rivet head. This method is not only slow but may result in damage to the work. A more convenient way is to use a pneumatic chipping hammer. In the case of large rivets a slot is cut through the center of the head, after which a tap with a hammer on each side of the head serves to break off the two halves; the rivet may then be easily driven out of the hole.

As it is not practical to keep a pneumatic chipping hammer on hand for occasional use in removing rivets, the Ingersoll-Rand Co., 11 Broadway, New York City, has recently added to its line the "Little David" rivet "buster" for use in connection with the pneumatic riveting hammers of its manufacture. This tool is shown in the accompanying illustration, from which it will be seen that it consists of a chisel which is mounted in the "Little David" riveting hammer, in place of the usual rivet set. The shank of the rivet "buster" is similar to that of the regular rivet set, and is so designed that it is held in place by the safety retaining spring. The rivet "buster" is of a size and shape which enable it to also be used for removing burrs or other defects from the metal. It can be conveniently carried in the workman's pocket where it is always available for use when necessary. The "Little David" riveting hammer was described in the May, 1913, number of MACHINERY, and the rivet set retainer for use on this tool was illustrated and described in the August, 1914, number.



"Little David" Riveter equipped with a Chisel for "busting" Rivets

"ACORN" DIE

The Wiley & Russell plant of the Greenfield Tap & Die Corporation, Greenfield, Mass., has recently added to its line what is known as an "Acorn" threading die, which is illustrated herewith. Fig. 1 shows the assembled die-holder ready to be mounted in the machine, while in Fig. 2 the parts of the die-holder and the die are shown arranged in their relative positions. These illustrations make the construction and operation of the die so clear that only a brief description will be necessary.

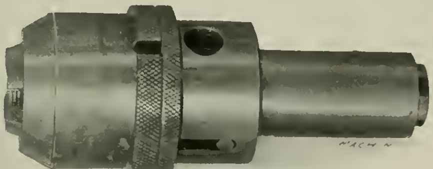


Fig. 1. "Acorn" Die mounted in Holder ready for Use

Referring to Fig. 2 it will be seen that the die *A* has the four lands contained in a single piece. The cap *B* fits over the die and engages the ground conical surfaces of the lands, affording adequate support to prevent the possibility of deflection, and at the same time providing means of adjustment. After the cap *B* has been screwed up to make the die cut to the required diameter, the lock nut *C* is screwed back tight against the cap to prevent it from turning and the size of the die from changing.

The die *A* is driven by the pins *D* in the face of the die-holder, while this holder, in turn, is driven by the pin *E* which enters the slot in the socket *F*. In assembling the die and holder, the screw *G* is tightened up, thus drawing the pin *E* in the die-holder back into the slot in the socket *F*. This brings the tool to the condition shown in Fig. 1. The cap *B* and collar *C* may then be adjusted in the manner previously described, after which the die is ready for use.

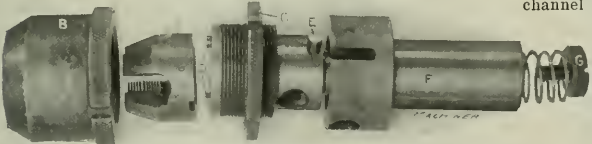


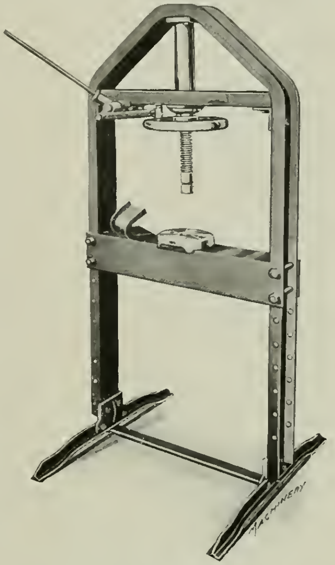
Fig. 2. Parts of "Acorn" Die and Holder in Position for assembling

The noteworthy features of this "Acorn" die are that when it is adjusted the four lands are sure to be moved in an equal distance toward the center, owing to the ground conical surfaces which engage the cap *B;* that the cap *B* affords a positive support for each of the lands; and that the chasers can be sharpened from fifty to one hundred times, provided the workman observes the necessary precaution in grinding them. When the die becomes dull, it is merely necessary to remove one or two thousandths of an inch from the cutting face of each of the four lands of the die. This removes the rounded edges of the lands and exposes a clean sharp cutting edge to the work. The projection of the lands beyond the cap *B* enables the die to cut close up to shoulders without difficulty.

This "Acorn" die and its holder are adaptable for use on all kinds of machines such as lathes, drill presses, hand or automatic screw machines, turret lathes, bolt cutters, etc. The holder has longitudinal float, thus permitting the die to follow its own lead independent of the travel of the machine. With any self-leading die, it is impossible to adjust more than a few thousandths of an inch without materially disturbing the lead of the screw or bolt, or spoiling the smoothness of the wall of the thread. The range of adjustment secured by regulating the position of the cap *B* is more than can ever result from variation in the process of manufacture.

WEAVER GARAGE PRESS

In the average garage or repair shop there is a great deal of work which could be most satisfactorily handled under a press, but the high price of an ordinary equipment of this kind leads many shops to continue to handle such work by more laborious and far less efficient methods. Realizing the demand which exists for a light press for use in the field referred to, the Weaver Mfg. Co., Springfield, Ill., has designed and placed on the market a hand-operated press which has a capacity of 20 tons. This equipment is of strong and compact construction so that it takes up very little space and has a capacity ample for the requirements of the work for which it is intended. Straightening shafts and axles, pressing wheels on and off shafts, compressing leaf springs in assembling, pressing bearings on and off, broaching holes, cutting keyways in pulleys, and bending and shaping bars are some of the operations that can be accomplished.



Hand-operated Press for Use in Garages and Repair Shops

It will be seen that the frame is made of a single piece of channel steel which is 5 by 2 inches in size. There are no joints or connections to weaken the frame. A hand-wheel 15 inches in diameter provides quick action for ordinary light jobs, and for securing the maximum pressure the auxiliary lever is employed. The ratio of the lever is 1500 to 1, and enables the maximum pressure of 20 pounds to be obtained without undue exertion on the part of the operator. The bolster which carries the plate is readily adjustable for height, it being necessary to remove the four bolts and replace them in holes in the desired position on the frame. The maximum adjustment of the press is 48 inches between the plate and the bottom of the screw. The screw is 2 inches in diameter and has a 3-pitch Acme thread; the thrust of the screw is taken by a bronze thrust bearing. The screw has a range of movement of 12 inches and the distance between the uprights is 32 inches, which permits the press to handle the largest automobile wheels.

BILLINGS & SPENCER BOX-JOINT PLIER

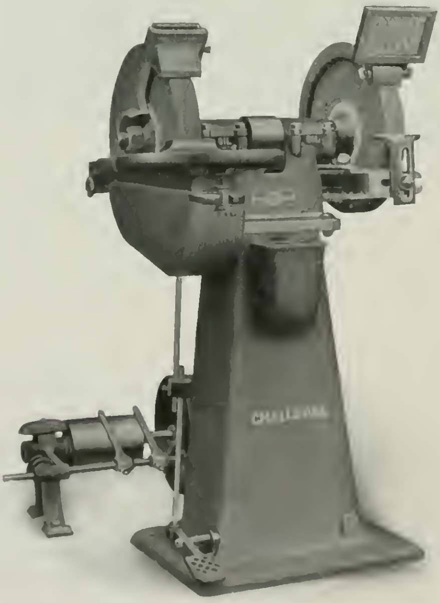
The model CC slip box-joint plier illustrated herewith is a recent product of the Billings & Spencer Co., Hartford, Conn. The application of the box joint to this plier insures perfect alignment of the jaws and side cutters. This increases the efficiency of the cutters, enabling them to cut easily any wire within their capacity. The tool is made of high-grade steel forgings with the handles knurled to afford a secure

Billings & Spencer Model CC Slip Box-joint Plier grip when the workman's hands are greasy. The features of the tool will be clear to any mechanic by referring to the illustration.

CHALLENGE COMBINATION GRINDER

Where a shop uses machine tools for a variety of work, the most efficient equipments are those which possess the widest range, this being in marked contrast to manufacturing machines which are used for turning out a strictly uniform product. There are few shops which have tools to be ground that do not have various other classes of grinding work, and where the tool grinders are single-purpose machines, it is necessary to have other grinding machines for handling miscellaneous work. Realizing the demand for a general-purpose grinder arising from this condition, the Challenge Machine Co., Inc., 5116 Springfield Ave., Philadelphia, Pa., is building what is styled a combination grinder. This machine has been built for some time but it has recently been re-designed and additional equipments provided to add to its field of usefulness. The name "combination grinder" arises from the fact that various units are provided which may be assembled on the machine to adapt it for handling various classes of work. These units are mounted without requiring any machining operations, and they may be easily removed and replaced by other units when the nature of the work handled on the machine is changed.

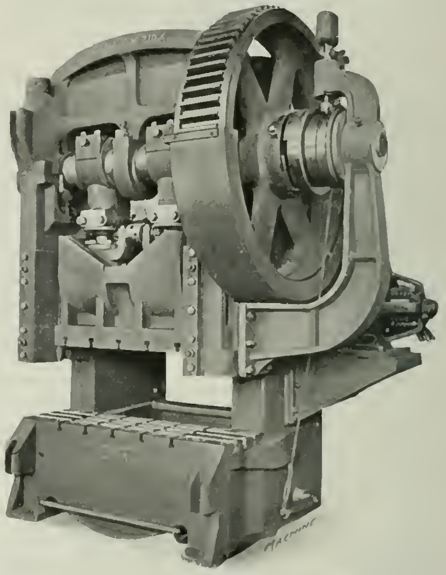
The head of the machine, or the "master unit" as it is called, may be used as a bench machine or it may be bolted to either of three types of base which adapt it for belt drive from an overhead shaft, belt drive from a pulley mounted on the base of the machine or individual motor drive. Among the units which may be provided for use on this machine are a ring wheel or disk unit; a wet tool grinding unit; a duplex surface grinding unit; a top surface grinding unit, in which the work is passed over a slot in the table through which the grinding wheel is exposed; and a wheel guard unit. It will be seen that the machine shown in the illustration is equipped with the wet tool grinding unit and the wheel guard. The wheel guard is one of the recently developed parts It is forged from channel steel, which provides adequate strength, and has both vertical and horizontal adjustment in order that the position may be regulated as the wheel is reduced in size through dressing. It will be noticed that an eyeguard is provided on this unit, the guard being made of wired glass so that it is not easily broken.



Challenge Combination Grinder equipped with Wet Tool Grinding Unit and Wheel-guard Unit

TOLEDO HIGH-SPEED FORGING PRESS

In the design of the high-speed forging press which forms the subject of this article, the construction of the frame is of particular importance. Referring to the illustration, it will be seen that this is of the gap pattern, the frame consisting of four pieces held together by four heavy steel bolts. Two of these bolts pass through the crown, uprights and bed of the press at the rear of the main shaft bearings, these bolts taking the entire stress in the press, while the uprights take the reaction. The other two bolts are situated at the front of the bearings and pass through only the crown and uprights. This machine was originally designed for handling the heavier classes of railroad track specialty forging, such as switch operating levers and links, rail plates, fish plates, etc.; but it may be used for all classes of heavy forging, forming, stamping and embossing. The press is capable of exerting pressures up to 500 tons and will withstand occasional overloads of 40 per cent or more.



Heavy Toledo High-speed Forging Press

The bed and face of the slide are provided with T-slots to accommodate all kinds of dies mounted in every conceivable position. The clutch is of the jaw type; it is steel faced at the engagement points and equipped with a special gravity release that eliminates the clicking and wearing off of the engaging points. The press is designed to operate at high speed—the recommended speed being not less than thirty strokes per minute—so that four, five or more forging operations may be performed in succession on a piece of work without requiring it to be reheated. In order to provide for running the press at high speed, it is geared comparatively low, the ratio being fifteen to one, which brings the speed of the back shaft up to 450 revolutions per minute. It will be seen that motor drive is employed, and when the press is working under full load a 100 horsepower motor will be required to drive it to capacity. This does not mean that the press will consume that amount of energy continually; on the contrary, the average requirements will not exceed from 25 to 30 horsepower.

Forging presses are subjected to severe treatment and as a result are likely to have a variety of accidents happen to them. To prepare this new Toledo press to withstand the most severe operating conditions, it has been designed with proportions that enable it to stand up under unusually heavy loads. Great care has also been exercised in the selection of material for those parts which are subjected to the most severe strains. For instance, the main shaft and the steel tie rods are made of steel of a special analysis which averages from 0.45 to 0.50 per cent of carbon; these parts are carefully treated after finishing to enable them to withstand the most severe stresses without being strained. The main gear is made of a special steel which possesses exceptionally good wearing properties. Particular care has been given to the design of the slide and its ways. The gibs are of unusual length and so arranged that the slide never comes out of the gibs. The part of the slide that moves within the gibs, and the gibs proper, are of exceptionally liberal proportions, and this fact combined with the length of the gibs permits of concentrating the heaviest load at any point of the slide and bed.

The principal dimensions of this machine are as follows: Stroke of slide, 6 inches; diameter of shaft, 10 inches; distance between uprights, 61 inches; available die space, 20 inches; size of main gear, 7 feet in diameter by 12½ inches face width; size of flywheel, 50 inches in diameter by 17 inches face width; and weight of flywheel, 4000 pounds. This new forging press is a recent product of the Toledo Machine & Tool Co., Toledo, Ohio.

BESLY GEAR TOOTH PATTERN GRINDER

Charles H. Besly & Co., 120 B. North Clinton St., Chicago, Ill., have recently developed a fixture for use on their No. 15-30 C patternmaker's disk grinder, which adapts this machine for forming single involute teeth for gear patterns. Fig. 1 shows one of these attachments in use, while Fig. 2 shows the design of the attachment in detail. The attachment is shown grinding teeth of 1 diametral pitch by 6 inches face width; and the fixture was especially designed for grinding 1-pitch teeth. The blanks are ground from the rough, *i. e.*, the grinder does everything with the exception of the rough sawing. In producing gear teeth on this attachment, the method of procedure is as follows: The rough sawed blocks are first ground on the top, bottom and ends, using a sliding bevel gage for squaring the ends, and a sizing bevel gage for grinding the top of the tooth pattern parallel with the base and to the correct height. After this preliminary work has been done, the blanks are ready to be inserted in the fixture for forming the sides of the teeth.

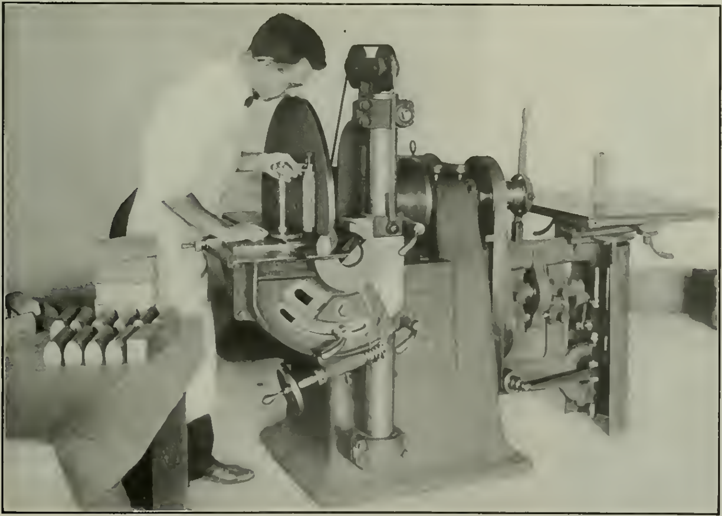


Fig. 1. Use of Gear Tooth Fixture on Besly No. 15-30 C Patternmakers' Disk Grinder

To operate the fixture, the base of the blank is placed against the back of the holder shown at *A* in Fig. 2, after which the plug *B* is pressed down so that the center point *C* imbeds itself in the wood. The plug *B* is then locked in place by tightening the thumb-screw *D*, which, in turn, chucks the work on the two points *E*. The next step is to set the stop-screw *F* to give the correct tooth thickness from flank to flank. This stop-screw engages the edge of the table of the disk grinder and controls the distance through which the work may be fed to the wheel. After setting the fixture for the tooth thickness, it is necessary to provide for obtaining the required flank angle and this is done by setting the pin *G* in the proper position in the segment of the fixture. The work is then forced against the grinding wheel until further movement is stopped by the screw *F* engaging the edge of the work-table as previously mentioned. After this has been accomplished, the spring pin *G* is released from the segment and the fixture swiveled back and forth about its pivotal center to grind the face of the tooth. After these two operations have been completed, the work has a flat flank and a circular face, but the face curve is not tangent to the flank.

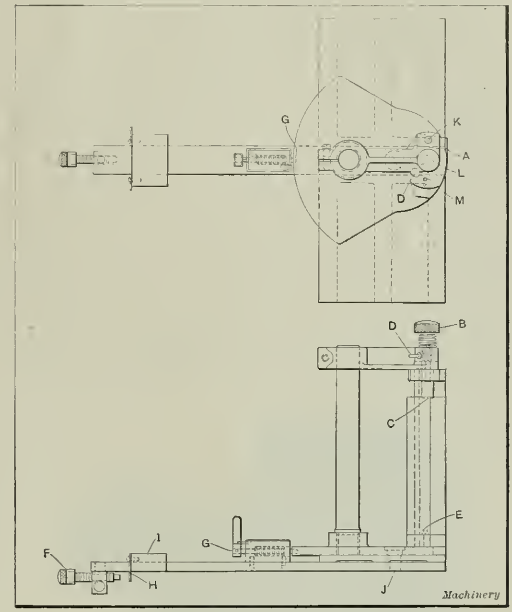


Fig. 2. Gear Tooth Grinding Fixture for Use on Besly Patternmakers' Disk Grinder

In order to secure a smooth surface and to approximate the required involute curve for the tooth, the next step is to withdraw the work from the wheel and move the leaf *H* carried by the block *I* into position against the end of the stop-screw *F*. After this has been done, the work is again brought into contact with the disk wheel and rotated about the pivotal center *J*. The effect of the leaf *H* is to increase the radius about which the fixture is pivoted, with the result that a so-called "face and flank" curve is generated, which is tangent to the flank of the pattern and connects smoothly with the face curve previously formed. The combination of the "face and flank" curve and the face curve results in the formation of a curve which is a very close approximation to the required involute tooth form.

After this has been done, the work is withdrawn from the disk wheel and the pin *K* is withdrawn to enable the work-holder to be revolved about the center *L* in order to bring the opposite side of the pattern into position to be formed by the disk wheel. The pin *K* is inserted in the hole *M* which locks the work in position for forming the opposite side of the tooth. This process enables gear teeth which are exact duplicates of each other to be made, and teeth made on this fixture are much more accurate as regards size, curvature and parallelism than it has formerly been possible to make them. Using this fixture on a Besly patternmaker's disk grinder, an apprentice can turn out more work in a few minutes than a skilled patternmaker could in a day when working by hand.

CINCINNATI GRINDER HEADSTOCK

A recent improvement made on the plain and universal grinding machines built by the Cincinnati Grinder Co., Cincinnati, Ohio, consists of a headstock with means for providing either a live center or a dead center according to the requirements of the work. The illustrations show the headstock for a universal grinder, but after reading the following description, it will be evident that the same arrangement is equally applicable for use on plain grinding machines. This new headstock is secured to the reciprocating table in the usual way. The spindle runs in any suitable form of bearings, and in the forward bearing a shoe is provided which enables the spindle to be clamped by tightening a hand-screw that binds the shoe against the spindle.

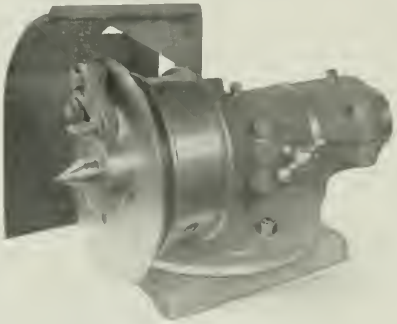


Fig. 1. Front View of Cincinnati Headstock

It will be seen that the spindle projects out from the front bearing and that a sleeve *A* is keyed to the spindle so that it rotates in unison with it. The driving pulley is journaled on the sleeve *A*, this pulley being provided with a lubricated anti-friction bushing. The pulley is held against longitudinal movement by means of the flange on the sleeve *A* and a similar flange on sleeve *B* which is threaded onto the end of the spindle. The faceplate *C* is secured to the pulley and provided with a work-engaging stud; and the end of the spindle hole is tapered to receive the usual form of tapered shank center or chuck, according to the requirements of the work.

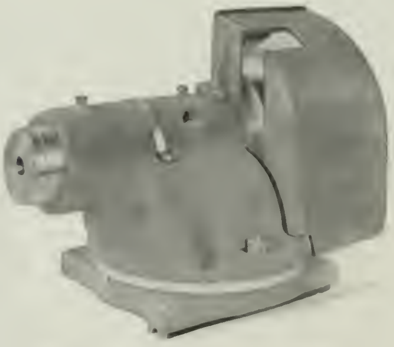


Fig. 2. Opposite Side of Cincinnati Headstock

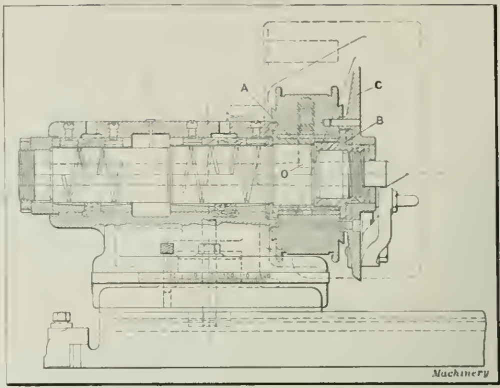
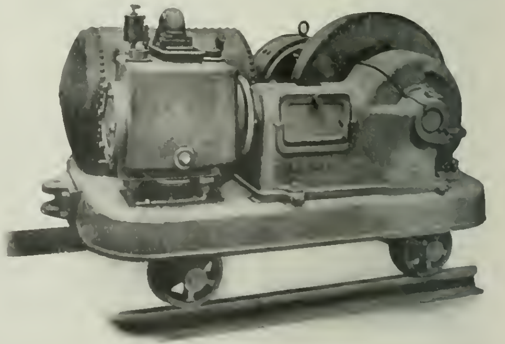


Fig. 3. Cross-sectional View of Headstock showing Tight or Loose Pulley Feature

When it is desired to operate the headstock with a live center the shoe *D*, which is carried in a socket in the pulley, is tightened by a screw so that the pulley is clamped to the sleeve *A* and consequently to the spindle. Under these conditions, the spindle rotates in the headstock, providing a live center. In order to obtain a dead center, the shoe *D* is loosened and the shoe in the front spindle bearing is tightened in order to bind the spindle and prevent it from rotating in the headstock, thus providing a dead center.

SULLIVAN PORTABLE AIR COMPRESSOR

The small motor-driven air compressor illustrated herewith is an extremely useful equipment in industrial plants which require compressed air for operating pneumatic tools and for other purposes. The complete unit is mounted on a truck of any desired wheel gage and is driven by a 15-horse-power motor supplied by the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Referring to the illustration, it will be seen that the equipment comprises the air compressor, a storage tank and a motor starting rheostat in addition to the driving motor. The motor is of the damp-proof type and will operate successfully in very damp locations. A motor may be provided for use on either alternating or direct current.

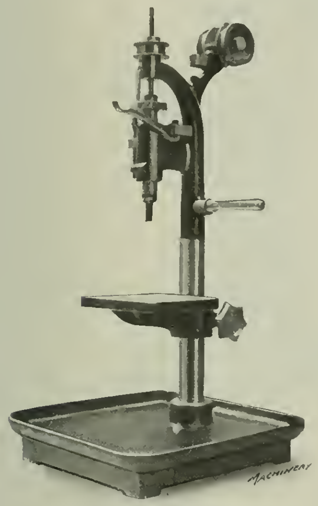


Sullivan Motor-driven Portable Air Compressor

The receiver is made of plate steel and is tested to withstand an air pressure of 100 pounds per square inch. A pop safety valve, a pressure gage and a blow-off or drain cock are provided on the receiver. The construction of the air compressor is very substantial. All bearings are provided with means of adjustment and may be easily removed, so that replacement is an easy matter, when necessary. The cylinder is lubricated by a sight-feed air cylinder lubricator, and the crankshaft and crosshead by the splash system. An unloading device on the air inlet valves saves energy when the demand for air is less than the capacity of the machine. This portable air compressor is a recent product of the Sullivan Machinery Co., Chicago, Ill.

LANGELIER HIGH-SPEED BENCH DRILL

The accompanying illustration shows a high-speed bench drill designed and built by the Langelier Mfg. Co., Providence, R. I., for use in drilling fine holes through steel piano wire gages. The machine may also be used for milling and burring small work. The standard machine of this type has a spindle turned to a taper to fit the No. 0 Morse taper socket of a Beach chuck for drills from No. 0 up to ⅛ inch. If so desired, any special spindle nose may be provided to meet the requirements of individual cases. This bench drill is designed to run at speeds between 4000 and 5000 revolutions per minute.



Langelier High-speed Bench Drill for driving Drills up to ⅛ Inch

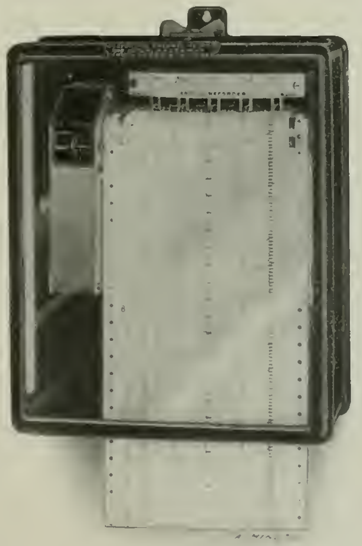
The main spindle is made of hardened and ground tool steel and runs in perforated phosphor-bronze bushings inside the feed sleeve. The perforations in these bushings act as reservoirs for collecting and distributing lubricant, which is supplied through a small tube oiler at the left-hand side of the feed sleeve bearing. The pinion feed shaft is pivoted on two hardened steel centers and the sleeve is fed by pressure of the thumb applied on the thumb lever shown at the right-hand side of the machine, which makes the drill exceedingly sensitive. The handle which projects at the right-hand side of the frame is a rest for the operator's hand and serves to steady it while feeding the sleeve by means of the thumb lever. A closely wound but very resilient steel spring located at the left-hand side of the machine returns the spindle the moment the pressure is released from the thumb lever.

In order to maintain the maximum sensitiveness of the feed and spindle return, the driving pulley, which is 1½ inch diameter by 9/16 inch face width and flanged for a ⅜-inch cotton belt, is mounted over a projecting phosphor-bronze bushing which is fixed in the upper bearing of the main spindle. The pull of the belt is carried by this bearing, which entirely relieves the main spindle from strains due to the belt tension. Two steel keys projecting from a steel driving collar, set flush and locked in the upper side of the driving pulley, engage two keyways in the main spindle, the drive being effected in this way.

The driving belt idler pulley bracket may be adjusted in or out to maintain the proper belt tension; this bracket is reversible to provide for driving the machine from above or below the bench. The idler pulleys are 2 inches in diameter by 9/16 inch face width, and are mounted on loose phosphor-bronze bushings which are perforated to distribute the oil over the pulley bearings. The work-table is accurately finished to bring it exactly square with the drill spindle. It may be adjusted vertically through a distance of 3½ inches or swung to either side to provide for handling special work. The distance from the lower end of the chuck to the table surface when the table is at the bottom of its adjustment is 6½ inches. It will be seen that the base of the machine has a projecting rim to provide for catching chips, etc. The bench space occupied is 11½ inches square, and the weight of the machine about 63 pounds.

ESTERLINE SERVICE RECORDER

Competition in manufacturing has encouraged the development of a number of instruments and devices intended to increase efficiency in machine tool operation, among which the service recorder may be mentioned. A new instrument of this type has recently been placed on the market by the Esterline Co., Indianapolis, Ind. This meter operates on the same general principles as common graphic or curve drawing instruments; it is equipped with any number of pens desired from one to ten inclusive, and each of these pens is controlled electrically. The entire instrument is mounted in an enameled metal case, with rubber covered binding posts located at the bottom for making connections, and the case has suitable lugs at the top and sides for fastening to a wall or partition. The front cover enclosing the chart and clock, is provided with glass panels on the sides, top and front to permit inspection of the record without opening the instrument. The pens rest on a long strip of paper or record chart which is driven through the meter at a constant rate of speed by a jewel balance wheel type of eight-day clock. This clock may be equipped with gears giving five paper speeds of ¾, 1½, 3, 6 or 12 inches per hour, and an attachment can also be provided giving additional chart speeds of 45, 90, 180, 360 and 720 inches per hour.



Esterline Service Recorder made for Use with from One to Ten Machines

The clock is provided with stops so that its operation may be interrupted at any time, and a regulator is furnished for adjusting the speed while in service. Clocks are furnished with a re-rolling device for winding up the finished record in the bottom of the case, or this device may be dispensed with and the finished chart fed through a slot in the bottom of the cover, the record being torn off daily. Record charts are supplied in rolls 90 feet in length and 6 inches in width, and this record may be cut up in short lengths for convenience in filing. Perforations are provided along each margin of the chart which are engaged by pins on the clock driving roll, insuring perfect alignment of the paper and accurate timing of the clock. Each pen is so controlled that when a record is made, a vertical line about ⅛ inch in length is drawn across the chart, the pen returning to the zero position after each record is made. The controlling devices for the various pens are connected to different machines in such a way that one record is produced for each operation or for a certain number of operations. On account of the paper being drawn through the meter by the clock, the resulting record is a series of short lines, the spacing of which represents the rate at which operations are being completed. If the machine is being operated up to capacity, the series of lines will be close together, but if the machine stands idle for several minutes, a straight line will be drawn on the chart showing that no work was accomplished during that time.

The electrical control for the pens is very efficient and requires such a small amount of current that the power consumption is negligible. The instruments have high internal resistance and may be operated at any distance from the machines. One instrument may be located in the superintendent's or manager's office and operated by small wires connected to the machines located at various parts of the plant several thousand feet away. Any source of direct current may be used for operating the instrument. On machines operating at a high rate of speed and completing a number of pieces or operations in a short period of time, it is advisable to gear the controlling device on the machine so that one line on the chart will represent 10, 100 or any other convenient number of operations. On account of the large number of chart speeds that may be obtained on this instrument, it is easily possible to get a suitable record on any class of work. If operations are completed at a slow rate, then the chart may be operated at a slow speed so as to shorten the record; but if operations are completed at a rapid rate, then a faster chart speed will give a clearer record. These instruments are also furnished with a counting attachment arranged in such a way that they total up the operations so that the total production for a day or period can be quickly determined direct from the recorders. Service recorders are used for a variety of purposes in addition to machine tool recording. Each pen can be arranged to give a record of when motors or other machines are being operated and when idle.

HENRY & WRIGHT TAPPING ATTACHMENT

The Henry & Wright Mfg. Co., 760 Windsor St., Hartford, Conn., is now making a tapping attachment which is illustrated herewith. The noteworthy feature of this device is that the forward drive is direct from the spindle of the drilling machine to the tapping chuck, while the reverse is through gearing which backs out the tap at a speed increase of about 20 per cent. The operation of the mechanism will be best understood by referring to Fig. 3. The gear A is secured to the sleeve or shank by which the attachment is connected to the spindle of the drilling machine. This gear rotates right-hand, and when it is desired to drive the tap forward the gear A is secured to the driving stem B on the tapping chuck. When it is desired to reverse the tap to back it out of the hole, this result is obtained by securing the gear C to the stem B. When this is done the drive from the gear A to the gear C is through the two idler gears which reverse the direction of rotation.

The connection of the gear A or the gear C to the driving stem B is effected by means of the three balls D which are carried in the driving stem. When the tap is fed into the hole, these balls enter the pocket in the driving gear A, which is eccentric to the driving stem B of the chuck. The resistance offered by the tap causes the balls D to bind in the pocket of the gear A, thus effecting a clutching action which possesses ample power to drive the tap direct through the stem B. The gear A causes the gear C to rotate, but during the forward motion of the tap the gear C is loose on the stem B and plays no part in the drive.

When the hole has been tapped to the required depth, and the feed lever on the drilling machine is drawn up, the balls D are pulled out of the pocket in the gear A and enter a

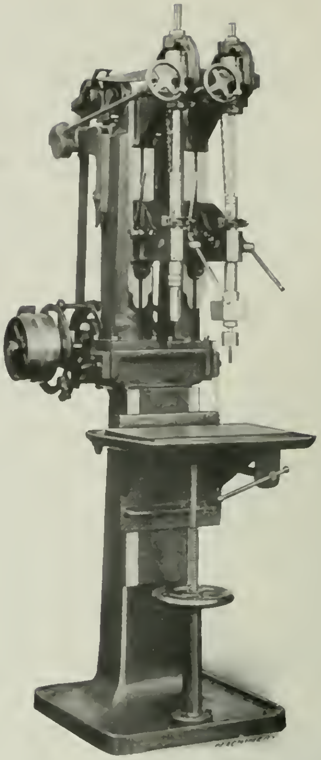


Fig. 1. Henry & Wright Drilling Machine equipped with New Tapping Attachment

similar pocket in the gear C, except that the eccentricity of this pocket relative to the driving stem B is in the opposite direction. In moving from the gear A to the gear C, the balls D pass the neutral position which is shown in Fig. 3, so that the attachment is momentarily at rest before the reversal takes place. This tends to relieve the mechanism of the shock of a sudden reversal. When the balls enter the pocket in the gear C, the gear A drives through the two idler gears, thus reversing the direction of rotation of the tap and backing it out of the hole. As previously mentioned, the ratio of the gearing is such that the tap is backed out at a speed increase of 20 per cent.

It will be seen that two methods of connecting the attachment to the drilling machine are shown in Fig. 3, one of these consisting of a sleeve which fits over the spindle and is driven by a key passing through the drift slot, while the other consists of a No. 2 Morse taper shank with the usual form of driving tang. Figs. 1 and 2 illustrate an even better method of attachment, which consists of making the attachment a part of the drilling machine spindle. At present these tapping attach-

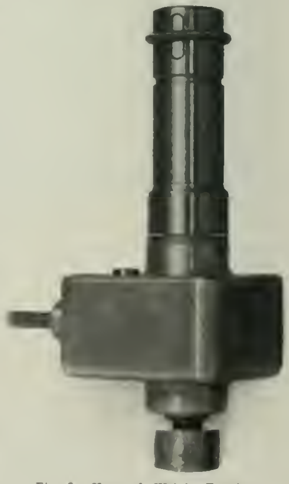


Fig. 2. Henry & Wright Tapping Attachment

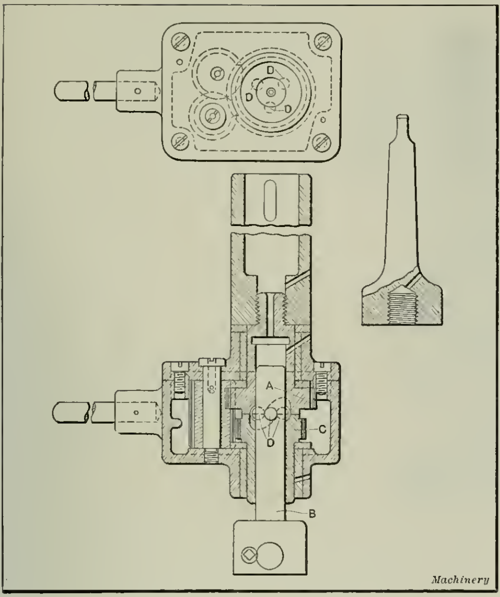
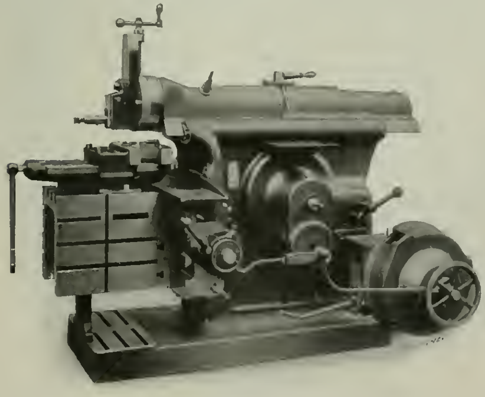


Fig. 3. Cross-sectional View showing Method of Operation

ments are being made in two sizes known as Nos. 4 and 5. The No. 4 attachment will drive taps up to ⅜ inch, while the capacity of the No. 5 attachment is for taps up to ½ inch. In a recent test conducted in the manufacturer's factory, a ¼-inch tap with twenty threads to the inch was operated in tapping holes ⅜ inch deep in malleable iron at the rate of one thousand holes per hour. The tap broke after completing 19,367 holes, which shows that the operation of the attachment is so accurate that no undue strain is put on the tap.

GOULD & EBERHARDT SHAPER PULLEY GUARD

The application of a constant-speed single-pulley drive instead of the four-speed cone pulley used on the shapers built by Gould & Eberhardt, Newark, N. J., makes possible the application of a gear guard to meet the most stringent requirements for safety measures for the protection of factory employes. It will be seen from the illustration that the guard completely encloses the pulley and clutch, so that it is impossible for the operator of the machine to be injured. The guard may be set around to any required position, according to the belt angle, and if necessary may be very easily removed. Progressive machinery builders are coming to recognize the desirability of equipping their machines with all necessary guards. Where this practice is followed, the guard is designed with the same care as other parts of the machine, and as a result it harmonizes with the machine instead of being an eye-sore, as it so often is when applied after the machine has been placed in operation in the user's shop.



Gould & Eberhardt Shaper equipped with a Guard over the Constant-speed Pulley

The single pulley is equipped with an improved form of clutch and brake, controlled by a lever, so located that the operator can stop the machine at any point of the stroke without requiring the driving belt to be stopped. The gear box is of the selective automobile transmission type. It is of simple design and the gears are easily shifted while the machine is running. In shifting from the lowest to the highest speed, however, it is desirable to stop the machine for a moment before re-engaging at the higher speed. The gears in the box have cut teeth and run in oil; they are made of hardened vanadium steel to give them a long life under the most severe operating conditions. The changes of speed are obtained by shifting the bottom lever shown in the illustration. It will be seen that there are four positions in which this lever can be located to give any of the four speed changes, the arrangement being such that two speeds cannot be engaged at the same time. This number of speeds is doubled by the back-gears, giving a total of eight available speeds. The back-gears are engaged by means of a small lever shown above the gear box at the extreme right of the illustration. Driving direct on a 28-inch shaper, the speeds obtained from the gear box are 39.9, 58.1, 821 and 115.3 strokes per minute. With the back-gears in, the corresponding speeds are 9.35, 13.22, 19.24 and 27 strokes per minute. The handwheel on the pulley shaft provides means for adjusting the drive to engage the back-gears when the machine is not in motion.

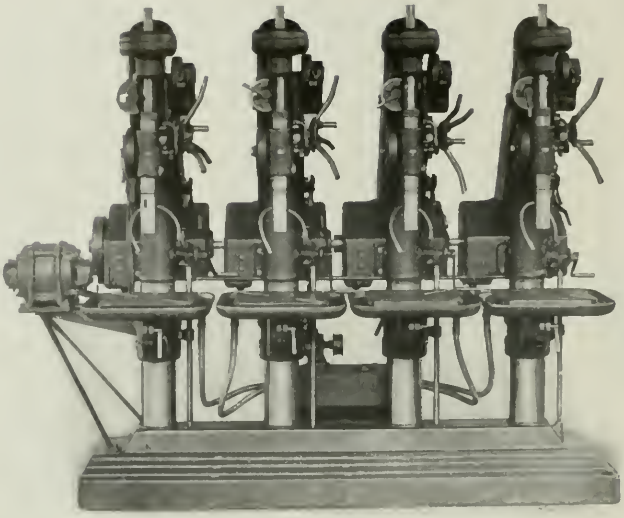
BERNSTEIN FACTORY TRUCK

For handling bar stock, the Bernstein Mfg. Co., Third St. and Allegheny Ave., Philadelphia, Pa., is manufacturing the steel factory truck which is shown in the accompanying illustration. The noteworthy feature of this equipment is that it is made of steel tubing and is practically indestructible. The uprights are made of 1⅜-inch stock, while the horizontal braces are of 1⅛-inch stock, these members being connected by chilled joints which are not likely to break. The truck is mounted on swivel wheels 6 inches in diameter, the wheel brackets being attached to the uprights of the truck by steel pins. The truck is 18 inches wide by 24 inches long; the height of the lower tier from the floor is 10 inches, and the clearance between the upper and lower tiers, 11 inches. When so desired, heavy removable steel shelves may be mounted on the tiers, and trucks of this type can be made with any number of tiers and in any required size.

Bernstein Truck for handling Bar Stock

BARNES GANG DRILLING AND TAPPING MACHINE

In the June, 1914, number of Machinery, the 20-inch self-oiling, all-geared drilling and tapping machine built by the Barnes Drill Co., 814 Chestnut St., Rockford, Ill., was illustrated and described. Since that time, the Barnes Drill Co. has developed a gang drilling and tapping machine which comprises four machines of the type described in the previous article referred to, which are mounted on a common base. Referring to the illustration, it will be seen that the



Four-spindle Drilling and Tapping Machine made by the Barnes Drill Co.

four machines are driven by a common motor and that a common reservoir and pump serves to deliver oil to all four machines.

Aside from the changes in construction incident to mounting four machines on a common base, the design follows closely along the lines of the single drilling and tapping machine. For the benefit of those who did not read the previous description, a brief summary of the important features will be presented. The exceptional strength and power of the self-oiling, all-geared machine makes it possible to operate at the maximum speeds and feeds of high-speed steel twist drills. Every bearing, with the exception of the spindle sleeve and cross spindle bearings, is self-oiled. Each spindle is provided with eight changes of geared speed and eight changes of geared feed, all of these changes being under instant control of the operator without requiring him to leave his position at the front of the machine. All speeds and feeds are independent of each other, and all gears are fully enclosed to meet the requirements of modern safety laws.

The spindles may be provided with back-gears, geared feeds and automatic stop; or with simple geared feeds and automatic stop. Reversing friction clutch gears and automatic reverse may also be applied, when required for the class of work to be handled on the machine. The oil for the self-oiling system is delivered to each machine from a common reservoir and distributed to all of the gears and bearings including the crown gears and the feed-box. Those who are interested in a more detailed description of the design and construction of the machine are referred to the description of the single machine published in June, 1914.

CINCINNATI BORING MILLS

One size of an improved line of boring mills which has been added to the products of the Cincinnati Planer Co., Cincinnati, Ohio, and which embodies all of the latest features of boring mill design, is shown in the accompanying illustrations. This line of machines includes six- and seven-foot sizes. The table is driven by a bevel gear and pinion, with the pinion supported by an extra bearing in the bed to eliminate the objectionable features of the overhang construction. The table rests on a self-centering angular track and is guided by a long spindle which revolves in bushed bearings in the bed. The angular table track is self-oiled by a spiral groove in the table which carries the oil from the reservoir to the top of the track, after which it returns to the reservoir. The vertical spindle bearings are oiled from the outside, the oil being delivered through a pipe of ample dimensions and distributed by spiral grooves on the spindle.

Either motor or belt drive may be employed to deliver power to the top shaft, from which a belt transmits the motion to the driving pulley at the base of the machine, the arrangement being clearly shown in Fig. 2. Power is also taken from the top shaft to operate the rail-elevating mechanism and the rapid power traverse mechanism. Twelve table speeds are provided, four of which are obtained from the speed box which is cast integral with the bed. The long lever with a pointer, which is clearly shown on the side of the housing in Fig. 1, controls two speeds and this lever also operates the brake which stops the table. This brake is a new feature of Cincinnati boring mills which operates automatically and has a constant braking value irrespective of the table speed. As soon as the handle is moved into the neutral position, the brake acts automatically and stops the table without any further effort on the part of the operator. The vertical handle shown at the side of the housing controls two speeds through a jaw clutch. The two handles referred to are carried on shafts which extend through to the opposite side of the machine, where a duplicate set of handles is provided to make it possible to obtain the speed changes from either side.

The feed is taken from the main driving shaft on the inside of the bed, the motion being transmitted to the feed-

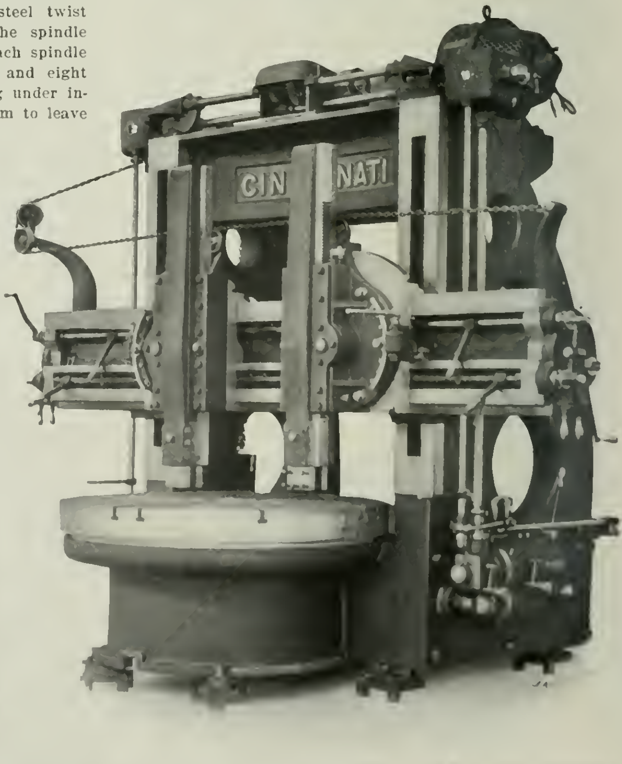


Fig. 1. Front View of Improved Cincinnati Boring Mill made in Six and Seven Foot Sizes

boxes at the sides of the housings. A tumbler gear arrangement gives five changes of feed, which are doubled by the handle shown at the side of the feed-box, thus providing ten changes of feed, each side being independent of the other. The feed reverse lever is conveniently placed for the operator; it is shown at the extreme front of the feed-box. The handles shown on the vertical rods control the rapid power traverse; the operation of these handles is extremely simple and "fool-proof." By turning the handles to either the right or left, the clutch from the feed-box is automatically disengaged, after which the rapid power traverse clutch becomes operative. The direction in which the handles are moved indicates the direction in which the heads will move. Sensitive adjustment handles are provided on the screw and rod for making the final adjustments of the tools; these handles are moved along the screws so that they are within instant reach of the operator at all times.

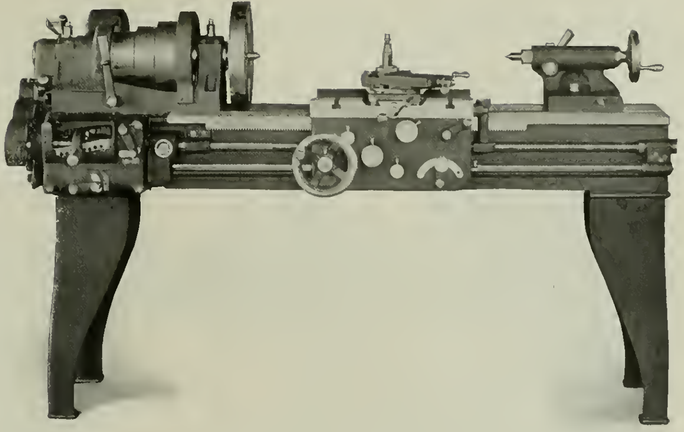


Fig. 1. Rockford 13-inch "Economy" Lathe equipped with Quick-change Gear Unit

The rail is of extremely heavy construction and clamped on both the inside and outside of the housing faces. The saddles have a long narrow guide bearing at the bottom of the rail which eliminates binding action while the heads are under cut, in this way relieving the feed mechanism from excessive strains. The housings are carried to the floor and locked to the sides of the bed by heavy tongues, bolts and dowel-pins; they are fastened at the top by a heavy arch. "Safety First" has not been overlooked in the design of these machines, as all gears and other revolving parts are completely enclosed.

ROCKFORD 13-INCH "ECONOMY" LATHES

To meet the demand for a small, heavy-duty lathe of sufficient weight and power to stand up under the conditions of rapid production existing in the up-to-date manufacturing plant, the Rockford Lathe & Drill Co., Rockford, Ill., has added to its line a 13-inch, double back-geared machine which is built with quick-change gears as shown in Fig. 1, or with a semi-quick-change gear mechanism as illustrated in Fig. 2. The machine is particularly well suited for handling the work of garages and general repair shops, and possesses the necessary accuracy to enable it to fulfill the requirements of toolroom work. The same description applies to both machines, with the exception of the paragraphs referring to the change gears.

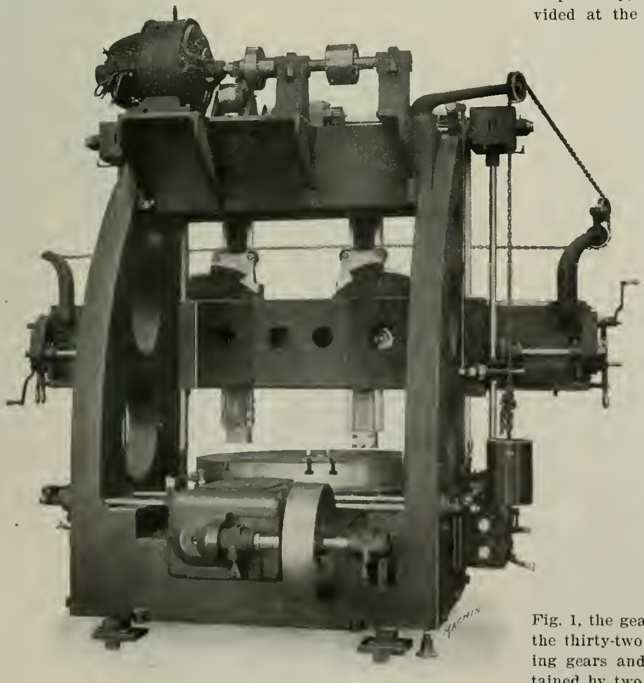


Fig. 2. Opposite Side of Cincinnati Boring Mill showing Arrangement of Drive

The bed is of deep cross-section with wide cross braces at short intervals which, together with its liberal proportions, effectually eliminate all vibration. The headstock is of massive construction and firmly bolted to the bed; it has a three-step cone pulley with steps of 6, 7¼ and 8½ inches respectively, and carries a 2½-inch belt. A handle is provided at the front of the head which affords a convenient means for shifting the double back-gears. The spindle bearings are bushed with high-grade phosphor-bronze, and the spindle is made of high-carbon steel accurately ground and with a 1 5/16-inch hole through it. The thrust on the spindle is taken by a special thrust bearing, consisting of alternate collars of hardened steel and bronze. The tailstock is of the offset type and may be set over to provide for turning tapers. The tailstock spindle can be locked by an improved form of clamp, which does not require the barrel to be split and so adds greatly to its strength.

The carriage has an unusually wide bridge which permits taking heavy cuts without chatter. The thread indicator can be disengaged when not in use; this indicator, like other types of instruments used for the purpose, enables the operator to catch any pitch of thread without reversing the lathe. The apron is of heavy design and provided with double bearings for all shafts, which is a very essential feature of a heavy duty lathe. The gears are of wide face and coarse pitch. All feeds are reversed in the apron and interlock with the bronze lead-screw nut, making it impossible to engage the lead-screw and feed-shaft at the same time.

On the quick-change gear lathe illustrated in Fig. 1, the gear box is a simple and powerful unit which gives the thirty-two changes of threads and feeds by means of sliding gears and hardened steel clutches. The changes are obtained by two handles in connection with the tumbler. A direct reading index plate is mounted on the front of the gear box. From 4 to 56 threads per inch may be cut without requiring the removal of any gears; and special pitches may be cut by substituting extra gears on the quadrant, an almost unlimited range being obtainable in this way. All gears in the quick-change unit have wide face and coarse pitch and are cut from solid steel blanks. The lead-screw and feed-shaft operate independently of each other and either the lead-screw or the feed-shaft is engaged by means of the knob at the front of the box.

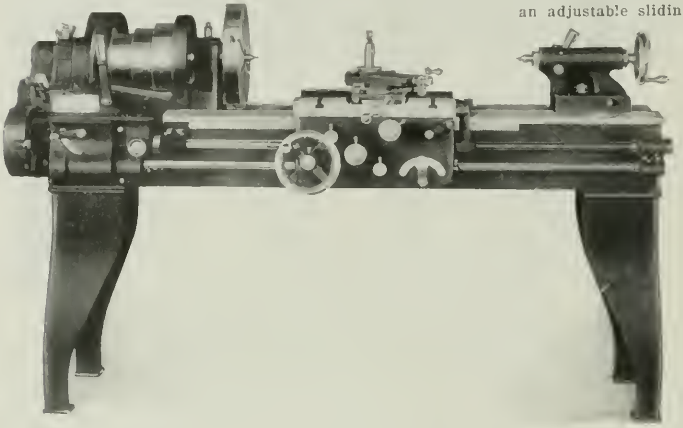


Fig. 2. Rockford 13-inch "Economy" Lathe with Semi-quick-change Gears

The machine shown in Fig. 2 is equipped with what is known as a semi-quick-change unit which provides three quick changes of feeds and threads for each change of gears, these changes being obtained through sliding gears and hardened steel clutches. A practically unlimited range of feeds for all classes of work may be obtained in this way. This gear box also simplifies thread cutting operations, each three changes of pitch being obtained by one change of gears. The necessity of compounding gears which has been one of the great drawbacks of change gear lathes is avoided. As in the quick-change gear lathe, the lead-screw and feed-shaft operate independently, either the lead-screw or the feed-shaft being engaged by the knob at the front of the box.

The principal dimensions of these 13-inch Rockford lathes are as follows: Swing over ways, 14⅛ inches; swing over carriage, 8 inches; distance between centers with a six-foot bed, 37 inches; length of bed, 6, 8 or 10 feet; ratio of back-gears, 3.42 : 1 and 9.07 : 1; available spindle speeds, 20 to 435 revolutions per minute; size of tool used, ½ by 1 inch; net weight of quick-change gear lathe with a six-foot bed, 1450 pounds; and net weight of semi-quick-change gear lathe with six-foot bed, 1425 pounds.

WATERBURY-FARREL DIAL PILLAR PRESSES

The accompanying illustrations show machines belonging to a new line of pillar presses manufactured by the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn. These machines may be equipped with either a ratchet dial attachment or a friction dial attachment, according to the requirements of the work; and the attachments are interchangeable. In order to avoid the difficulty which has been experienced in applying the usual forms of dial feed attachments to pillar presses, two special mechanisms have been designed to meet the requirements of this type of machine. The construction and method of operation of these two dial feeds will be readily understood from the following description and illustrations.

Fig. 1 shows one of the Waterbury-Farrel pillar presses equipped with the ratchet dial attachment, and Figs. 2 and 3 show front and rear views of the mechanism which controls the operation of the dial. Referring to these illustrations, it will be seen that the pawl is mounted on an arm *A* which causes it to move in a circle concentric with the dial. It will be seen that link *B* is connected to the end of the pawl which is shaped like a bellcrank, and that there is a stop on the arm *A* which limits the motion of the pawl. The link *B* is operated by the arm *C*, which is pivoted at a point behind the right-hand upright of the press; this arm is, in turn, operated by the roll arm *D*, the two members being connected by an adjustable sliding block which may be regulated for the use of any number of notches in the dial from 12 to 24. The pawl, together with the complete dial driving mechanism, is returned by a spring which is located in such a way that it acts on both the levers *C* and *D*, eliminating lost motion from the mechanism and making the safety device (which will be described in a subsequent paragraph) more positive in action than it would be if the levers were allowed to get loose at the joint.

The timing of the dial operating cam, which, as shown, is mounted on a side shaft and driven from the left-hand end of the crankshaft by bevel gears, is such that the dial starts to move forward when the ram is half way up and the indexing of the dial is completed at or before the time when the ram reaches the highest point of its stroke. The cam holds the pawl and dial in this position until the ram has practically reached the lowest point of its stroke, and by this time the tools have entered the dial so that before the pawl releases it, all possibility of its shifting out of place has been eliminated. When the pawl starts to move back, the first part of the motion consists of lifting the pawl out of the dial notch, this motion being limited by the stop in the lever *A*. The lever *A* is then carried back until the pawl has been brought into position to enter the next notch in the dial. It will be evident from this description that the wear resulting from drawing the pawl over the dial is eliminated. Dur-

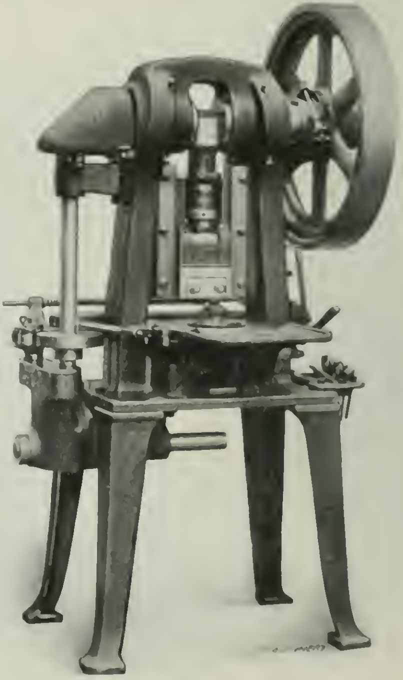


Fig. 1. Waterbury-Farrel Pillar Press equipped with Ratchet Dial

ing this time, the ram has moved up and if, through the breaking of any part or from some other unusual condition, the dial is not indexed to the right place, the locking lever *E* which is mounted on the lever *C*, will not enter the slot in the dial, and as a result, the opposite end of the lever *E* will engage the stop on lever *F*, thus holding this lever up and making it impossible to engage the clutch for the next stroke of the press. The arrangement of this mechanism is clearly shown in Fig. 3.

In running a dial press, it sometimes happens that the knockout will fail to bring the work out of the die or that the bottom of a shell will be torn out in drawing it through the die, thus leaving a shell between the die and the dial. To avoid a serious accident in the event of an occurrence of this kind, the link *B* is so designed that it will be bent or broken before any other part of the press gives way, and as this link is simply a piece of cold-rolled stock, an accident of this kind is not serious. The clutch furnished on these machines is of the standard key type and the knockout is operated from cams carried on an under motion shaft, the cams acting directly on the end of a straight knockout rod. The knockout shaft is made of ample size and overhang, so that the cams can be readily changed. Its construction allows special cams to be easily substituted if necessary, and while the knockout motion can be easily changed to suit the work, its operation is very positive and the same type of mechanism has been used for many years on machines of the eyelet type. Referring to the general view of the machine shown in Fig. 1, it will be seen that all gears are thoroughly guarded and that a table is provided for holding the work; also that there is a shelf on the side of the machine for holding the wrenches that are required for making adjustments. The machine is controlled by a hand lever, or a foot treadle can be used without requiring any change in the controlling mechanism.

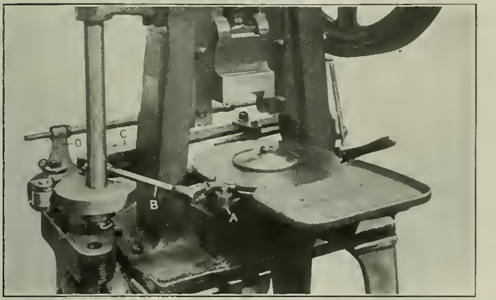


Fig. 2. Front View of Ratchet Dial Operating Mechanism

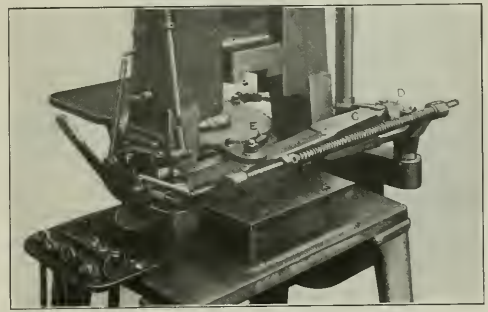


Fig. 3. Rear View of Ratchet Dial Operating Mechanism

Fig. 4 shows one of the Waterbury-Farrel pillar presses equipped with the friction dial attachment. There is nothing particularly unusual in the design of the friction dial, except that it is so arranged that the work can be either carried through the dies or brought up by the knockout so that it can be knocked from the top of the dies, a knockoff attachment being furnished for this purpose. Users of power presses know that a friction dial machine, while it is only useful for one operation and is only applicable for handling round work, can be operated at a very high rate of speed and by cheap labor, as it is merely necessary for the operator to place the work right side up on the dial. These Waterbury-Farrel pillar presses are made in four sizes of the so-called short-stroke machines, and four sizes of a machine of practically the same design except with a long stroke. The two largest machines of the line can be furnished either plain or geared, as desired.

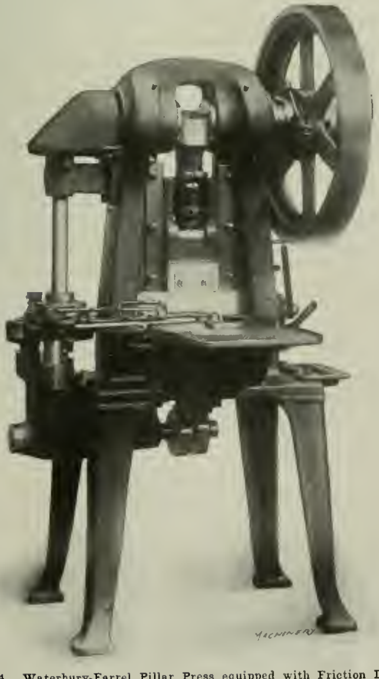
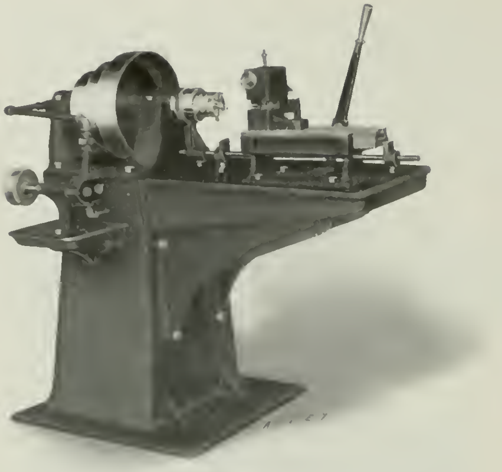


Fig. 4. Waterbury-Farrel Pillar Press equipped with Friction Dial

WEBSTER & PERKS THREADING MACHINE

The machine which forms the subject of this article was designed for the rapid and accurate threading of many parts, such as studs, rods and work of special shape, that are usually finished on screw machines. It is fitted with an adjustable self-opening die-head provided with adjustable front and rear stops; the front stop is employed to trip the die-head when the thread has been cut to any predetermined length, and the rear stop closes the head when the carriage has been returned by means of the hand lever. An automatic gripping holder is provided for use in connection with round stock studs or any similar work within its range. The holder grips the work automatically when the hand lever is pressed forward to bring the piece to be threaded into engagement with the die, and releases automatically when the carriage is returned to close the die. The carriage of the machine is also designed to permit of the ready application of special holding fixtures for handling odd shaped pieces.

Lubricant is supplied to the die-head by means of a geared oil pump which forces the oil through the hollow spindle; however, lubricant may also be supplied at the front of the die-head and delivered directly onto the work to be threaded. This machine has a range for U. S. standard threads from ¼ to ⅝ inch, inclusive, but the maximum diameter may be exceeded on especially fine pitches. By employing reversing pulleys in place of the cone pulley, and suitable tapping chucks, this machine is admirably adapted for tapping parts that come within its range. The machine is a recent product



Threading Machine built by Webster & Perks Tool Co.

of the Webster & Perks Tool Co., Springfield, Ohio, and in addition to the single spindle machine illustrated, a two-spindle machine is also made.

IMPROVED PICOLET CIRCULAR SLIDE-RULE

The circular pocket slide-rule illustrated herewith has undergone marked changes in construction since its first appearance about a year ago. This rule consists of a disk 2¾ inches in diameter by about ⅛ inch in thickness which has logarithmic scales graduated on both faces. Fig. 1 shows the side of the rule used commonly for performing the operations of multiplication and division. Referring to this illustration it will be seen that two direct reading logarithmic scales are provided. The inner scale is graduated on a small disk which can be rotated in relation to the main disk to provide for making the necessary settings of the scales. The transparent runner is held in frictional contact with the inner disk and provides a convenient means of rotating it relative to the larger disk.

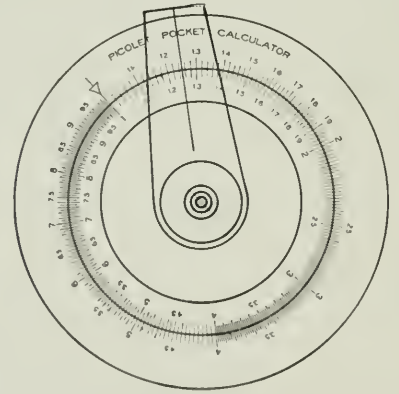


Fig. 1. Side of Circular Slide-rule commonly used for performing Operations of Multiplication and Division

Fig 2 shows the graduations on the opposite side of the slide-rule, and referring to this illustration it will be seen that the large disk has an inverted logarithmic scale graduated on it and a direct reading scale inside the inverted scale. The small disk has an inverted scale graduated on it. The inverted scales afford a very convenient method of extracting cube roots, while the inverted scale on the small disk and the direct scale on the large disk are used for extracting square roots. A pamphlet is provided with each rule explaining the methods of performing these operations.

No change has been made in the arrangement of the scales on the rule, but noteworthy improvements have been made in its mechanical features. As first issued, the scales were printed directly upon pyralin, a material similar to and best known under the proprietary name of celluloid. They are now printed upon the underneath side of transparent thin pyralin, a milk-white backing bringing out the characters in excellent contrast. The scales are then mounted upon a disk of sheet steel and held together on the opposite faces of the steel disk by a narrow ring of cement around the edge. A cross-section of the instrument, with thicknesses exaggerated, is shown in Fig. 3. This mode of printing protects the scale, and the steel reinforcement prevents the warping that almost invariably occurs with cellulose material. The smaller disks are treated in the same way and are prevented from buckling by thin metal disks which cover them within a quarter inch of the edge. The divisions and centering are accurate and the rule is guaranteed for a precision equivalent to three-place logarithms. The rule is also made with either the direct or inverted scale on one face and the other left blank.

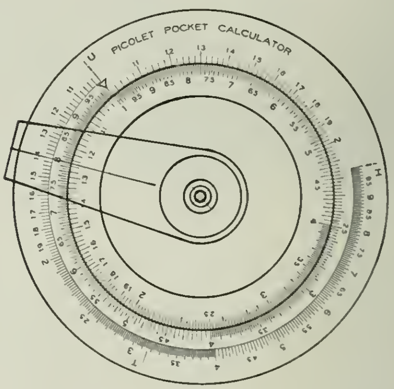


Fig. 2. Side of Circular Slide-rule used for extracting Square-roots and Cube-roots

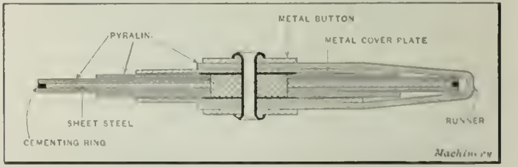


Fig. 3. Cross-sectional View of the Picolet Slide-rule showing Improvements in Construction

The dimensions are 2¾ inches in diameter by about ⅛ inch thick, and the rule is supplied in a round leather case. This slide-rule is made by Lucien E. Picolet, 19 South 9th St., Philadelphia, Pa.

M. B. HILL TOOL-HOLDER AND UNIVERSAL INDICATOR

The M. B. Hill Mfg. Co., Worcester, Mass., has recently added to its line a combination threading and cutting-off tool and the universal test indicator. These two tools are shown in the accompanying illustrations, and the following is a brief description of their more important features.

The tool-holder is offset at an angle of 30 degrees, which prevents interference when it is used for threading short work. This construction also enables the cutting-off tool to be set close to the chuck when engaged in cutting off stock. The blades are made of high-speed steel and held rigidly to the shank of the tool, which is made of ½ by 1 inch stock.

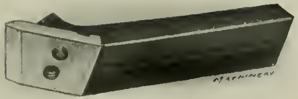


Fig. 1. M. B. Hill Threading and Cutting-off Tool-holder

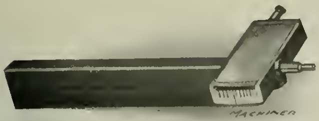
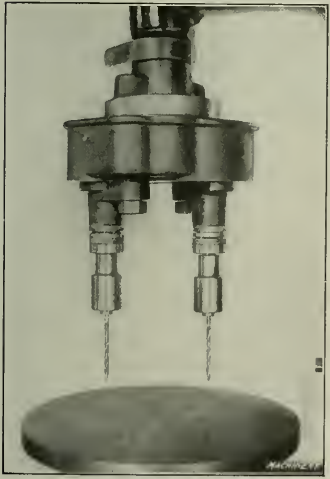


Fig. 2. Hill Universal Test Indicator

The universal test indicator is used for testing the truth of work in the lathe, drill press or planer according to the usual methods employed in using an instrument of this type. When mounted in the toolpost, the indicator can be used in any position, as the head swivels in every direction. The graduations read to 0.001 inch when used either externally or internally. The indicator is sensitive in action, but constructed in such a way that it will not be easily injured. The shank upon which the instrument is mounted is 7/16 by 7/8 inch in size.

SELLEW ADJUSTABLE DRILL HEAD

The two-spindle adjustable drill head illustrated herewith has been designed and placed on the market by the Sellew Machine Tool Co., Pawtucket, R. I., for use on sensitive drilling machines. The head is adjustable, its range being from 1 to 3½ inches center distance between the spindles. As the drill spindles of this head run much faster than the spindle of the drilling machine, the head is suitable for driving small drills.


Sellew Two-spindle Adjustable Drill Head

An interchangeable sleeve connects the drill head to the quill of the drilling machine in such a way that it can be adjusted around the spindle in order to have the center line of the drill chucks stand in any desired location. Owing to the arrangement of the spindles when they are adjusted in any location from the minimum to the maximum, the pressure of the feed cannot produce undue friction and heat in the head. The spindles and gearing are of alloy steel and bronze bushings or ball bearings are employed. All gearing is enclosed to provide for the safety of the operator. This drill head is made in three sizes and fitted with either solid or adjustable chucks or with Morse taper spindles, as desired.

SLOAN & CHACE AUTOMATIC LATHE

The small automatic lathe, front and rear views of which are illustrated in Figs. 1 and 2, is intended for machining small tapered bushings which are ½ inch in length by ⅝ inch in diameter at the large end. The Sloan & Chace Mfg. Co., Ltd., Sixth Ave., corner 13th St., Newark, N. J., builds a great variety of special metal working machines, and this is an example of an equipment of this kind recently designed and built in the company's shops. The operation of the machine is controlled entirely by cams, so that it is merely necessary for the operator to feed the blanks in at the top of the chute. As a result, the cheapest kind of labor can be used with satisfactory results. The output of the machine is eight or nine pieces per minute, and the results obtained have been so satisfactory that the Sloan & Chace Mfg. Co. intends making this machine as a regular product.

It will be evident from the illustrations that the head is driven by the usual form of cone pulley, and the taper of the work is obtained by means of a special tool-slide, the design of which is somewhat similar to the familiar form of taper attachment used on engine lathes. The five cam movements which control the traverse of the tool-slide, the feeding of the work and the opening and closing of the chuck, are driven from the pulley seen at the left-hand end of the machine in Fig. 2. The cycle of operations performed by the machine consists of taking a blank from the chute and transferring it to the chuck, closing the chuck on the blank and feeding the tool across the blank, then opening the chuck and ejecting the finished piece of work. The way in which these operations are performed may be briefly described as follows: Referring to Fig. 1, it will be seen that there is a pin mounted in the edge of the positive cam located at the front of the machine. When this pin engages the roller at the lower end of the lever which holds the blanks in the feed chute, this lever is swung about its pivot against the tension of a coiled spring, and allows one blank to drop out of the chute. As soon as the pin has passed under the roller at the lower end of the feed lever—which allows just enough time for one blank to drop out of the chute—the lever descends and holds the rest of the blanks up in the chute.

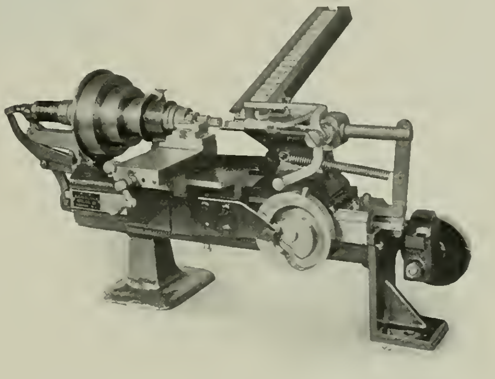


Fig. 1. Front View of Sloan & Chace Automatic Lathe

The next step is to convey the blank over to the chuck, which is open at this point in the cycle. This is accomplished by means of the horizontal plunger which moves over and pushes the blank into the chuck. This plunger is held back during the remainder of the cycle by means of a cam which releases it at the proper time so that the spring may pull it to the left, Fig. 1, and convey the blank to the chuck. With the blank in place in the chuck, the tool-slide begins to feed

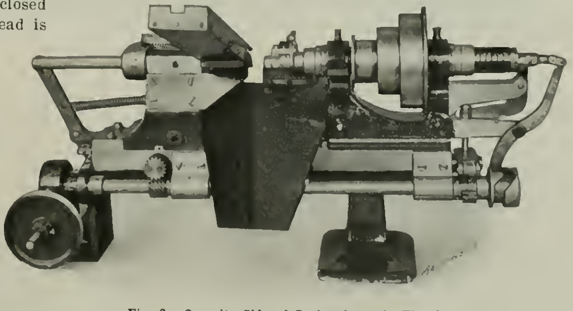


Fig. 2. Opposite Side of Latho shown in Fig. 1

to the left, through the action of a coiled spring, which moves it under control of the feed-cam, and in this way the work is turned to the required taper through the action of the special tool-slide with which the machine is equipped.

After the turning of the blank has been completed, the positive cam shown at the front of the machine in Fig. 1 starts to return the tool-slide to the starting point; and at the same time, the edge-cam located near the right-hand end of the horizontal cam-shaft in Fig. 2 raises a plunger into contact with the pivoted lever which controls the action of the collet chuck. This lever works against the tension of a coiled spring and opens the chuck, after which the barrel cam at the extreme end of the horizontal cam-shaft is able to operate the ejector rod to remove the finished work from the chuck. This sequence of operations is performed with the utmost smoothness and regularity and, as previously stated, the only attention which the machine requires is to have the blanks fed into the chute. A girl of average intelligence is able to handle this work.

LINDERMAN UNIVERSAL MACHINE TOOL

In engine rooms, experimental shops, on board ship, in garages, etc., there is need for a small machine shop, but lack of space frequently makes it necessary for the machine work to be sent out. Such a method of procedure is unsatisfactory because the cost of the work is high and the delay incident to sending the work to the jobbing shop, explaining what is to be done and then waiting for the work to be turned out, means serious inconvenience. To meet the requirements of this field, the Linderman Machine Co., Muskegon, Mich., has brought out a universal machine tool comprising a lathe, drill press, shaper, milling machine and keyseater. This machine is 11 feet long by 22 inches wide; and the floor space occupied is 20 square feet. It is stated that this machine meets all requirements of individual machines of the types which it comprises, and the floor space required is obviously much less. The machine is driven by an individual motor, so it is self-contained and installation is simplified as far as possible. If necessary, three men can work at this machine at the same time.

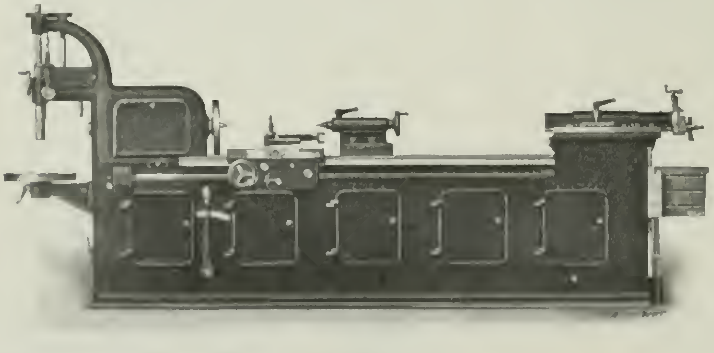


Fig. 1. Linderman Universal Machine Tool arranged for the Lathe, Drill Press, Shaper Combination

Fig. 1 shows the machine arranged for the drill press, lathe and shaper combination. In Fig. 2 the machine has been converted into the drill press, lathe and milling machine combination. Referring to this illustration, it will be seen that the shaper ram has been fitted with outboard support for the milling machine arbor, and that an auxiliary table has been fitted on the shaper table. The drive to the milling machine spindle is through a shaft from the lathe spindle, which is geared to the milling machine spindle as shown. In addition, the machine can be arranged for the combination of drill press, lathe and keyseater.

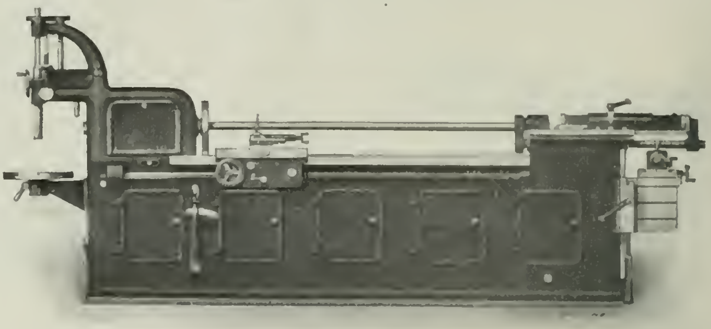


Fig. 2. Linderman Universal Machine Tool arranged for the Lathe, Drill Press, Milling Machine Combination

The principal dimensions of the lathe are as follows: Distance between centers, 44 inches; swing in gap, 24 inches; swing over carriage, 10 inches; diameter of large faceplate, 13¾ inches; diameter of small faceplate, 8 inches; cuts any standard thread from 3 to 24 per inch, including 11½ threads per inch. The headstock is of the all-geared type with the gearing enclosed, and eight changes of speed are provided. The lathe is equipped with a compound rest and set-over tailstock.

The drill press has a capacity for drilling holes from ⅛ up to 1½ inch in diameter, and drills to the center of a 20¼-inch circle. The movement of the spindle is 8 inches and the hole in the spindle is No. 3 Morse taper.

The extreme length of stroke available on the shaper is 14 inches and the cross motion of the table 19 inches; the vertical adjustment of the table is 14 inches. The distance between the table and the ram is 16 inches and the feed of the tool-block 4 inches. The table is 15 by 11 inches in size and the tilting table may be set at any angle between zero and 90 degrees.

The keyseater has a stroke of 14 inches and a maximum keyseating capacity of 8 inches. The work is held in the lathe chuck, and the keyseating bar is guided by a support held in the toolpost. The keyseating bar is actuated by the shaper ram, and the feed of the keyseating tool is through the cross-slide.

The shaft which transmits power from the lathe head to the milling machine is back-geared in a ratio of 2 to 1. The milling machine table has a transverse feed of 14 inches, a lateral feed of 4 inches, and a vertical feed of 14 inches. The distance between the table and the spindle may be from 3 to 14 inches, and a dividing head may be provided for handling those classes of work for which it is required.

The following outlines a few of the operations that can be conveniently handled on this machine. Pulleys or gears up to 24 inches in diameter may be turned, bored, faced and keyseated at a single chucking. Nuts and bolts of practically any diameter and thread may have the thread cut in them. Pipe and fittings up to 8 inches in diameter may be cut off and threaded. Keyways up to ¾ inch wide by 13 inches in length may be cut. Both internal and external grinding may be handled with the grinding attachment; and the machine may be conveniently used for profiling cams of various forms. One slot may be milled lengthwise and another slot shaped crosswise at a single chucking of the work.

Where a dividing head attachment is provided, spur or bevel gears may be cut. These are but a few typical operations which will tend to show the wide range of work for which this machine is adapted.

REED-PRENTICE FOUR-WAY DRILLING MACHINE

This special four-way drilling machine was designed and built for the Ford Motor Co., Detroit, Mich., for use in drilling four holes simultaneously in universal joint rings. The rings are held in individual fixtures, several of these fixtures being used with the machine so that while one ring is being drilled, a blank may be put in another fixture ready for the subsequent drilling operation. After the four holes have been drilled, the main fixture on the machine is unloaded and another ring—already clamped in a subordinate fixture—is re-loaded into the main fixture, after which the machine is again ready for operation. The spindles are driven from a main driving pulley located at the side of the machine and power is transmitted to each of the four spindles through spur gears, shafting and bevel gears.

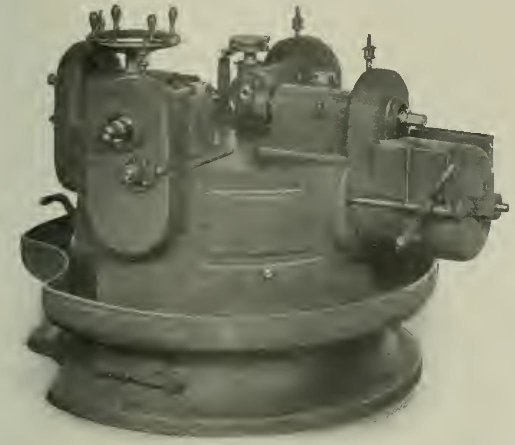


Fig. 1. Reed-Prentice Four-way Drilling Machine for drilling Universal Joint Rings

The heads are rigidly held to the main base of the fixture to maintain the alignment of opposite holes and to have the adjacent holes as nearly at right angles to each other as possible. The feed mechanism is of the rack and pinion type, power being delivered to each of the spindles by a bronze worm-wheel and hardened steel worm. The trip mechanism acts on the "drop worm" principle. In order to start the feed, a lever which is conveniently located at the operator's left hand brings the worm and worm-wheel into mesh. When the spindles have traveled in the required distance, an automatic knockoff cam located at the top of one of the rack pinions, engages the trip rod and automatically disengages the feed mechanism. The spindles are then returned to their original or starting positions by the operator, who can control the return by the wheel shown in the head at the left-hand side of the machine.

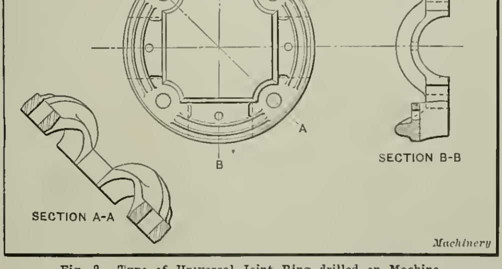


Fig. 2. Type of Universal Joint Ring drilled on Machine shown in Fig. 1

The driving gears of this drilling machine are all of the helical type and all bearings are bushed with phosphor-bronze. Wherever it is feasible, the shafts are provided with double support. The problem of lubrication is well taken care of by a pump and piping which leads to each individual bearing and provides a copious supply of oil. This system keeps the bearings clean at all times; the surplus oil drains back to a main reservoir, where it is filtered before again being pumped through the machine. The floor space occupied is 6 feet 6 inches by 5 feet 6 inches and the weight of the machine is approximately 7000 pounds. The Reed-Prentice Co., Worcester, Mass., is the manufacturer of this machine.

NEW MACHINERY AND TOOLS NOTES

Knurling Head: National-Acme Mfg. Co., Cleveland, Ohio. A knurling head adapted for use in one of the regular self-opening die-heads of this company's manufacture. The knurls are mounted in holders which are inserted in the head in place of the usual chasers.

Weight Calculating Instrument: Pittsburg Instrument & Machine Co., Pittsburg, Pa. This device was developed to provide a means for rapidly and accurately determining the weight of car wheels, gear blanks, dies and other circular metal parts from the drawings.

Punch Press Safeguard: H. & A. Lock Co., 156 Fifty-third St., Brooklyn, N. Y. An improved type of the duplex punch press safeguard which is styled the "duplex superior." This is really a simplified combination of the simplex and duplex safety attachments made by this company.

Set-screw Lock-nut: Hollow Screw Co., 41 Park Row, New York City. This set-screw is used for locking the ordinary type of socket safety set-screw in place. The lock-nut is of similar design to the set-screw but shorter, and is screwed down on top of the screw in the usual way.

Hob Grinder: Union Twist Drill Co., Athol, Mass. The hob to be sharpened on this grinder is mounted on an arbor which is carried by a center in the headstock spindle and supported at the outer end by the tailstock center. Index plates for any number of flutes from 5 to 14 are provided.

Gasoline Torch: Decker Mfg. Co., Newark, N. J. A torch designed to operate on the principle of liquid expansion. By filling the priming cup on top of the container and lighting the gasoline, the heat is carried to the gasoline in the container, causing it to expand and create a natural pressure.

Hold-down for Thin Work: Ready Tool Co., 223 Water St., Bridgeport, Conn. A positive spring hold-down particularly adapted for securing thin work in the vise of the shaper or milling machine. This device consists of three parts, *viz.*, the holder, the triangular clamping piece, and the springs.

Arbor Press: Lourie Mfg. Co., Springfield, Ill. An arbor press equipped with a differential hydraulic pump which has two pistons of unequal size. When the pressure becomes heavy, the larger piston is automatically disengaged and heavier pressures are then easily obtained by working the small piston.

Tap and Reamer Wrench: Russell Mfg. Co., Greenfield, Mass. An adjustable wrench for holding taps and reamers, the body of which is drop-forged steel, casehardened and fitted with tempered tool steel jaws. The handles are made of steel tubing and are knurled to afford the operator a good grip on them.

Electric Welder: National Electric Welder Co., Warren, Ohio. A flue welding machine which has a capacity for welding tubing from 1¼ to 3 inches in diameter. Such material as round or square steel bars from ½ to 1¼ inch in diameter can also be handled on this machine when equipped with suitable clamping dies.

Gages: Union Twist Drill Co., Athol, Mass. Gages for testing rotary cutters to provide for having each tooth cut to an equal depth. These gages were originally developed for use in the shops of the Union Twist Drill Co., but the increasing demand for tools of this kind has led to their being placed on the market.

Machinists' Small Tools: Union Caliper Co., Orange, Mass. Recent additions to the line of small tools manufactured by this company consist of a quick-adjusting spring caliper, an adjustable boring-bar and a keyseat rule block. These tools have features which will doubtless commend them to the progressive mechanic.

Motor Truck Crane: Brown Hoisting Machinery Co., Cleveland, Ohio. A one-ton pillar jib crane carried on a motor truck built by the Peerless Motor Car Co., of Cleveland, Ohio. This crane enables heavy loads to be lifted to and from the truck with the greatest facility. The crane is adaptable for use on any motor truck.

Punch Press Safeguard: Yale & Towne Mfg. Co., 9 E. Fortieth St., New York City. This guard was originally developed for use in the plant of the Yale & Towne Mfg. Co., where a strenuous accident prevention campaign has been carried on. The device has not been patented and anyone who desires to use it may do so.

Gap Lathe: Putnam Machine Co., Fitchburg, Mass. A double back-geared sliding gap lathe which swings 18 inches over the bed and 36 inches in the gap. This machine is also built in two other sizes, one of which swings 22 inches over the bed and 46 inches in the gap, while the other swings 28 inches over the bed and 57 inches in the gap.

Square Swivel-base Vise: Skinner Chuck Co., New Britain, Conn. This vise is intended for use on the shaper, planer or milling machine, but is especially adapted for shaper work. It has a square base with four slots for bolting it to the table of the machine. The upper section of the sub-base is graduated to enable the operator to set the vise to any required angle.

Counterbore: Eclipse Interchangeable Counterbore Co., Detroit, Mich. A counterbore of simple design which consists of a holder provided with the usual form of shank and tang to fit into the spindle of the machine. The cutter is made with a shank to fit into the socket of the holder and different cutters may be easily mounted in the holder ready for use.

Bench Lathe: Dalton Machine Co., 108-110 E. 129th St., New York City. A 6-inch bench lathe which has a capacity for taking work up to 13 inches in length between centers. The cross-slide travels 5½ inches and the compound rest 2⅝ inches. The length of the bed is 30 inches. The machine will cut screws with from 3 to 140 threads per inch, including 11½ threads per inch.

Foot Press: Ferracute Machine Co., Bridgeton, N. J. A small foot press mounted on a conical shaped pedestal instead of the usual four legs. The height from the bed to the ram at the top of the stroke and adjustment is 6 inches. The depth of the throat back from the center of the ram is 4½ inches and the bed is 8 inches in diameter with a 3-inch round hole in the center of it.

Multiple Punch Press: Rockford Iron Works, Rockford, Ill. This press has a capacity for work up to 75 inches long by 5 inches wide. It consists of two Rockford presses mounted on a base to which a heavy bed-plate is attached. The dies are assembled in this bed-plate in any desired position. The punch-holder is of similar construction to the bed-plate and counterbalanced.

Acetylene Generator: Vulcan Process Co., Minneapolis, Minn., and Cincinnati, Ohio. A generator designed for use in connection with autogenous welding outfits. The feature of the equipment is the extreme simplicity of its design. The carbide feed is so arranged that the amount of carbide delivered to the water can be accurately regulated and varied according to the amount of gas being used.

Portable Hoist: Ingersoll-Rand Co., 11 Broadway, New York City. A portable hoist known as the "Little Tugger" which is intended for light lifting and hauling, the capacity being up to ½ ton. The weight of the hoist is only 300 pounds, so it is especially suitable for contract work, for use in manufacturing plants, railroad shops, etc., where it is required to move the hoist from place to place.

Punch Press: Loshbough-Jordan Tool & Machine Co., Elkhart, Ind. The ram of this machine is provided with a square opening to receive punch shanks of various sizes. The press is of the inclinable type, the inclining mechanism consisting of a worm and worm-wheel. A safety bolt is provided, which prevents tripping the press while the operator is setting the dies. The bearings on the machine are self-oiling.

Car Wheel Boring Machine: Putnam Machine Co., Fitchburg, Mass. This machine is built in two sizes which have capacities for handling work up to 42 and 52 inches in diameter, respectively. The boring spindle has an exceptionally long traverse so that the cutter-bar can be drawn up within the spindle bearing to avoid damage to the cutters when placing work in position or removing it from the machine.

Power Hacksaw: W. Robertson Machine & Foundry Co., 32 Greenwood Place, Buffalo, N. Y. The noteworthy feature of this machine is that the entire mechanism is mounted on a swivel base so that it may be set for cutting work at any desired angle. This marks a decided improvement over the use of a swivel vise, because when cutting long pieces of work the use of a swivel vise necessitates a large amount of room around the machine.

Power Press Safeguard: Superior Tool, Die & Stamping Co., 2396 Silver St., Brooklyn, N. Y. This safeguard consists of a movable arm operated by the clutch rod of the press, with a narrow band at its end which fits around the punch. This band acts in the double capacity of a stripper and a guard. In the event of the operator leaving his hands on the die, the band cannot drop down into place, and as a result the press cannot be tripped.

Punch Press Guard: Charles Seitz, Albany, N. Y. This guard consists of a stationary rod clamped to the left-hand side of the press and a movable rod carrying flexible chains secured to a lever pivoted at the right-hand side of the press. A connecting link connects the short end of the lever to the treadle rod. When the lever is depressed, the movable rod is raised to within ½ inch of the stationary rod before the clutch is engaged. It is impossible to engage the clutch while the operator has his hands on the die.

Tapping Chuck and Tapping Attachment: Peter Bros. Mfg. Co., Algonquin, Ill. These are two products which were formerly manufactured by the Woodstock Safety Chuck Co., Woodstock, Ill. The turning resistance of the tapping chuck is obtained by the combination of an adjusting nut, a spring, and male and female friction cones. The taps are driven in the usual way by the square end. The tapping attachment provides for handling tapping operations on drill presses which are not provided with a reverse motion.

Automatic Screw Machine: Cincinnati Automatic Machine Co., Cincinnati, Ohio. A five-spindle automatic screw machine which can be so easily set up that it is claimed that it may be used advantageously in producing small lots of work. The method of shifting from right- to left-hand thread cutting is very simple. The tools are returned positively before the head is indexed, thus preventing accidents in case the contact spring fails to operate. Changes of speed are easily made and plates fastened to the speed-boxes give all the necessary information.

Multiple Punch and Spacing Table: Hilles & Jones Co., Wilmington, Del. A multiple punching machine built for the passenger car department of the Harlen & Hollingsworth Corporation of Wilmington, Del. The machine has a capacity for punching eighteen holes 9/16 inch in diameter at one stroke through a ¼-inch steel plate. The distance between the housings is 50 inches and the machine is driven by a 20-horsepower motor. The machine is equipped with a Thomas spacing table and control mechanism furnished by the Standard Bridge Tool Co. of Pittsburg, Pa.

Heavy Double Crank Power Press: Cleveland Machine & Mfg. Co., 4944 Hamilton Ave., Cleveland, Ohio. In the December, 1913, number of MACHINERY one of a line of double crank presses manufactured by this company was illustrated and described. A larger machine of very similar design is now being built, the frame of which consists of four pieces held together with heavy steel tie rods. The length of the housings can be varied to suit individual requirements, giving a maximum die space of 72 inches between the bed and the slide. Where the extreme die space is required, a special connection is provided which permits adjustment of the slide through the whole die space and eliminates the necessity of using auxiliary bed plates, ring bolsters, etc., when the press is used in connection with dies of normal height. The slide ways of this machine are extended so that the slide never overhangs its bearings. The machine is equipped with a powerful multiple disk friction clutch which is enclosed so that there are no revolving parts exposed. The adjustment is universal on all levers, and the brake arms are operated by a pair of toggle links. The clutch is controlled by a hand lever conveniently located for the operator.

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BRASS MACHINE PARTS MADE BY HYDRAULIC PRESSURE

A method has recently been developed in Germany for producing small brass machine parts, plumbers' brass fittings and similar products by hydraulic pressure. This method is intended to replace casting such parts and has many points to commend it where the number of pieces to be made is sufficient to warrant the expense of making the necessary dies. In the first place, the high pressure under which the work is formed serves to compress the metal and materially increase its strength; second, defective work resulting from blowholes, etc., is avoided, which means a saving in material and labor; third, the finish of the work is such that in many cases it requires no subsequent machining. It is stated that shops that are using this method find it cheaper to produce work in this way than by casting. R. F. Lang, 8-10 Bridge St., New York City, is the sole agent for this process in the United States and Canada.

NINTH ANNUAL FOUNDRY AND MACHINE EXHIBIT

WORLD'S RECORD MADE IN DRILLING STEEL—EXHIBITORS AND EXHIBITS IN THE MACHINERY FIELD

THE annual convention of the Allied Foundrymen's Associations and the Ninth Annual Foundry and Machine Exhibit was held in Chicago from September 5-11, inclusive. The Allied Foundrymen's Associations include the American Foundrymen's Association, which convened at the Hotel La Salle, the American Institute of Metals, which was also in convention at the Hotel La Salle, and the Associated Foundry Foremen, who made their headquarters at the Fort Dearborn Hotel. During the week each of these organizations heard a number of exceptionally interesting papers read by their members.

On Monday no executive meetings were held, the day being set apart for registration at the respective headquarters of the three organizations which constitute the Allied Foundrymen's Associations. On Tuesday morning all three organizations met at the Hotel La Salle, where an address of welcome was delivered by H. O. Lange, chairman of the general committee. President Alfred E. Howell of the American Foundrymen's Association, President G. H. Clamer of the American Institute of Metals, and President S. V. Blair of the Associated Foundry Foremen then made their annual addresses in the order named. Following these opening exercises, the morning was given over to the reading of papers dealing with different methods of insuring safety and sanitation in the foundry. During the remainder of the week, a number of papers of exceptional interest and value to men in their respective industries were read. The subjects dealt with comprised methods of cost-keeping in the foundry, the application of scientific management in foundry practice, methods of calculating metal mixtures, steel foundry practice, modern die-casting practice, the nomenclature of alloys, modern practice in brass founding, and a number of other subjects.

The feature of the meeting of particular interest to readers of MACHINERY was the Ninth Annual Foundry and Machine Exhibit which was held in the International Amphitheatre. The exhibit was one of exceptional interest and was marked by an unusually representative gathering of manufacturers of equipment for the various branches of foundry and machine shop work. Coming at a time when European complications have depressed our manufacturing activity, it was remarkable to note the spirit of optimism shown by the majority of the visitors. Many of the exhibitors reported orders taken at the exhibition and others found "prospects" which ought undoubtedly to develop into future orders. The visitors at the exhibition are connected with a great variety of industries and should be in a position to express reliable opinions in regard to the probable course of industrial progress during the coming year. If the consensus of opinion expressed by these men is accurate, there should be little doubt of the coming of a marked improvement of conditions at an early date.

A test of twist drills was made on a Colburn drilling machine, exhibited by the Colburn Machine Tool Co., Franklin, Pa. This machine was driven by a 25-horsepower Westinghouse motor running at 1100 revolutions per minute. Tests were made on steel 35-40 point carbon and cast iron. The steel block 4¼ inches thick was successfully drilled with a 1½-inch drill running at 343 revolutions per minute, feeding 0.061 inch per revolution, the rate of penetration being 20.92 inches per minute. This is believed to be the world's record for rapid drilling in steel. In drilling cast iron, a drill 3 inches diameter drilled through the block at the rate of 343 revolutions per minute, feeding 0.061 inch per revolution, the rate of penetration being 20.92 inches per minute in this case also.

The following gives a list of the more prominent exhibitors in the machinery field and the products that were shown.

Acme Machine Tool Co., Cincinnati, Ohio, "Cincinnati-Acme" geared head flat turret lathe, motor-driven.

American Tool Works Co., Cincinnati, Ohio. Tool-room lathe; motor-driven lathes; universal shaper; motor-driven shaper; planers; and plain radial drill, motor-driven.

Armstrong-Blum Mfg. Co., Chicago, Ill. Power hacksaw machines, hand-lever shears, hand-lever punches, hand-lever rod cutters, drill press vises.

E. C. Atkins & Co., Indianapolis, Ind.

Baker Bros., Toledo, Ohio. Heavy-duty ball-bearing high-speed drilling machine; keyway cutting machine for cutting internal keyways and miscellaneous slotting; and gear box for demonstrating gear shift.

Barber-Colman Co., Rockford, Ill. Hobs, hobbing machine, and milling cutters.

Barnes Drill Co., Rockford, Ill. All-geared drill press with positive oiling device.

Benjamin Electric Mfg. Co., Chicago, Ill. Benjamin safety and efficiency devices for punch presses; factory signal systems; and industrial lighting fixtures.

Charles H. Besly & Co., Chicago, Ill. Besly patternmakers' disk grinder (motor-driven); "Helmet" cement; "Helmet" oil; "Helmet" spiral circles; and "Helmet" pressed-steel ring wheel chuck.

Brown & Sharpe Mfg. Co., Providence, R. I. Heavy plain milling machine; plain grinder; automatic screw machine; universal milling machine and cutters; and small tools.

Carborundum Co., Niagara Falls, N. Y. Carborundum and aloxite products in the form of wheels, rubbing bricks, sharpening stones, paper and cloth.

Central Iron Works, Quincy, Ill. Cuts, photographs, drawings and descriptive matter of latest improved tumbling mills, water cinder mill, combination brass cinder mill and casting tumbler; patented screen-cleaning device; dust arrester; sand-blast machines; exhaust fans; and air compressors.

Chicago Pneumatic Tool Co., Chicago, Ill. Pneumatic hammers; drills; and "Little Giant" drills and grinders.

Chicago Pulley & Shafting Co., Chicago, Ill. S. K. F. ball bearings; and steel pulleys.

Chicago Steel Foundry Co., Chicago, Ill. Steel castings; cast-steel flasks; and wire-rope sockets.

Cincinnati-Bickford Tool Co., Cincinnati, Ohio. Cincinnati high-speed, shaft-driven upright drill; and Cincinnati-Bickford regular plain radial drill.

Cincinnati Milling Machine Co., Oakley, Cincinnati, Ohio. Plain, high-power milling machine; universal cone machine; and cutter and tool grinder.

Cincinnati Planer Co., Cincinnati, Ohio. Heavy-pattern Cincinnati planer, with two heads on the cross-rail and two side heads, equipped with 15-horsepower General Electric reversible motor drive and rapid power traverse to the rail heads.

Cincinnati Pulley Machinery Co., Cincinnati, Ohio. "Avey" high-speed ball-bearing drill presses, motor-driven.

James Clark, Jr., Electric Co., Inc., Louisville, Ky. Direct-driven drill; friction-driven drill; bench grinder; power hacksaw and floor grinder; combined wet and dry grinder; bench grinder; jeweler's sensitive drill; portable drills; center grinders; and assortment of miscellaneous tools.

Cleveland Pneumatic Tool Co., Cleveland Ohio. Pneumatic drills; riveting hammers; chipping hammers; portable grinders; valve grinders; wood-boring machines; bench grinders; air hose; and air hose couplings.

Coburn Trolley Track Mfg. Co., Holyoke, Mass. Two different types of overhead monorail systems, together with motion pictures illustrating their application.

Colburn Machine Tool Co., Franklin, Pa. High-speed, heavy-duty drill press, motor driven; and a vertical boring mill, motor-driven.

Cowan Truck Co., Holyoke, Mass. Cowan transveyors; and new storage battery transveyor.

Curtis Pneumatic Machinery Co., St. Louis, Mo. Foundry crane mounted on crane runway; jib crane; overhead trolley system, including main and divergent tracks; trolleys; switches; and cross-overs. Vertical, single-stage, double-cylinder, Curtis air compressor in operation; and one vertical, single-stage, double-cylinder Curtis air compressor; also one balanced pressure air hoist in operation; and two types of sand blast.

Diamond Machine Co., Providence, R. I. Heavy shop face grinder, motor-driven; automatic surface grinder, motor-driven.

Joseph Dixon Crucible Co., Jersey City, N. J. An assortment of crucibles and miscellaneous refractory articles.

Atlas Press Co. (G. T. Eames Co.), Kalamazoo, Mich. Compound mandrel or arbor presses.

Edgemont Machine Co., Dayton, Ohio. Extended sleeve friction clutches; countershaft friction clutches; and gas engine friction clutches.

E. L. Essley Machinery Co., Chicago, Ill., representing the American Tool Works Co., Diamond Machine Co., International Machine Tool Co., Colburn Machine Tool Co., the Cincinnati Pulley Machinery Co., Barnes Drill Co., Skinner Chuck Co., and G. T. Eames Co.

Flexible Steel Lacing Co., Chicago, Ill. "Alligator" steel belt lacing; "Alligator" tape fasteners for printers' tapes; and a standard testing machine for demonstrating tensile strength of "Alligator" fasteners.

Gardner Machine Co., Beloit, Wis. Vertical and horizontal disk grinders; band-polishing machines; patternmaking disk grinders; sand-roll pattern machine; buffing lathes; surface grinders; band wheels; ring-wheel chucks; abrasive disks; disk materials; disk grinder supplies; and Gardner hard oil.

Garvin Machine Co., New York City. Monitor lathe; and automatic tapping machine.

General Electric Co., Schenectady, N. Y. Centrifugal air compressor; portable arc welding set; high-efficiency incandescent lamps and fixtures; crane motor with solenoid brake; and cabinet with display of motor parts.

Gisholt Machine Co., Madison, Wis. Automatic chucking lathe; universal tool grinder; solid adjustable reamer; adjustable boring-bars; tool-holders; and periodograph for getting accurate "time on the job" records.

General View of Foundry and Machine Exhibit in the Amphitheater, Chicago, September 5-11

Goldschmidt Thermit Co., New York City. Full line of carbon free metals and ferro alloys; welding equipment; and a large crankshaft welded by the thermit process. Demonstrations of welding high-pressure pipe.

Gould & Eberhardt, Newark, N. J. Eberhardt automatic gear hobbing machine, and Eberhardt "Invincible" shaper.

Greaves-Klusman Tool Co., Cincinnati, Ohio. All-geared-head engine lathe, with flexible motor drive, single-lever control of selective speed changes, with apron control of start, stop and reverse of spindle.

Heald Machine Co., Worcester, Mass. Wet cylinder grinder; wet ring grinder; chuck bench with testing outfit and four Heald magnetic chucks; wet internal grinder; wet rotary surface grinder; and drill grinder.

Hunter Saw & Machine Co., Pittsburg, Pa. Newton cold saw, saw sharpening machine, tooth grinder, inserted tooth saws; Higley type saws; Bryant type saws; high-speed tube saws, hot saw, high-speed friction saw, and Newton saws.

Independent Pneumatic Tool Co., Chicago, Ill. "Thor" piston air drills, flue rolling, reaming, tapping and wood-boring machines, pneumatic portable grinders; close-corner drills; pneumatic chipping, calking, flue beading and riveting hammers; and "Thor" electric drills.

International Machine Tool Co., Indianapolis, Ind. "Libby" new type heavy turret lathe, $7\frac{1}{2}$-inch hollow spindle.

Keller Pneumatic Tool Co., Fond du Lac, Wis. Keller pneumatic, bench and floor rammers; chipping hammers; drills and appliances.

Julius King Optical Co., Chicago, Ill. "Saniglas" King's safety eye protectors; helmets for welders, etc.

Landis Machine Co., Waynesboro, Pa. Single and double head bolt cutter; pipe die-heads; and automatic screw cutting die-head.

La Salle Machine & Tool Co., La Salle, Ill. La Salle plain and surface grinder with micrometer adjustment.

Lodge & Shipley Machine Tool Co., Cincinnati, Ohio. Selective head manufacturing engine lathe; and selective head universal tool-room lathe.

J. R. Long & Co., Akron, Ohio. Automatic forged-steel machinist's vises, pipe reamers and pipe cutters; and double and single swivel automatic vises.

Machinery, New York, N. Y. Collection of Machinery's field service advertisements and photographs; Machinery's mechanical books, including Machinery's Handbook and new book on Spur and Bevel Gearing; Machinery's Reference and Data Books.

Macleod Co., Cincinnati, Ohio. Buckeye sand blast tumbling barrel and revolving table; blacking swab sprayers; portable hose sand blast; and oxy-acetylene welding outfit.

Manufacturers' Equipment Co., Chicago, Ill. "Aero" chucks; collapsible taps and parts.

Marshall & Huschart Machinery Co., Chicago, Ill. "Acme" flat turret lathe; Baker high-speed drill; Baker keyseater; Cincinnati high-power, motor-driven milling machine, flooded lubrication; Cincinnati cone-type universal miller; Cincinnati cutter and tool grinder; Cincinnati-Bickford high-speed upright drill, also plain radial, motor-driven; Gould & Eberhardt gear hobber, also "Invincible" shaper with "Reliance" variable-speed motor; "Cincinnati" planer with reversible motor drive, Greaves & Klusman engine lathe, motor drive; Landis double-head bolt cutter, motor driven; Lodge & Shipley universal tool-room and selective-head manufacturers' lathes, motor driven, "Rockford" manufacturers' gang drill, motor driven; "Monarch" engine lathe, geared head, motor driven; Richmond staybolt drilling machine, motor driven; Rivett bench lathe, complete; and Partridge grinders.

Metals Coating Co. of America, Chicago, Ill.; Schoop metal spraying pistol, with attendant equipment.

Monarch Machine Co., Sidney, Ohio. Standard single back-gear engine lathe; and an eight-speed, all-geared-head, motor-drive engine lathe.

Mott Sand Blast Mfg. Co., Chicago, Ill. Sand-blast barrel; sand-blast room, dust collector and fan; and sand-blast machine, hose type.

National Machinery Co., Tiffin, Ohio. "National" single bolt cutter; die sharpener; and open die-head.

Norton Co., Worcester, Mass. Grinding wheels; grinding machines; Norton grinding wheel floor stands in operation; and Norton grinding wheel bench stands in operation.

Oxweld Acetylene Co., Chicago, Ill. "Oxweld" welding and cutting blow-pipes; and other "Oxweld" apparatus.

Prest-O-Lite Co., Inc., Indianapolis, Ind. Oxy-acetylene welding and cutting apparatus; and portable acetylene gas cylinders.

General View of Foundry and Machine Exhibit in the Amphitheater, Chicago, September 5-11

Puro Sanitary Drinking Fountain Co., Haydenville, Mass. Drinking fountains.

Reeves Pulley Co., Chicago, Ill., and Columbus, Ind. Reeves wood split pulley; "American" steel split pulley; Reeves variable speed transmission; Alexander leather belting bond double-sure transmission line; Makutchan roller bearing; and "Rhineland" ball bearing.

Richmond Stay-Bolt Drilling Machine Mfg. Co., Inc., Richmond, Va. Stay-bolt drilling machines.

Rockford Drilling Machine Co., Rockford, Ill. Four-spindle, manufacturers' gang drill; and heavy-duty type drilling machine.

Rock Island Mfg. Co., Rock Island, Ill. Vises of all kinds, a type and size for every service.

Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. Three-ton capacity, cage-controlled, monorail, electric hoist; one-ton capacity, floor-controlled, high-lift type electric hoist; one-ton capacity, floor-controlled, A. C. electric hoist; five-ton capacity, electric traveling crane trolley; and back-geared electric motor with winch head.

S. K. F. Ball Bearing Co., New York, N. Y. Ball-bearing hangers, mounted on frame; various sizes of S. K. F. ball bearings; pillow blocks and hangers.

Skinner Chuck Co., New Britain, Conn. Full line of chucks, independent, combination and geared scroll; also drill chucks.

R. R. Street & Co., Inc., Chicago, Ill. Billings & Spencer tools; Hyatt roller bearings; Keystone steel pulleys; Slocomb micrometers; E. G. I. friction clutches; Brown utility vises; and Horton lathe and drill chucks.

Sullivan Machinery Co., Chicago, Ill. Sullivan air compressor, angle compound WJ-3 type; also single-stage, belt-driven type in operation; and Sullivan air compressor, steam driven, straight line, single-stage type.

Templeton, Kenly & Co., Ltd., Chicago, Ill. "Simplex" emergency jacks demonstrated under heavy load.

U. S. Electrical Tool Co., Cincinnati, Ohio. Electric drills and grinders.

Vanadium-Alloys Steel Co., Chicago, Ill. "Red-Cut" cobalt high-speed steel; "Red Cut" superior high-speed steel; and drills made of "Red Cut" superior high-speed steel.

Vulcan Engineering Sales Co., Chicago, Ill. Pneumatic and electric sand sifters; cold metal saws; air hoists, trolleys and suction lubricator.

Warner & Swasey Co., Cleveland, Ohio. Universal hollow hexagon turret lathe equipped for chucking work; universal turret screw machine equipped for bar and chucking work; plain head turret lathe with hexagon turret; automatic chuck and hand longitudinal feed for cut-off.

Weaver Mfg. Co., Springfield, Ill. Weaver roller jaw drill chucks; auto twin jacks; and garage presses.

Wernicke-Hatcher Pump Co., Grand Rapids, Mich. Rotary air compressors and receiver, with gages, etc.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Arc welding outfits; alternating-current motors; direct-current generators; and switchboards.

Whiting Foundry Equipment Co., Harvey, Ill. Electric crane trolley on structural frame; spur-geared tumbling barrel; section of standard drawer type core oven; and flat-top turntable.

Wilmarth & Morman Co., Grand Rapids, Mich. Wet surface grinder; universal cutter and reamer grinder; "New Yankee" drill grinders (all motor driven); combination wet tool and drill grinders; and combination cutter, reamer and drill grinder.

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MACHINE TOOLS FOR SPAIN

The Spanish government has entered the American market for immediate delivery of a great quantity of ordnance and rifle-making machinery. Inquiries have been directed by a large Madrid contracting firm representing the Spanish government to the Foreign Trade Bureau of the Philadelphia Commercial Museum. The firm making the inquiry furnishes all the factories of the war and navy department in Spain with machines and tools, and manufacturers of the following lines of machine tools are requested to enter into communication with the Foreign Trade Bureau of the Philadelphia Commercial Museum for the supply of this machinery. The classes specified are sensitive and upright drilling machines, gear-cutting machines, grinding and polishing machines, cold metal saws, punching and shearing machines, and machines for the manufacture of cartridges for Mauser rifles.

BUSINESS SITUATION IN THE CENTRAL AND WESTERN STATES

The business situation in the Central and Western States affecting the machine tool trade and closely related lines is much better than a few weeks ago, though yet far from normal, but the volume of orders recently placed indicates that the worst is over. Machine tool builders who have hardly received an order for months report more inquiries and some orders; some contracts have been closed on inquiries recently received from England. One machine tool builder in Milwaukee says, "We are running full force, full time, full equipment; orders are good and inquiries are better."

A number of the machine tool builders who exhibited at the Foundry & Machine Builders' Exhibition in Chicago have already closed orders on inquiries secured at the exhibition. The freight rate situation and the European war have unfavorably affected the railroads, making their apparent condition worse than ever before; but the Western railroads have an enormous grain crop to haul and must keep their rolling stock and motive power in condition for business. One railroad running into Chicago nursed along a list of tools approximating $100,000 for nearly eighteen months. The order was ready for final O. K. when an order was issued from headquarters to cut out every possible purchase. When the order for this list of tools will be placed is indefinite, but it is not likely to be acted upon this year.

Builders of agricultural machinery and implements are convinced that business conditions have improved with the moving of the grain crops. This happier feeling is also shared by the financial interests affected. The country banks will call less on the city banks for funds now that the grain is moving. This of course reacts favorably on the large financial interests which express the opinion that business is slowly but surely changing for the better. When the banker regains confidence and shapes the policy of his own bank accordingly, business begins to revive. The banker is the ultra-conservative—he is first to "view with alarm" and also the first to get the right view of conditions as they improve.

F. L. H.

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EDISON TELEPHONE CONVERSATION RECORDER

Another interesting device has been added to the long list of inventions by Thomas A. Edison, called the "telescribe," an instrument for recording telephone conversations. It is used as an auxiliary to the Edison commercial phonograph or dictating machine, and enables the user to record both sides of a telephone conversation on a wax cylinder. The device is compact and in no way interferes with the ordinary use of the telephone. Batteries are provided which actuate a microphone used to amplify the sound waves. The microphone is attached to the dictating machine, which swivels into place over the wax cylinder, and is wired to the telescribe located on the user's desk. The order of recording a telephone conversation on the instrument is as follows:

The receiver of the regular desk telephone is removed from the hook and placed in a socket of the telescribe. The acoustic connection to the dictating machine is made in this way without danger of affecting the telephone line. The user then takes up a small receiver, which is a part of the instrument, and gives his call to the telephone exchange; he starts and stops the dictating machine by means of two small buttons located on the telescribe and connected to the dictating machine by a rubber tube. The messages impressed on the wax cylinder can be taken from the dictating machine in the usual manner, and both sides of a conversation transcribed for permanent record by a typist. The telescribe will be useful to firms doing much business by telephone, especially brokers, etc

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Since the beginning of the aluminum industry in 1883, when the production amounted to eighty-three pounds, the advance has been so rapid that the production in 1913 amounted to 72,500,000 pounds.

PERSONALS

A. H. Whiteside has been made vice-president and general manager of the Goulds Mfg. Co., Seneca Falls, N. Y., succeeding W. E. Davis.

S. W. Potts, mechanical engineer of the E. W. Bliss Co., Brooklyn, N. Y., has resigned to take a similar position with R. Hoe & Co., New York City.

Victor E. Schmiedeknecht, designer for the Aurora Automatic Machinery Co., Chicago, Ill., has resigned and taken a similar position with the Pneumatic Chuck Co., Louisville, Ky.

A. H. Ingle, formerly of the Ingle Machine Co., and Rochester Boring Machine Co. of Rochester, N. Y., has taken the management of the Bridgeford Machine Tool Works, Rochester, N. Y.

J. H. Maysilles, for three years superintendent of the George D. Whitcomb Co., Rochelle, Ill., recently resigned the position, and established a foundry and machine shop at Grafton, W. Va., under the firm name of Hefner & Maysilles. Mr. Maysilles is vice-president and general manager.

A. J. Gardiner, for many years connected with the Landis Tool Co., Waynesboro, Pa., has taken a position with the Modern Tool Co., Erie, Pa. Mr. Gardiner will cover the same territory as when with the Landis Tool Co., selling a full line of self-contained single pulley drive grinding machines that the Modern Tool Co. has just brought out.

Henry D. Shute has been elected treasurer of the Westinghouse Electric & Mfg. Co., to succeed T. W. Siemon, who recently resigned to take the position of secretary-treasurer of the Union Switch & Signal Co., Swissvale, Pa. Truman P. Gaylord, district manager of the Westinghouse Electric & Mfg. Co. at Chicago, was elected acting vice-president to succeed Mr. Shute.

Edward J. Kunze, who for the past four years has been assistant professor of mechanical engineering, in charge of machine design and construction at the Michigan Agricultural College, has been appointed professor of mechanical engineering in charge of the department of mechanical engineering at the Oklahoma Agricultural and Mechanical College, Stillwater, Okla.

R. Poliakoff, assistant professor and lecturer on technology in the Imperial Technical Institute of Moscow, Russia, who came to the United States in the latter part of June to study the Taylor system of management, American methods of manufacturing machine tools, etc., sailed for Russia, September 10. Prof. Poliakoff made a special study also of automobile manufacturing methods in the Ford plant at Detroit.

Howard A. Flagg who has just become associated with the selling force of the Standard Welding Co., Cleveland, Ohio, has been connected with the seamless tube industry for the past fifteen years, having held high positions in the sales departments of the Shelby Tube Co., National Tube Co. and the Ohio Seamless Tube Co. At one time Mr. Flagg was sales manager of the steel tubing department of the Standard Welding Co. He is widely known in the automobile, bicycle and motor cycle trades.

The University of Texas has established a school of mechanical engineering, and Prof. Forrest E. Cardullo, a well-known contributor to MACHINERY, is to be the head of the new school. Prof. Cardullo is a graduate of Sibley College, Cornell University, class 1901. He became instructor at Syracuse University after having acquired four years of practical experience with the McGraw Oil Co., the Cleveland *Engineer* (now merged with *Power*), and the Holly Mfg. Co. After serving successively as instructor, associate professor and professor in charge of machine work and design and of the shop, he became professor of mechanical engineering at New Hampshire State College, where he remained six years.

James Thane sailed for South America October 1 on the steamer *Vestris*, as special representative of the American Express Co. and New York Central Lines. A. B. Howard also sailed on the same steamer as special representative of the financial department of the American Express Co. Both have had many years' experience covering representative branches of foreign trade and are competent to deal with questions arising in connection therewith. They expect to visit the chief ports or commercial centers of Brazil, Argentina, Uruguay, Chile and Peru, stopping on the return journey at Panama and Colon. Exporters and importers generally may avail themselves of the services of these representatives. Communications intended for them should be addressed to the American Express Co., South American Department, 65 Broadway, New York City.

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OBITUARY

James H. Van Dorn, president of the Van Dorn Iron Works Co., and the Van Dorn & Dutton Co., Cleveland, Ohio, died August 29, aged seventy-three years. Mr. Van Dorn was born in York, Ohio, and moved to Cleveland in 1873, where he founded the two companies of which he was president.

EFFECT OF LIGHT ON THE EYES*

Three years ago the American Medical Association appointed a special committee to make a study of the effect of different lighting systems on the eye. The problem of lighting, as treated by engineers, has been for the most part an attempt to discover the most efficient forms of lighting from the point of view of economy—that is, how to get the most illumination for the least expenditure of energy. The problem of this committee has been to discover the form, distribution, intensity, and quality of light from the point of view of the health of human eyes.

The work of this committee is not yet completed, but preliminary announcements of results are of considerable interest. Among the aspects of lighting that have definite relations to the eye are: evenness of illumination; the angle at which the light falls on the object viewed; the diffuseness of the light; the evenness of surface brightness; the intensity of the illumination; and the quality of the light. The first four of these factors have been found by means of experimentation to be closely connected, although not absolutely uniform in their variations. Together they constitute what the experts call the *distribution* of the light. The ideal condition of distribution is to have the illumination as uniform as possible over the field of vision, with no extremes of surface brightness.

Daylight is the most satisfactory form of illumination, from the point of view of distribution. Daylight is well diffused by numerous reflections before it reaches the windows. Inside the room, the window or skylight has a comparatively large area of relatively low brilliancy. These two factors contribute to a nearly uniform illumination of diffused light, with absence of extreme surface brightness.

Of the systems of artificial illumination, the so-called indirect is the best. In this system, the source of light is concealed from the eyes, the light being reflected to the ceilings or walls, and from these to the working surface. In direct illumination there is always the danger of having extremely bright spots in the illuminated surface. A system called the "semi-indirect" was found to be little better for the eye than the direct system. In this the light is thrown to the ceiling or walls, as in the indirect system; but part of the light is allowed to come through translucent shades.

The relation of the different systems of lighting to the diminishing efficiency of the eyes was brought out in a series of experiments in which daylight was shown to be almost without effect upon the eyes after three or four hours of work; under direct artificial illumination the eye loses working power at a very rapid rate, and almost as rapidly with the semi-indirect illumination. The indirect illumination was found nearly as harmless as the daylight. Sharpness of vision was also found to be highest, for any given degree of illumination, under daylight, and poorest under direct artificial lighting.

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* From an article in the "Scientific American," August 22, 1914.

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In an article by Dr. Lederer, in the *Vossiche Zeitung*, as translated by *Pages Engineering Weekly*, attention is called to the unhappy situation of the German industry at the present moment. According to the author of this article, the removal from German works of all men capable of bearing arms has "smashed industry to atoms." The crisis, with regard to money and credit, which occurred in the first instance, was accentuated by the necessity of financing the war by a single stroke. There is in evidence the apparent paradox that in spite of the increasing absorption for military purposes of men capable of working, there is an increase of unemployment among those that remain behind. Dr. Lederer states in conclusion that the available raw materials will probably not be sufficient for any length of time.

COMING EVENTS

October 22-23.—Annual convention of the National Machine Tool Builders Association. Hotel Astor, New York City, headquarters. Charles E. Hildreth, general manager, Worcester, Mass.

December 1-4.—Annual meeting of the American Society of Mechanical Engineers, New York City; Engineering Societies Bldg., 29 W. 39th St., headquarters. Calvin W. Rice, secretary.

December 9-12.—Eighth annual convention of the National Society for the Promotion of Industrial Education, Richmond, Va. C. A. Prosser, secretary, 140 W. 42nd St., New York City.

December 12-19.—Second International Exposition of Safety and Sanitation, Grand Central Palace, New York City. F. W. Payne, manager. Department of Exhibits, 29 W. 39th St., New York City. The exhibit offers the opportunity to manufacturers of safety and sanitation devices to bring their products to the attention of large numbers advantageously. Last year 110,000 attended the exposition and the attendance expected this year is about 125,000.

SOCIETIES, SCHOOLS AND COLLEGES

New Mexico State School of Mines, Socorro, N. M. Catalogue 1913-1914, with announcements for 1914-1915.

Polytechnic Institute of Brooklyn, College of Engineering, Brooklyn, N. Y. Pamphlet on evening technical courses offered by the institute for 1914-1915, covering engineering and chemistry, mathematics and languages, history and economics.

Society for Electrical Development, Inc., 29 W. 39th St., New York City. Report to members for September on the progress of the society's work. The slogan of the society is, "Do It Electrically," its object being to promote the use of electricity in all industrial activities.

Municipal School of Technology, Manchester, England. Prospectus of university courses for the session 1914-15. 190 pages, 5½ by 8½ inches. Attention is called to the fact that the mechanical engineering department is equipped to give a thorough training to students specializing in that branch of engineering, as well as the more general training required by engineers.

National Association of Corporation Schools, Irving Place and Fifteenth St., New York City. Executive committee's report on scope of activities, 1914-1915. The report comprises reports of the sub-committees on safety, hygiene and cooperation, public education, allied institutions, special schools, and includes syllabi of courses recommended to be included in all corporation schools.

Detroit Technical Institute, Detroit, Mich. Catalogue 1914-15, containing faculty list, general information and specific information on the technical courses provided, which are as follows: Mechanical engineering, electrical engineering, architecture, pharmacy and chemistry, business administration, public speaking. Practical instruction is given in shop work, motor operation, plumbing, watchmaking, etc.

Michigan College of Mines, Houghton, Mich., has instituted special short courses in mining, metallurgy, mapping, methods of measurements and calculation, drawing, concrete construction, etc., for practical men. Anyone who can read and write the English language will be admitted to specialize in these subjects. The courses will require from five to twelve weeks, depending on the subjects and their scope, which will be adjusted to suit the popular demand.

American Museum of Safety, 29 W. 39th St., New York City. Leaflet containing seven rules for shop safety as follows: 1. Organize safety committees. 2. Act promptly upon recommendation for safety. 3. Safeguard all dangerous machinery and moving parts. 4. Keep the plant clean. 5. Enforce rules and regulations for safety and health. 6. Educate employes in caution and responsibility. 7. Encourage cooperation for safety. The sub-heads give further details. Copies of these rules will be sent to any address on application.

Wentworth Institute, Boston, Mass. Catalogue for 1914-1915. This school was founded by Arioch Wentworth "for the purpose of furnishing education in the mechanical arts." It provides day courses in carpentry and building, patternmaking, machine work, foundry practice, electric wiring, plumbing, machine construction and tool design, electrical construction and operation, foundry management and operation, and architectural construction. Evening shop courses are also provided as well as evening technical courses. The machine construction courses became so popular that the two-year course in foundry management and operation was added.

Pratt Institute, Brooklyn, N. Y., has issued an information sheet for prospective students in the Pratt Institute evening course in trade teaching. This course has been developed for experienced trade workers who wish to become teachers of trades. It emphasizes the fact that men with trade experience are in demand as teachers, and states what salaries are paid. These range from $800 to $2000 a year. Instructors are demanded in the machinists' trade, carpentry, cabinet making, patternmaking, electrical work, sheet metal working, printing, drafting, plumbing, etc. The statement deals also with qualifications, getting positions, etc.

NEW BOOKS AND PAMPHLETS

Manual of Engineers and Surveyors' Instruments. (Fourth Edition.) 186 pages, 5¾ by 8½ inches. Illustrated. Published by Queen & Co., Philadelphia, Pa.

Polarimetry. 140 pages, 6 by 9 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Circular of the Bureau of Standards, No. 44.

Disposal of Manufacturing Wastes. By James A. Newlands. 6 pages, 6 by 9 inches Published by James A. Newlands, State Chemist, 11 Laurel St., Hartford, Conn.

The Testing of Hydrometers. 16 pages, 6 by 9 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Circular of the Bureau of Standards No. 16.

Testing Potential Transformers. By H. B. Brooks. 6 pages, 6 by 9 inches. Published by the Department of Commerce, Washington, D. C., as Scientific Paper of the Bureau of Standards No. 217.

Flame Standards in Photometry. By E. B. Rosa and E. C. Crittenden. 40 pages, 6 by 9 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Scientific Paper of the Bureau of Standards No. 222.

Indicator Diagrams for Marine Engineers. By W. C. McGibbon. 196 pages, 7¼ by 9½ inches. Illustrated. Published by James Munro & Co., Ltd., Glasgow, Scotland, and D. Van Nostrand Co., New York City. Price, $3 net.

Determination of Ammonia in Illuminating Gas. By J. D. Edwards. 23 pages, 6 by 9 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Technologic Paper No. 34 of the Bureau of Standards.

Production of Temperature Uniformity in an Electric Furnace. By A. W. Gray. 23 pages, 6 by 9 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Scientific Paper of the Bureau of Standards No. 219.

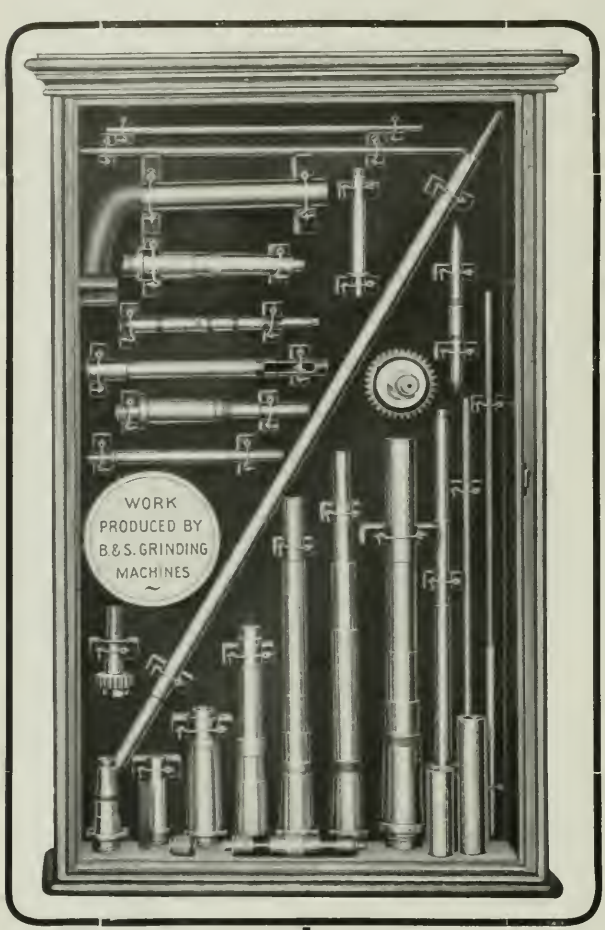
Combustion Method for the Direct Determination of Rubber. By L. G. Wesson. 11 pages, 6 by 9 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Technologic Paper No. 35 of the Bureau of Standards.

Special Studies in Electrolysis Mitigation, No. 2. By E. B. Rosa, Burton McCollum and K. H. Logan. 34 pages, 6 by 9 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Technologic Paper of the Bureau of Standards, No. 32.

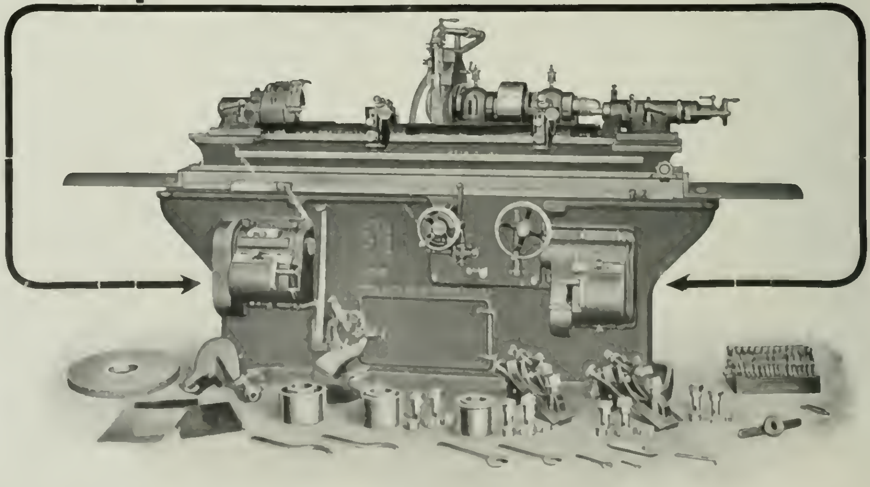
Determination of Carbon in Steel and Iron by the Barium Carbonate Titration Method. By J. R. Cain. 12 pages, 6 by 9 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Technologic Paper No. 33 of the Bureau of Standards.

Simple Problems in Marine Engineering Design. By J. W. M. Sothern and R. M. Sothern. 191 pages, 5 by 7½ inches. Published by James

How You
Saving



Brown & Sharpe Plain Grinding Machines have a new type of drive which gives results that reduce your grinding costs. Whether you want better quality, or increased output these machines will amply meet your requirements.



Can Effect A Material Grinding Pieces Like These

In Your Shop when work like any in the case is given to an operator, it is difficult for the foreman to tell exactly what speeds and feeds should be used unless it happens to be a job that has been done before and there is a record. He can tell the operator what finish is required and may indicate in a general way how to get it. But it rests with the operator to get the best results possible.

If it is a difficult matter to get the right combination of speed and feed to give the desired finish most economically, the operator either lets a wrong combination stand, or time is lost shifting belts to secure the desired results.

The B. & S. Way. The operator of a B. & S. Plain Grinding Machine has no such trouble securing the *right* combination. He has a wide choice of speeds and feeds, all of which are readily available *without moving from his position.*

Operation is completely controlled from the front of the machine.

How Changes are Made. Two quick-change gear mechanisms are located on the front of the machine. These are quickly and easily operated. A slide index knob is moved along to the required position and a lever is raised into place. It is an easy matter to try speeds and feeds until the correct ones are obtained. This means a substantial saving on setting-up time in addition to getting conditions which mean better work and increased production. You can easily figure what even a small gain on each piece means in a day's work.

The quick-change mechanisms are self-contained and independent of each other. There are no complicated overhead works. Belts are interposed between the gear mechanisms and the headstock spindle, thus avoiding gear marks on the work. The long lever near the left gear case controls the machine independent of the wheel.

A Correct Finishing Feed is provided. By throwing a small lever a slow table traverse, which gives a smooth finish on work, is secured without disturbing adjustments for a roughing feed.

There are other production features in which you will surely be interested. Ask us about them. We shall be glad to send you a circular.

BROWN & SHARPE MFG. CO.

PROVIDENCE, R. I.

OFFICES: 20 Vesey St., New York, N. Y.; 654 The Bourse, Philadelphia, Pa.; 626-630 Washington Blvd., Chicago, Ill.; 305 Chamber of Commerce Bldg., Rochester, N. Y.; Room 419 University Block, Syracuse, N. Y. **REPRESENTATIVES:** Baird Machinery Co., Pittsburgh, Pa., Erie, Pa.; Carey Machinery & Supply Co., Baltimore, Md.; E. A. Kinsey Co., Cincinnati, O., Indianapolis, Ind.; Pacific Tool & Supply Co., San Francisco, Cal.; Strong, Carlisle & Hammond Co., Cleveland, O., Detroit, Mich.; Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; Perine Machinery Co., Seattle, Wash.; Portland Machinery Co., Portland, Ore. **CANADIAN:** The Canadian Fairbanks-Morse Co., Ltd., Montreal, Toronto, Winnipeg, Calgary, Vancouver, St. Johns, Saskatoon. **FOREIGN:** Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow. F. G. Kretschmer & Co., Frankfurt, a/M., Germany. V. Lowener, Copenhagen, Denmark; Stockholm, Sweden; Christiania, Norway. Schuchardt & Schutte, Petrograd, Russia. Fenwick Freres & Co., Paris, France; Liege, Belgium; Turin, Italy; Zurich, Switzerland; Barcelona, Spain. The F. W. Horne Co., Tokio, Japan. L. A. Vail, Melbourne, Australia. F. L. Strong, Manila, P. I.

READ PAGE 56

Munro & Co., Ltd., Glasgow, Scotland, and D. Van Nostrand Co., New York City. Price, $1 net.

The six sections of the work deal with simple mathematics; general problems; boiler design; engine design; speed, consumption and indicated horsepower; and marine turbine design.

Practical Mathematics for Young Engineers. By E. Hovenden. 144 pages, 5 by 7½ inches. Published by James Munro & Co., Ltd., Glasgow, Scotland, and D. Van Nostrand Co., New York City. Price, $1 net.

This book on arithmetic was compiled for the use of apprentices who intend to become marine engineers, and was designed to form a groundwork upon which the special knowledge necessary to obtain a Board of Trade certificate may be founded. Many of the examples are taken from the Board of Trade examination papers.

The Young Man and the Electrical Industry. By James H. Collins. 24 pages, 5 by 7 inches. Published by the Westinghouse Department of Publicity, East Pittsburg, Pa.

This booklet, reprinted from the "Scientific American," is of interest to young men. It tells what electricity might do for young men and what they might do for electricity, and is illustrated with views of the Westinghouse works, typical views of electrical apparatus in process of construction, etc. Copies can be obtained free on addressing the Westinghouse Department of Publicity.

Elementary Mathematics for Marine Engineers. By J. W. M. Sothern and R. M. Sothern. 174 pages, 5 by 7½ inches. Published by James Munro & Co., Ltd., Glasgow, Scotland, and D. Van Nostrand Co., New York City. Price, $1 net.

This work, containing algebra, logarithms, entropy, trigonometrical problems, etc., is intended as an introduction to the study of mathematics, applied to marine engineering, but with the exception of a few practical marine problems, the treatise is one of pure mathematics, as applicable to one branch of engineering as another.

The Origin of Coal. By David White and Reinhardt Thiessen. 390 pages, 6 by 9 inches. Illustrated. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Bulletin 38.

The purpose of the studies that form the basis of this valuable report was to learn from examinations of coal how far and in what way the grouping of coal by types depends on differences in the kinds of plant material from which it was formed, and on the conditions of its accumulation. A chapter on the origin and formation of peat was contributed by Charles A. Davis. The work as a whole is a most interesting and valuable contribution to the literature on coal.

Our Mineral Reserves—How to Make America Industrially Independent. By George Otis Smith. 48 pages, 6 by 9 inches. Published by the United States Geological Survey, Department of the Interior, Washington, D. C., as Bulletin 599.

The bulletin was issued in response to the request of business men all over the country, who were writing to inquire where various mineral products could be obtained in the United States. The bulletin was prepared also to stimulate other requests for cooperation. It deals with iron, manganese, zinc, lead, tin, copper, aluminum, antimony, arsenic, platinum, radium, cement, barytes, phosphate rock, potash salts, nitrate, graphite, flint, sulphur, magnesite, fluorspar, strontium and other products.

Engine Operator's Guide. By C. E. Leslie. 76 pages, 3¾ by 6 inches. Illustrated. Published by the International Harvester Company of America, Chicago, Ill.

The author states in the preface that the object of the book is to place at the disposal of every engine owner and operator reliable information concerning internal combustion engine troubles. The fact that the book has been just issued in a fifth revised and enlarged edition indicates that it has met a common want. It treats of the installation and adjustment of gas engines, how to locate troubles, starting troubles, faulty ignition, batteries, cylinder troubles, worn valves, smoke, hot boxes, leaking gaskets, deposits in the compression chamber and water jacket, lubricating oil, care of an engine, starting and stopping engines, magneto troubles, wiring diagrams, etc. The book is of convenient form to carry in the pocket and thus to keep conveniently at hand and an ever present help in time of trouble.

Mechanics for Marine Engineers and Engineering Students. By A. N. Somerscales. 277 pages, 5 by 7½ inches. Published by James Munro & Co., Ltd., Glasgow, Scotland, and D. Van Nostrand Co., New York City. Price, $1.50 net.

The work consists of a series of lessons prepared with the view of treating applied mechanics by pure arithmetic. They were originally prepared for evening classes at the Hull Young People's Institute, England, and contain a large number of problems and answers involving plane figures and linear measurements, areas, solids; velocities, work required to lift weights, friction, pulleys, levers, inclined planes, wheels and axles, screws, pumps, belt rope and toothed gearing, moments, parallelogram of forces, tension, shear and compression, strength of pipes and cylinders, strength of shafts, beams, girders, tests of metals, centrifugal force, kinetic energy, horsepower, mechanical efficiency of engines, etc.

"Verbal" Notes and Sketches for Marine Engineers. By J. W. M. Sothern. 676 pages, 6 by 9 inches. Illustrated. Published by James Munro & Co., Ltd., Glasgow, Scotland, and D. Van Nostrand Co., New York City. Price, $5 net.

This work, which now appears in the eighth edition, treats of: Work shop practice; boilers; notes and sketches of various details; slide valves, piston valves, valve data; general notes and descriptions, marine engineering chemistry notes; marine electric lighting; propellers; refrigeration; internal combustion engines, etc. The work is of a very practical nature, being intended for the use of naval and mercantile marine engineers of all grades, students, foreman engineers, etc., especially when preparing for examinations. Many of the diagrams are on a large scale printed on inserts. The chapter on valve settings will especially interest those concerned with the complexities of marine engine valve gears.

American Machinists' Handbook. By Fred H. Colvin and Frank A. Stanley. 672 pages, 4 by 7 inches. Published by the McGraw-Hill Book Co., New York City. Price, $3.

This is the second edition of a reference book for the machine shop and drafting-room which was first brought out in 1908. There has been considerable material added to this edition, there being in all more than 150 additional pages, covering, in many instances, important machine shop data not touched upon in the earlier issue. The machine-building field is familiar with the book and its general arrangement, which has been retained in the present edition, the new material having been interspersed at appropriate places throughout the book. Among the subjects which are more completely handled in this book than in the previous edition are spiral gearing; milling and milling cutters; grinding and lapping; circular forming tools; broaching; fits, ball bearings; horsepower, belts and shafting; forge shop data; and miscellaneous tables.

Handbook of Tables and Formulas for Engineers. Compiled by Clarence A. Peirce and Walter B. Carver. 168 pages, 4 by 6¾ inches. Bound in flexible leather. Published by the McGraw-Hill Book Co., New York City. Price, $1.50 net.

The book was compiled to meet the needs of students of Sibley College of Cornell University and the needs of engineering students elsewhere. The formulas and data are divided into ten sections, as follows: Algebra; geometry and trigonometry; analytic geometry; calculus; measurement; physical and chemical properties of substances; mechanics; strength of materials; standard gages, fastenings and flanges; and mathematical tables. The text is printed on thin paper and the data have been arranged in a convenient and attractive form. No doubt the class for whom the work was compiled will find it a good working tool. It is not, however, a book to be recommended to engineers in general, as its scope is too limited.

Air Brake Catechism. By Robert H. Blackall. 411 pages, 4½ by 7 inches. 149 illustrations. Published by Norman W. Henley & Son, New York City. Price, $2.

This is the twenty-sixth edition of this well-known book on the air brake. The many editions brought out give evidence of the popularity of the book as well as of the catechism method, in accordance with which the book is arranged throughout. The new edition has been revised to date, and while it is practically the same as the previous issue, changes have been made where necessary. It treats on the equipment manufactured by the Westinghouse Air Brake Co. The operation of all parts of the apparatus is explained in detail, and practical methods for finding defects, together with proper remedies, are given. The book contains 2500 questions relating to air brake mechanism, the answers to which are given in a direct and simple manner. It is intended for engineers and firemen and other railroad men, preparing to pass an examination on the subject of air brakes.

The Railway Library, 1913. Compiled and edited by Slason Thompson. 460 pages, 5½ by 8½ inches. Published by R. R. Donnelley & Sons Co., Chicago, Ill. Price, 50 cents.

This book contains a collection of noteworthy addresses and papers delivered mostly during the year 1913. In addition to the various articles and addresses thus given permanent form, a number of statistical abstracts are given at the end of the book. These cover the railways of the world and are of considerable interest, although, in some instances, they ought to have been supplemented with explanatory notes where conditions differ from those in this country. For example, the statistician himself has made the usual mistake on page 414 of comparing ton-mile rates of American railways with those of various European railways, forgetting entirely that when counting ton-mile rates in this country we speak only of heavy freight traffic, whereas, in the European countries, the business that is generally handled by the express companies in this country is also included, which, of course, increases the ton-mile rate to a considerable extent, making a direct comparison absolutely impossible and valueless.

Marine Engineering Rules and Tables. By A. E. Seaton and H. M. Rounthwaite. 713 pages, 4 by 6¼ inches. Published by Charles Griffin & Co., Ltd., London, and D. Van Nostrand Co., New York City. Price, $3.60 net.

The first edition of this special pocketbook of memoranda, tables, etc., for the use of marine engineers, naval architects, designers, superintendents and others engaged in the design, construction and care of marine machinery was published in 1893. Since then, ten editions of the work have been published and in this, the twelfth, an extensive revision has been made, due to the fact that conditions of marine engineering have been considerably modified, and to the introduction of the turbine and internal combustion engines to shaft propulsion, etc. The general contents comprise the following subjects: Efficiency of marine machinery; propulsion of ships and resistance; compound engines; piston speeds and revolutions of engines; cylinders, pistons; piston rods; connecting rods; shafting; thrust shafts and blocks; stern-tubes; main bearings of crankshafts; condensers; air pumps; cooling water pumps; feed and other pumps; slide valves for steam distribution; valve gears; reversing gears; steam turning gears; screw propellers; paddle-wheel propellers; steam turbines; internal combustion engines; superheated steam; balancing engines; boilers and their fittings; strength of materials; Lloyd's rules; tables, etc.

NEW CATALOGUES AND CIRCULARS

Merchant & Evans Co., Philadelphia, Pa. Pamphlet advertising the Evans automatic sprinkler apparatus.

Beady Tool Co., 223 Water St., Bridgeport, Conn. Insert leaf for general catalogue illustrating shaper and milling machine vise "hold-downs."

McGill Mfg. Co., Valparaiso, Ind. Catalogue of "Loxon" lamp guards and protectors; trouble finders; cord adjusters; gasoline torches, etc.

Trabern Pump Co., Rockford, Ill. Circular describing the Trabern power rotary force pump and giving table of sizes and list prices for same.

Moline Tool Co., Moline, Ill. Illuminated post card advertising "Hole Hogs"—the multiple-spindle drilling machines made by the company.

Joseph Dixon Crucible Co., Jersey City, N. J., has issued a handy little book of useful Spanish words and phrases, compiled for the use of tourists.

Lutter & Gies Co., Milwaukee, Wis. Circulars descriptive of the "Milwaukee" wet tool grinder and "Milwaukee" 16-, 20- and 24-inch back geared crank shapers.

Howard E. Tracy, 393 Main St., Worcester, Mass. Circular of prices on photostat reproductions of drawings, diagrams, printed matter, typewritten letters, etc.

W. S. Rockwell Co., 50 Church St., New York City. Wall hanger, "Comparative Scale of Fahrenheit and Centigrade Thermometers" for use in furnace rooms, etc.

American Blower Co., Detroit, Mich. War map of Europe printed in colors, with data of the fighting strength and resources of the contending nations printed on the back.

U. S. Ball Bearing Mfg. Co., Oak Park, Ill. Leaflet describing U. S. ball bearings made for all kinds of service. The radial bearings are of both single- and double-row types.

American Blower Co., Detroit, Mich. Bulletin 27, treating of the "Sirocco" system of heating and ventilating and its application in Toledo's crystal palace for manufacturing enterprises.

Mark Mfg. Co., Evanston, Ill. Circular of the Mark cold-drawn steel pipe union. It has the advantages of uniform expansion, non-corrodibility, great strength, and freedom from blowholes and leaks.

Carter & Hakes Co., Sterling Place, Winsted, Conn. Circular of a quick-operating, wide-open lever vise for milling machines, drilling machines, etc. The vise is designed to give an operating opening of ¾ inch.

J. R. Long & Co., Akron, Ohio. Leaflet illustrating and describing a swivel base machinists' vise made entirely of drop forgings. The vise locks automatically on the swivel base when the jaws are clamped.

Bernstein Mfg. Co., Third St. and Allegheny Ave., Philadelphia, Pa. Circular of pressed steel lockers, steel shelving, factory stools, wardrobes, sectional factory bins, library shelving and steel equipment for industrial plants.

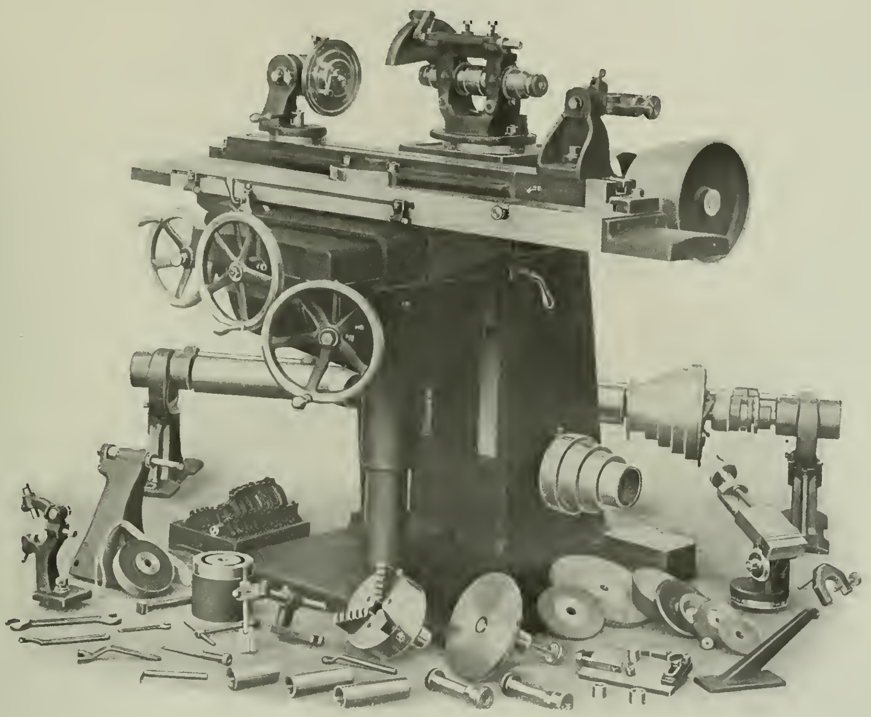
Tahara Co. of America, Glenwood Ave. and Second St., Philadelphia, Pa. Catalogue describing the Tahara automatic process of burnishing silver, and the machines used. These machines employ steel balls in the polishing process.

Independent Pneumatic Tool Co., Chicago, Ill. Circular V, descriptive of "Thor" roller bearing piston air drills, pneumatic chipping, calking and flue beading hammers, turbine drills, staybolt drivers, air hose, couplings, etc.

National Transit Co., Oil City, Pa. Loose leaf binder and bulletins 10 and 11 treating of pumping machinery. Directions for setting up and operating pumps are given, as well as tables of sizes and capacities of duplex piston pumps.

Charles H. Besly & Co., 120 B N. Clinton St., Chicago, Ill. Post card advertising the Besly No. 15-30-C patternmakers' grinder which was exhibited at the Foundry & Machine Exhibition, Chicago, Ill., September 5 to 11.

CORRECT CLEARANCE



The "Cincinnati" No. 2 Cutter Grinder

quickly sharpens milling cutters with the correct clearance. Some of its time-saving features are:

A graduated dial on the headstock spindle, from which the clearance angle may be read directly. NO CLEARANCE TABLES OR DIAGRAMS ARE NEEDED.

A large swiveling headstock, which receives the shanks of end mills, face mills, etc., holding them for the sharpening operations just as they are held in the milling machine spindle.

A gear cutter sharpening attachment which grinds the teeth straight and radially.

Simple overhead works. Entire grinder driven by single belt from line shaft.

Speed changes for grinding wheel spindle obtained on machine.

Grinding wheel head swivels on the column to any angle with work being ground.

Dial reading in degrees and also a scale reading in inches per foot for angular and taper work.

New No. 2 GRINDER CATALOG describes many other productive features of this machine.

THE CINCINNATI MILLING MACHINE CO.
CINCINNATI, OHIO, U. S. A.

Challenge Machine Co., Inc., 5116 Springfield Ave., Philadelphia, Pa. Leaflet of the wet tool and dry grinder wheel guard. This machine is adapted for rough dry grinding and tool grinding, being essentially two machines in one.

National Tube Co., Frick Bldg., Pittsburg, Pa. Bulletin of the N. T. C. iron-body brass-mounted wedge gate valve, illustrating a variety of styles and sizes. Tables of dimensions, comprising all essential data for users, are included.

S. W. Card Mfg. Co., Mansfield, Mass. New catalogue 27, covering the complete line of taps, dies and screw plates made by this company. The catalogue contains 168 pages, and several new lines of goods not previously shown are included.

J. R. Long & Co., Akron, Ohio. Leaflet illustrating and describing Long's instantaneous adjusting pipe cutter which provides means for quickly adjusting the rolls to a pipe and screwing the cutter against the pipe when cutting it off.

Gould & Eberhardt, Newark, N. J. Circular entitled, "Electric Motor Application to G. & E. High-duty Shapers," showing Gould & Eberhardt shapers equipped with adjustable-speed motor, with constant speed motor and with single-pulley belt drive.

Firth-Sterling Steel Co., McKeesport, Pa. Circular in regard to the supply of American tool steel, suggesting that users who have depended on a foreign supply will have no reason to go without a good steel in view of the adequate supply of good American steels.

Standard Chain Co., Pittsburg, Pa. General catalogue on chains, 122 pages, 7¾ by 10¾ inches, giving dimensions for coil chains, crane chains, dredge chains, cable chains, wagon chains, ring dogs, hooks for chains, cold-shuts, trace chains, hobble chains, heel chains, lap links, etc.

American Tool Works Co., Cincinnati, Ohio. Post card advertising "American" radial, plain radial, sensitive radial and full universal radial drills. The advantages claimed for these drills are extreme rigidity, and rapidity of operation. Some examples of work actually done by "American" drills are shown.

Gisholt Machine Co., Madison, Wis. Circular of the Gisholt automatic turret lathe, giving figures of production in the Dodge Bros. plant, Detroit, Mich., on automobile flywheels. The machines in this plant ran 21¼ hours a day, each machine producing twenty-one wheels per hour. One man operated two machines.

Gisholt Machine Co., Madison, Wis. Circular of the Gisholt universal tool-grinder for grinding tool-post tools for turret lathes, shapers, boring mills, slotters, planers and engine lathes. The machine will grind tools up to 1¾ inch by 3 inches or 1¾ inch square, and will grind broad-face cutters up to 9 inches in length.

Extensive Mfg. Co., 90 West St., New York City. Circular of the "Simplex" combination bench filer and metal hacksaw. The machine has a stroke variable from 0 to 6 inches, and an adjustable table 10 inches in diameter. The circular gives a partial list of prominent concerns that are using the machine for filing dies, etc.

Ingersoll Milling Machine Co., Rockford, Ill. Catalogue 35, descriptive of the Ingersoll cutter grinder for grinding face milling cutters from 4½ to 36 inches diameter at one setting. The catalogue is particularly well illustrated, the details of the mechanism being shown on such an enlarged scale as to make the construction absolutely clear.

National Machinery Co., Tiffin, Ohio. National Forging Machine Talk No. 5 deals with maintaining alignment on the slides of forging machines. The new "suspended" heading and gripping slides employed on the National heavy-pattern forging machine enables the alignment to be effectually maintained and obviates any wobbling movement that might result in abnormal wear.

R. F. Lang, 8-10 Bridge St., New York City. Circular of brass machine parts produced by hydraulic pressure. It is claimed that every piece, being perfect and non-porous, the losses in material and labor resulting with castings are not incurred. The claim is made also that, with this process, brass articles can be produced at lower prices than are now paid for brass castings.

Diamond Machine Co., Providence, R. I. Catalogue illustrating and describing Diamond automatic and hand surface grinding machines built in four sizes to grind work 24, 36, 48 and 60 inches in length, 12 inches wide and 12 inches high. These machines are built either for belt or motor drive. The catalogue also gives sizes and capacity of magnetic chucks made by the company for use in connection with its grinding machines.

Panama Pacific International Exposition, San Francisco, Cal. Illustrated booklet on the Panama Canal and the Panama Pacific International Exposition beginning February 20, and closing December 4, 1915. Color studies of the exposition city give a vivid idea of the splendor of the buildings and grounds. A section of the booklet is devoted to the scenic attractions of California. Those contemplating visiting the exposition will find the booklet of much interest.

Heald Machine Co., Worcester, Mass. Catalogue of Heald magnetic chucks, describing their characteristics and showing uses. The construction is illustrated and described in detail. The line of Heald chucks comprises rotary and flat types for use on lathes, boring mills, cylindrical grinding machines, shapers, planers and surface grinding machines. The company also supplies demagnetizing switches, demagnetizers and generators for use with the magnetic chucks.

Industrial Instrument Co., Foxboro, Mass. Bulletin 82, illustrating and describing Foxboro liquid level recording gages. Several interesting records are reproduced, showing the application of the liquid level gages in actual practice. Bulletin 88 shows Foxboro improved recording gages for all purposes. These recorders are made in three sizes, 8, 10 and 12 inches and for any range from full vacuum to 20,000 pounds per square inch pressure. A complete list of ranges, prices and code words are conveniently tabulated.

Quigley Furnace & Foundry Co., Springfield, Mass. Bulletin 5, descriptive of the oil and gas burning appliances manufactured by the company. Burners of varying designs, styles and sizes, for different fuels, are made, according to the class of work for which they are to be used. The bulletin shows high-pressure, medium-pressure and low-pressure oil burners, gas burners, fuel oil pumping systems, rotary oil pumps, steel fan pressure blowers, gages, strainers, valves, etc.

H. P. Townsend Mfg. Co., Hartford, Conn. Circular of automatic hopper-feed screw machines—shavers and slotters, pointers and threaders—adapted to handle all the various kinds of work that can be fed from a hopper or a stack feed. These machines are designed to be used instead of automatic screw machines working from the rod, the claim being made that a large economy is effected in saving of the stock wasted in chips. The company is prepared to build special machines to order.

Harris Patents Co., 200 Fifth Ave., New York City. Bulletin of the Harris valveless engine, Diesel principle, designed to start under load like a steam engine. The bulletin illustrates two- and four-cylinder engines of the two-stroke cycle type and describes the working principle. The advantages of the internal combustion engine for tug boats, police, pilot, fire boats, etc., are dwelt on at length. The fuel cost of power generated by the Harris engine is stated to be from 1/5 to 1/3 cent per horsepower hour.

Clipper Belt Lacer Co., 1020 Front Ave., Grand Rapids, Mich. Booklet entitled, "How Scotchie Made Good," containing a story of how "Scotchie"—an ambitious apprentice—in order to increase his piece-work, bought a Clipper belt-lacer out of his own earnings for use in his work, and of how through his introduction, the machine was adopted for the entire plant, resulting in much saving to the company and a "step up the ladder" for Scotchie. Those who do not know what the Clipper belt-lacer can do, will do well to get a copy of this story.

Billings & Spencer Co., Hartford, Conn. Catalogue of machinists' tools, comprising adjustable pocket wrenches; adjustable automobile wrenches; adjustable S-wrenches; bicycle wrenches; special wrenches; combination pliers; wire cutters; screw-drivers; cold chisels; tap and reamer wrenches; riveting hammers; machinists' hammers; drilling ratchets; socket wrenches; lathe dogs; adjustable and C-clamps; lathe tools; hand vises; drop-forged machine wrenches, in great variety; drop-forged wrenches in sets for automobilists; drop-forged blanks; crankshaft forgings; etc.

Tate, Jones & Co., Inc., Pittsburg, Pa. Catalogue of appliances for burning fuel oil. The first part of the book deals with the advantages to be derived from the use of oil fuel for furnaces, being illustrated with examples taken from actual practice. Following this, the importance of the burner is treated and types of Tate-Jones oil burners are illustrated. The last part of the book is devoted to pumping systems for heating and regulating the oil flow to the burners. Sizes and capacities for the steam-, belt- and motor-driven systems are given.

Illinois Steel Co., Chicago, Ill. Safety Bulletin No. 30, containing an illustration of the safety committee of slabbing and plate mills at the Illinois Steel Co.'s South Works plant in Chicago. This department has made a record of having no lost time accidents in the slabbing mill up to August this year, when the bulletin was published, although more than 125,000 tons of product had been rolled. The two plate mills had made reductions of approximately 65 per cent for accidents for 1914, as compared with the previous year. The bulletin contains helpful hints and suggestions for the prevention of accidents in the company's mills.

W. M. & C. F. Tucker, Hartford, Conn. Catalogue 5 on Tucker oil-hole covers and positive lock compression grease cups. Several new models of oil-hole covers are shown in this edition. The Tucker grease cups and oil hole covers are efficiently protected from dirt and chips, convenient to operate and of "safety first" design. Among the types shown are two-piece oil hole covers and cups, which can be turned in either direction, with the fingers; self-closing oil hole covers, which are closed automatically by a ball and spring; and various other designs. Dimensions and price lists for sizes carried in stock are given, and special sizes will be made to order. This catalogue cancels all previous editions.

Hindley Gear Co., 1105 Frankford Ave., Philadelphia, Pa. Catalogue of Hindley worm gearing and Hindley spirals, listing wheels and worms of various leads and velocity ratios that the company is prepared to furnish on short notice. Illustrations of Hindley worm gears and spirals appear throughout the book. The section on Hindley spirals is arranged similarly to that on worm gearing. The term "spiral gears" is applied where the angle of teeth of the gears is such that either gear will drive freely in either direction. The company is ready to furnish these gears, which are used chiefly for automobile rear axle drive, of ratios from 1 to 1 up to 10 to 1. The catalogue also lists hobs for straight worm-gears.

Garvin Machine Co., Spring and Varick Sts., New York City. Circular 212 entitled "Automobile Manufacturing Kinks," showing a line of Garvin machines especially adapted for making automobile parts and accessories, among which are: vertical spindle milling machine for milling cylinder ends, crank and transmission cases; duplex milling machine for milling transmission and crank-cases and all double-end operations; two-head automatic tapping machine for tapping cases, cylinders and small parts in which several different sized holes are to be finished; special spark plug milling machine; automatic threading machine; duplex horizontal drill; four-head turning machine; monitor lathes with wrenchless chucks; coil forming machine; tire mold profiling machine. The list given will indicate the value of this little book to those engaged in automobile manufacture.

Hill Clutch Co., Cleveland, Ohio. New general catalogue 11, 224 pages, 6 by 9 inches, fully illustrating and describing the complete line of Hill power transmission machinery for belt and rope drive, including the Smith type of Hill friction clutches and Hill collar oiling bearings. The products made by the Hill Clutch Co. include: shafting, couplings, bearings, base plates, wall box frames, floor stands, hangers, clutches, pulleys, belt tighteners, tension carriages, rope sheaves, cement machinery, gears, sprockets, etc. The book is unusually complete, giving all the information on the line that the customer might desire. The section on manila rope transmission describes the American and English systems, the advantages of rope transmission in general, gives dimensions of sheaves for different rope sizes and width of grooves for pulleys. An interesting part of the book is that which gives instructions in transmission rope splicing. The making of the English transmission splice is described, step by step, and clearly illustrated by seven half-tone plates. The supplement contains descriptions and specifications of the new Cleveland type collar oiling bearing. The book is concluded with engineering notes of use in connection with transmission machinery.

TRADE NOTES

Lester & Wasley Co., Norwich, Conn., manufacturer of paper and novelty machinery, will move October 1 from its location on Falls Ave. to a better building at 282 Franklin St., Norwich.

Agnew Electric Welder Co., 47 Campau Bldg., Detroit, Mich., is now prepared to furnish a complete line of electric welding machines, comprising six spot welders and four butt welders of varying capacities.

Stow Mfg. Co., Binghamton, N. Y., was recently granted a United States patent on an improved electrical center grinder construction which provides an improved adjustable bearing for the armature and work spindle.

J. N. Lapointe Co., New London, Conn., is building a three-story 40 by 80-foot brick addition to its plant in order to provide better facilities for the manufacture of broaching machines. The addition will contain a hall for employes.

C. & C. Electric & Mfg. Co., Garwood, N. J., manufacturer of electric motors, generators and electric arc welding equipment, has removed its Detroit office from 144 Seyburn Ave. to 1111 Chamber of Commerce Building. The office is in charge of R. K. Slaymaker.

Interstate Machine Co., New London, Conn., has moved to Rochester, N. Y., where the company has a three-story building that provides greatly increased facilities for the line of small steam engines it manufactures. The company will also build a new force feed lubricator.

Atlas Press Co., 314 North Park St., Kalamazoo, Mich., is successor to the G. T. Eames Co., manufacturer of the Eames compound mandrel presses. The business has been run for about three years under the name of G. T. Eames Co., and the name was changed when J. H. Penniman purchased the interest of G. T. Eames.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has followed the custom four years of providing a summer course for a class of college professors in regular shop and engineering work. Eighteen professors from the prominent technical institutions took the course this year, beginning July 13 and ending August 15.

Logemann Bros. Co., Milwaukee, Wis., manufacturer of baling presses, cabbaging machines, hydraulic presses and pumps, has removed to its new plant at 32d and Burleigh Sts. The new plant was built especially for the construction of the company's products and occupies 2½ acres. The company will add to its extensive line of baling machines.

Watson-Stillman Co., 192 Fulton St., New York City, has closed a contract for over $100,000 worth of hydraulic jacks, piping, valves, fittings and hydro-erectors to be used in the construction of the tunnels under the East River, forming part of the new subway system of Greater New York. This equipment will be used with the ten shields employed for driving the tunnels.

Walworth Mfg. Co., Boston, Mass., has taken over the manufacture of the Parmelee wrench, which was originally designed for the handling of brass pipe. While it is essentially a friction grip wrench its action is positive and quick, the girth gripping with the slightest movement of the handle. The wrench will not mar any finished surface, and can be used on nipples without damaging the thread.

Gisholt Machine Co., Madison, Wis., is prepared to estimate on and build standard or special machinery complete or individual parts for same. The company's special tool department is ready to make

MACHINERY

NOVEMBER, 1914

PRODUCTION METHODS FROM THE LOCOMOBILE FACTORY

MACHINE FIXTURES AND A STOCK SYSTEM THAT FACILITATE THE MANUFACTURE OF A HIGH-GRADE MOTOR CAR

BY CHESTER L. LUCAS*

AT the factory of the Locomobile Co. of America in Bridgeport, Conn.—the factory that turns out but four cars per day and prides itself on those four—there are many creditable methods in use. In the following article, some of these methods are described.

One of the most striking operations that may be seen by a visitor to this factory is the milling of the sides of the crankshaft bearings in the engine cases. Fig. 1 gives a good idea of the way this operation is performed on a special Beaman & Smith milling machine. The milling of the sides of the crankshaft bearings—seven in number—and finishing them to size is done in one operation. This means that fourteen cutters are required; these are shown in detail on the arbor of the machine in Fig. 2. It will be noticed that these cutters are of the side-milling type, and are made with inserted blades of "Novo" steel. The location of these cutters upon the arbor is, of course, a very important feature, as their position governs the distance at which the milling cuts are made. The cutters are located approximately on the arbor by means of collars of the right thickness. As they must frequently be removed for grinding, however, it is necessary to have individual adjustment to make up for the amount lost in grinding, etc. To take care of this, the cutters are made after the manner illustrated in Fig. 3, so that after they have been spaced approximately, the adjusting screws may be changed in order to slip the outer section of the cutter to one side or the other to make up the desired minute adjustment. There are six of these adjusting screws, three on a side, as illustrated. The section in the lower left-hand corner shows how the adjustment is made possible. The core of the cutter is indicated at *A* and the outer section at *B*. The hollow set-screw *C* has a tapered head that bears against the corresponding surface on section *B* and thus draws the sections together. For moving the outer section in the other direction, the three screws on the opposite side are used, first, however, loosening the other set. Fig. 1 illustrates the manner in which this milling is done. The engine case, which is of government bronze, comes to the milling machine with the caps loosely bolted in place. The operator inserts steel plugs in the bearings and clamps the caps upon them. There is, of course, plenty of room at the ends of the plugs to allow the milling cutters to pass. By clamping the plugs in place in the bearings, it is insured that the bearings will not be distorted by the milling. With the assistance of a crane hoist, the engine case is raised and placed in position on the inclined fixture on the table of the milling machine. In order to locate it properly, pins are placed in the cam-shaft bearing holes and these rest against stops on the fixture on the milling machine. After the engine case has been located on the fixture, and clamped in position by draw-bolts, which may be seen on the under side of the fixture, one feeding of the cutters across the work completes the milling. It takes about forty minutes to place

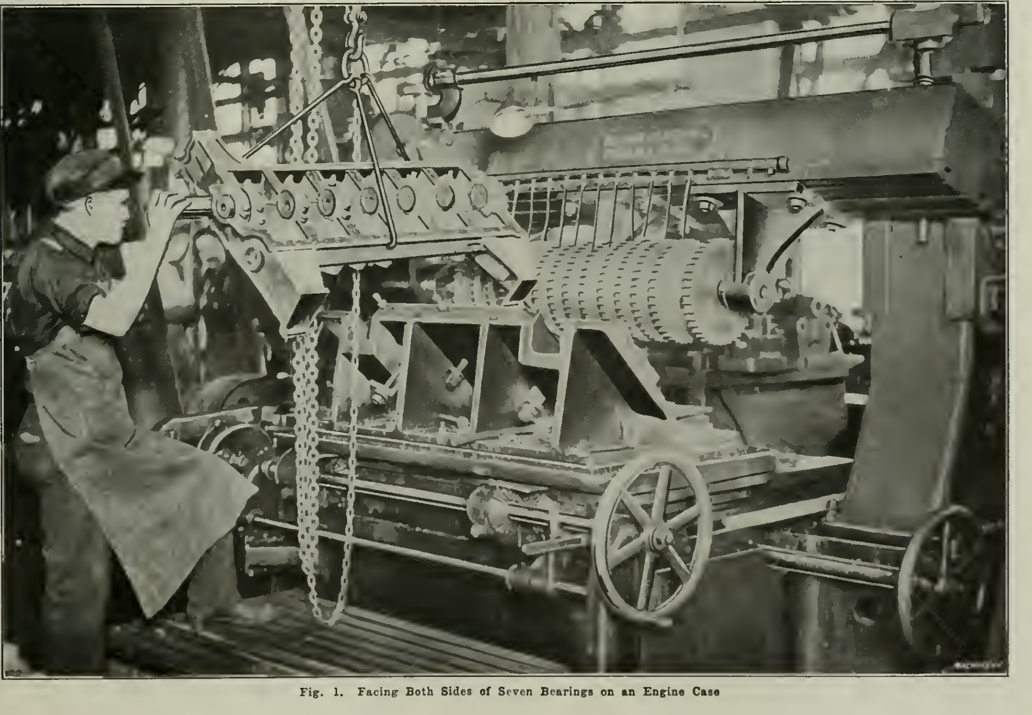


Fig. 1. Facing Both Sides of Seven Bearings on an Engine Case

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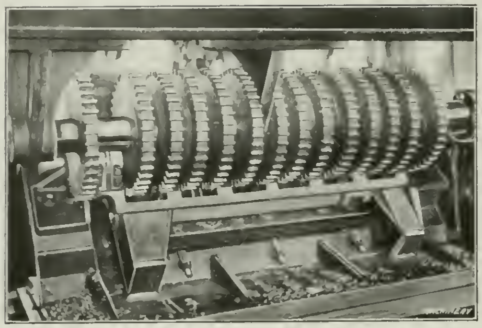


Fig. 2. Detail View of Cutters used for Engine Case Milling

the work in the fixture and perform these operations. From each bearing end, 3/16 inch of metal is removed by the milling.

Connecting-rod milling, a familiar operation in any motor building shop, is handled at the Locomobile factory in the manner illustrated in Fig. 4. The work is done on an ordinary horizontal milling machine, the two connecting-rods being clamped in position on the fixture, so that the small end of one rod is opposite the large end of the other. The fixture consists of the main casting *A* on which is the plate *B* which swivels about the center stud *C*. After one end of the pair of connecting-rods has been milled by the three face milling cutters on the arbor, pin *D* is removed and the fixture rotated so as to bring the opposite ends of the connecting-rods into the milling position. There is, of course, a corresponding hole in the opposite end of the fixture to locate it for the second operation. The clamping bolts are fitted with springs to keep the clamps in approximately the correct position when removing or replacing the work. The large ends of the rods are located under the hinge-clamp *F*, that is fulcrumed on pin *G* and bears on the work when set-screw *H* is tightened.

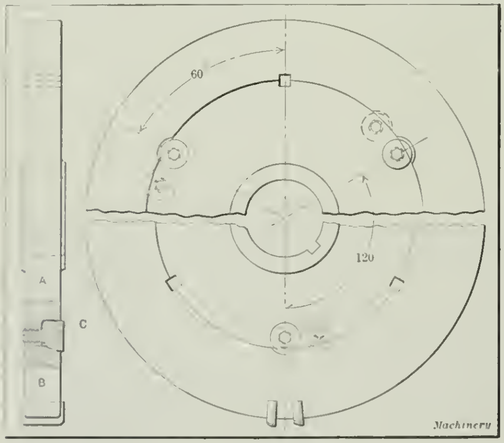


Fig. 3. Construction of One of the Adjustable Facing Cutters

In the crankshaft turning department may be observed an interesting fixture for turning the cheeks of the different throws of a crankshaft. On a six-throw crankshaft, the rough-turning is done first, allowing the center-rest *A*, Fig. 5, to be applied. On the carriage of the lathe, at the front, is the fixture *B* that holds the fixed turning tools *C*, which are, in turn, dovetailed into slides in the blocks *D*. The turning tools are sharpened in the form of side tools, but are used in just the opposite manner, being fed in from the outside. The tools in the blocks are, of course, located laterally in fixed positions and size the distances across and between the cheeks of the crankshaft. For adjusting for depth of cut, the screws *E* are provided. Clamping bolts *F* hold the tools firmly in place. In order to face the cheeks of the three throws, it is necessary to have four tool-blocks, and the one at the extreme left, it will be noticed, requires but one tool for machining the outside of the first throw. The shaft is then reversed and the remainder of the throws are completed.

Line-reaming the Engine Bearings

The line-reaming of the engine bearings for the locomobile is a very interesting operation and leaves the bearings in excellent condition. Briefly, the work consists of reaming three guide bearings, one at each end and one at the center, reaming the intervening bearings, and finally finishing by planish-broaching the entire set of seven bearings. By referring to Fig. 6, a good idea of the way the operation is performed may be obtained. The operator first inserts steel plugs at each end of the casing in the timer-shaft bearing holes and the cam-shaft bearing holes. Two of these studs may be seen at *A* and *B* in Fig. 6. Over these studs are slipped the end bearing caps *C* and *D* that support the reamers and broaches while doing their work. Reamer *E* is now put into position and the bearing caps at the ends and center are clamped in place. These three bearings are now reamed by means of the hand wrench at the end, following which the remainder of the bearing caps are put into place, first, however, putting the reamer *F* into position. By observing reamer *F* in its position in front of the fixture, it will be seen that there are four sets of blades for the purpose of reaming the four bearing caps and bearings, two of which are at each side of the center. Thus reamer *E* reams the central and two end bearings, and reamer *F* reams the two bearings on each side of the center bearing, completing the total of seven.

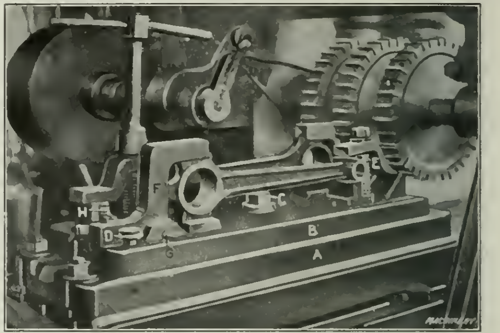


Fig. 4. Facing Ends of Connecting-rod Bearings

The finishing of the bearing surfaces by planish-broaching is performed in a similar manner to that in which the reaming is done. This operation is shown in Fig. 8. The end of the broach is in the form of a screw and is shown at *A*. This screw is for the purpose of pulling the broach through the work and it works within the long nut *B* which is held against the last bearing. In order to divide the pulling strain of the broaching operation, expansion bushings *C* are placed between each pair of bearings. These expansion bushings

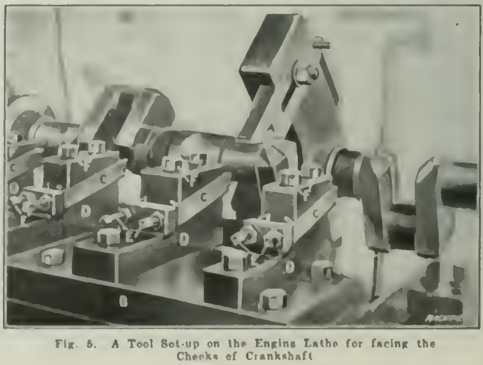


Fig. 5. A Tool Set-up on the Engine Lathe for facing the Cheeks of Crankshaft

may be opened out until all of the space between the bearings is taken up; thus the thrust is not all taken on the first bearing. Only a few thousandths inch of stock is planished by the broach, but it is enough to harden the surface of the bearing and give it a true as well as a long wearing surface.

Two types of a surface grinding machine that is used largely at the Locomobile Co.'s factory are shown in Figs. 7 and 9. These views show the upright and horizontal types of the "Peerless" surfacing machine. This machine is of the emery belt type, working against a surface plate. Miscellaneous castings of brass, aluminum, iron or steel are surfaced on these machines and they are then ready for assembling. One advantage claimed for the machine is that the finishing lines left on the work all have the same direction. Because the belt is traveling at the same rate of speed at the center and edges, there is no tendency for it to cut faster at any particular point, which is often the case on other types of grinding machines.

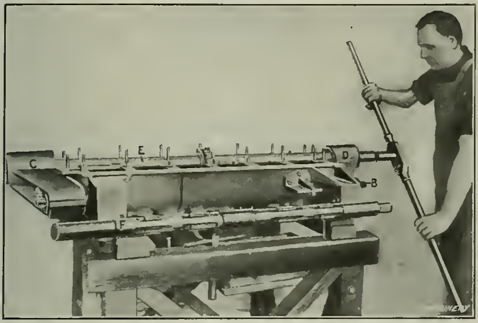


Fig. 6. First Operation in line-reaming the Engine Bearings

Letting Light into the Stock-room

One of the surest ways of having things run as they should is to pull them out into the light where they will be in plain view of everyone. This is just the principle that is employed in running the stock department for finished parts at the Locomobile factory. Many stock departments are run in a haphazard way, and the number of finished parts on hand or needed is always a question. For instance, if ten parts of one kind are required each week, unless things are run very carefully there are likely to be weeks when there will be only five or six parts supplied and other weeks when it will run up to fifteen or twenty. In this factory, such trouble is helped by a series of large blackboards posted in front of the finished parts stock-room on each floor. One of these blackboards that well explains the system may be seen in Fig. 10.

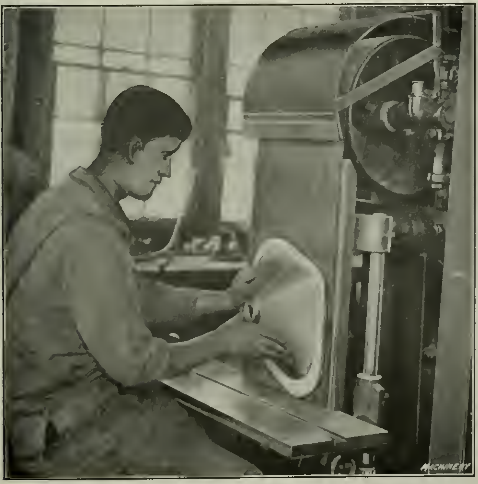


Fig. 7. Vertical Type of "Peerless" Surfacing Machine

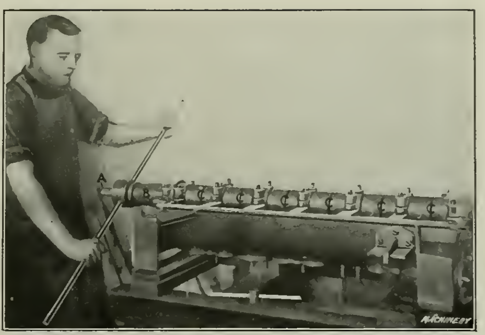


Fig. 8. Second Operation in line-reaming the Engine Bearings

Forty of these boards are now in use for keeping the production records of the most important parts. Each part or unit is assigned a part number and opposite it is the weekly schedule, that is, the number of parts required each week to keep up the standard production. This schedule may be changed from time to time in accordance with the production requirements. Following this column is a series of five spaces for registering the deliveries made each week. Each week also, the total number of parts delivered is changed to agree with the increase, and in the last column is the number of pieces that will be required on a certain date. Thus the superintendent, foreman or any of the workmen may see at a glance, without going through any red tape, just what the condition of the stock is, whether they are falling behind or getting ahead on any one part, and will be able to direct their attention accordingly. Take, for instance, on the blackboard shown in Fig. 10, part No. 59,006. The weekly schedule on October 25 called for fifty-four pieces; on October 11 fifty pieces were delivered to the stock-keeper, four pieces below the standard required. On October 18, sixty-one pieces were delivered, bringing them a little ahead of the schedule. On October 25, fifty-seven pieces were delivered, putting them a little farther ahead. The total number of pieces delivered up to October 25 was seven hundred and ninety-eight, and on November 8 nine hundred pieces would be required. As there were two more delivery dates, November 1 and November 8, the schedule of fifty-four pieces a week would bring them to nine hundred and six pieces, which is slightly in excess of what is desired. One of the principal advantages of the system is that it is right in the limelight so that everyone knows what everyone else is doing—there is nothing that can be covered up.

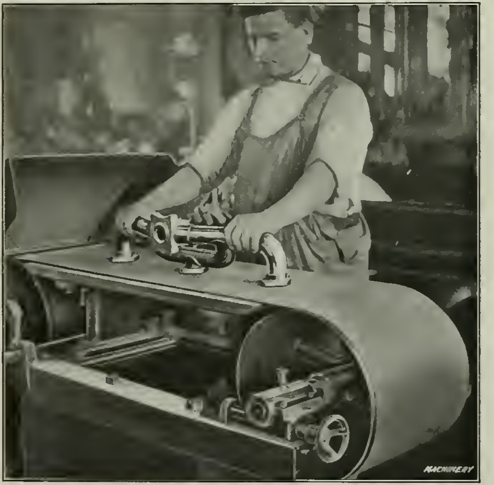
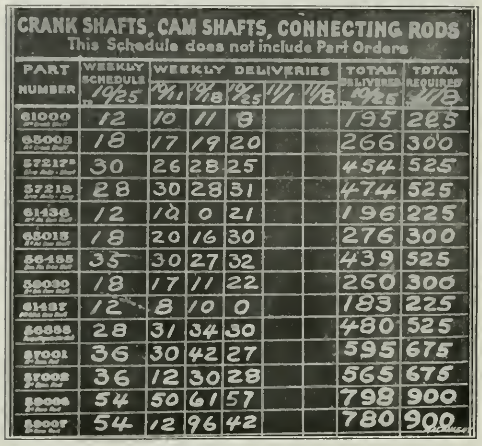


Fig. 9. Horizontal Type of "Peerless" Surfacing Machine

Supplementing the blackboard system, are the production record blueprint sheets which are made out, one for each department and one as a summary of all departments, giving the general condition of the stock in the whole factory. These are shown, respectively, in Figs. 11 and 12. In Fig. 11 is shown the record that is made out for each department. This record is for Department 24 and is a summary of all the blackboards in that department. Each week a clerk posts on this chart the number of pieces listed on the blackboards. He figures out the percentage of parts that are above and below the schedule called for, and enters them on the chart. Thus on November 1, 42 per cent of the parts made in Department 24 were above schedule, 14 per cent were below schedule and the balance or 44 per cent were on a normal basis. This is carried out from week to week and thus by observing the rise and fall of the record, an accurate check may be kept on the stock of the department. The nearer the two record lines approach the normal line, the more ideal is the production.



CRANK SHAFTS, CAM SHAFTS, CONNECTING RODS
This Schedule does not include Part Orders

PART NUMBER	WEEKLY SCHEDULE 10/25	WEEKLY DELIVERIES 10/11	10/18	10/25	11/1	11/8	TOTAL DELIVERED 10/25	TOTAL REQUIRED 11/8
61000	12	10	11	8			195	225
65008	18	17	19	20			266	300
57217B	30	26	28	25			454	525
57218	28	30	28	31			474	525
61436	12	10	0	21			196	225
65018	18	20	16	30			276	300
56485	35	30	27	32			439	525
58030	18	17	11	22			260	300
61487	12	8	10	0			183	225
56888	28	31	34	30			480	525
87001	36	30	42	27			595	675
87002	36	12	30	28			565	675
89006	54	50	61	57			798	900
89007	54	12	96	42			780	900

Fig. 10. Blackboard showing Condition of Stock at All Times to Everyone

Similarly, a blueprint record is kept for the chief executive of the factory which gives a summary of the production of the different departments. On this latter record is kept the total number of parts from all departments, and from week to week the percentage above or below schedule is noted on the chart. This, of course, results in two lines across the chart that denote the progress in keeping up with the demands of stock. The record in Fig. 12 denotes, for instance, on September 20 that, in the entire factory, 34 per cent of the parts were above the desired schedule and 40 per cent were below schedule. The balance, 26 per cent, was normal. On November 1, however, the condition of the general stock was much better, as only 23 per cent was above schedule and 17 per cent below schedule, leaving 60 per cent of the stock normal. This stock-keeping system has worked out very successfully and shows at a glance just how things stand in any one department or in the factory as a whole.

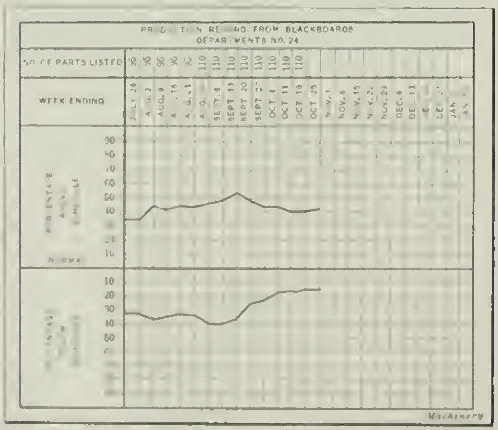


Fig. 11 Production Record from One of the Departments' Blackboard Bulletins

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MOVING PICTURES IN SCIENTIFIC RESEARCH WORK

The part that moving pictures have played in scientific and technical research is outlined by Dr. Hans Goetz in the *Zeitschrift des Vereines deutscher Ingenieure.* One of the ways in which the moving picture acts as an aid to science is in recording rare phenomena, such as observed in the life of animals that are seldom seen, or those that are difficult of access, unusual surgical operations, etc. This is only the beginning of the usefulness of the moving picture in scientific research. The fact that by an increase in speed it is possible to produce, in a few minutes, a record of what has taken place during several days or even months, as, for instance, the possibility of producing in three minutes a ten-day period of growth of a plant, where pictures were taken at five minute intervals, is a very interesting and valuable aid to science. A large field for the study of the growth of plants is thus opened up. Just as the slow movements can be hastened so that it is possible to see the total effect in a better perspective, so it is also possible to retard and analyze quick movements. With the most refined mechanical device it is not possible to take more than 250 pictures per second, but by illuminating the moving object with regularly succeeding electric sparks and photographing on a film moving continuously, rather than intermittently, it has been found possible to increase the number of exposures to 2000 per second. The flight of insects, for instance, can be shown very clearly in this manner. In engineering, moving pictures have been used in studying the flight of projectiles and their effect on armor plate. Electrical apparatus, with high frequencies, are necessary for this purpose, and from 9000 to 50,000 exposures per second are obtained by this method. The moving picture thus opens up a field for studying on the one hand motions that are so slow that it has hitherto been impossible to form any conception of them as a whole, and on the other, of movements that are so rapid that it has been impossible in any way to study the details connected with them.

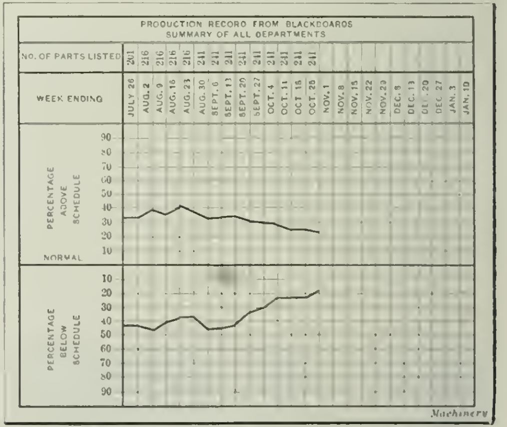

Fig. 12. Production Record Summary from All Departments showing Percentage of Parts above and below Schedule

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The temperatures at which certain substances in contact with the atmosphere at ordinary pressures will catch fire are assumed to be as follows: Illuminating gas, 1110 degrees F.; benzine, 780 degrees F.; petroleum, 715 degrees F.; gas oil, 660 degrees F.; machine oil, 715 degrees F.; coal tars, 930 degrees F.; tar oil, 1075 degrees F.; and benzol, 970 degrees F.

CENTERING DEVICES

TWELVE DIFFERENT MECHANISMS FOR RETURNING A MACHINE MEMBER TO THE STARTING POINT

BY CHARLES A. CLARK*

CENTERING devices, as their name implies, are used for automatically returning machine members to the starting point or central position. A typical application is on alternating current motors where a centering device is required owing to the necessity of subjecting the motor windings to a low voltage in starting the motor, after which the full voltage is used for running under normal conditions. In the event of the current's failing, it is necessary for the starting switch to be returned to the "off position," and for this purpose a centering device is used. When the switch is pulled over to the "running position" it is held in place by an electromagnet, but in the event of the current's failing the magnetic attraction ceases. The centering device is then able to return the switch to the off position.

Fig. 1 shows a mechanism which is known as a Gherkin's latch which is used in conjunction with certain types of centering devices. This latch consists of a handle *A* which is mounted on shaft *B*. The handle has a projecting boss *E* which engages with the latch *C* that is pivoted on the pin *D*.

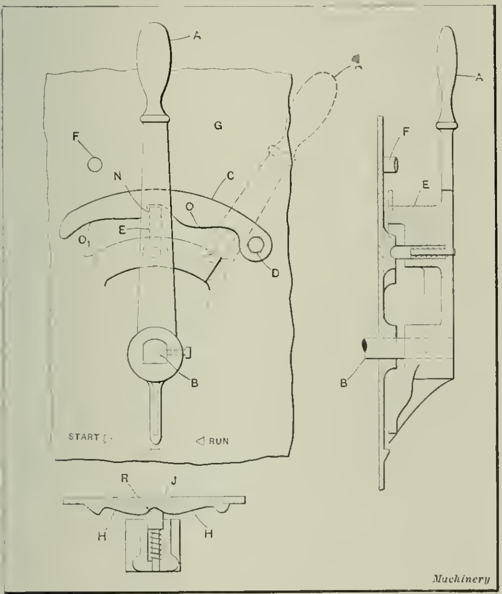
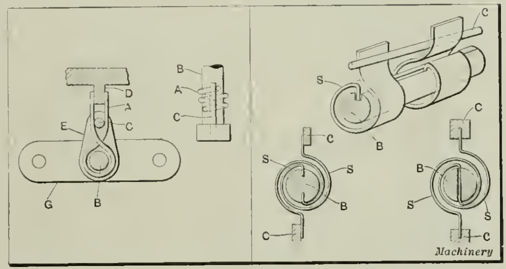


Fig. 1. The Gherkin Latch used on Electrical Equipment

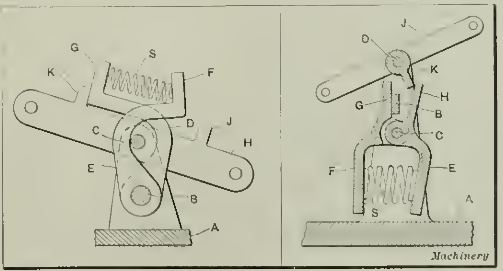
The pin *D* is carried by the case *G* and the movement of the latch is limited by a second pin *F*. This latch is so constructed that when the handle is moved slowly to the left, the latch will prevent the handle moving beyond the notch *N*; but if the handle is moved over to the extreme right—as shown dotted in the illustration—and then thrown quickly in the opposite direction, the boss *E* on the handle will leave the top of the incline *O* on the latch with sufficient speed to enable it to jump across the notch *N*, in which case the handle will come to rest in the position marked O_1 which is the running position. The pin *R* riding on the surfaces *H* will lock the handle in the cavity *J* when the action of the centering spring becomes effective. In this way the handle is securely held in the central or off position. This latch may be used in connection with either of the centering devices shown in Figs. 2 and 3. The centering spring has one end attached to the shaft *B* of Fig. 1 and the opposite end to the case *G*.



Figs. 2 and 3. Two Forms of Centering Devices that may be used with a Gherkin Latch

Referring to the illustration of the centering spring, or so-called "cross legged spring" shown in Fig. 2, it will be seen that a coiled spring *A* is employed to connect the shaft *B* with the case. The effectiveness of this spring is dependent on the following conditions: first, that the ends cross each other in a line which is perpendicular to the horizontal axis of the spring; second, that the ends of the spring extend far enough above the outside of the coils to enable a pin or bar *C* and a fixed boss *D* to be inserted between these two ends. This condition is clearly shown in Fig. 2. The pin or bar *C* is carried by the crank *E*, which, in turn, is carried by the shaft *B* of the mechanism shown in Fig. 1. An arm *G* or some other means provides for transmitting the motion so that when the shaft *B* is moved in either direction the cross legged spring will be put in tension by having one end turned through the action of the pin *C*. This spring tension provides for returning the arm *G* and the shaft to which it is secured to the central position when the action of the spring becomes effective. A very simple centering device is illustrated in Fig. 3, the only difference from the preceding type being that two separate springs are employed in this case. One end of each of these springs *S* is secured in a slot in shaft *B*, while the other end is held by the fixed pin *C*. When shaft *B* is turned in either direction, one of these springs is put under tension and this spring tension provides for returning the shaft to the central position when the action of the spring becomes effective. Two modifications of this design are shown in the lower corners of this illustration.

Another form of centering device is illustrated in Fig. 4. Referring to this illustration, it will be seen that there is a bracket *A* which supports a pivot *B* and a pin *C*. Two arms *D* and *E* are mounted on the pivot *B*, on which they are free to swing. On the ends of the arms are projections *F* and *G* which are secured to opposite ends of the spring *S*. These projections *F* and *G* also engage with bosses *J* and *K* on the moving member *H*. This moving member is carried by the pin *C*, upon which it is free to swing. Assuming that the moving member *H* is rotated in a clockwise direction, the centering device will assume the position shown in Fig. 4. The arm *E* is held against the pin *C*, while the boss *G* on the arm *D* engages the boss *K* on the movable member *H*. Further rotation of the member *H* will compress the spring



Figs. 4 and 5. Two Types of Double-arm Centering Devices

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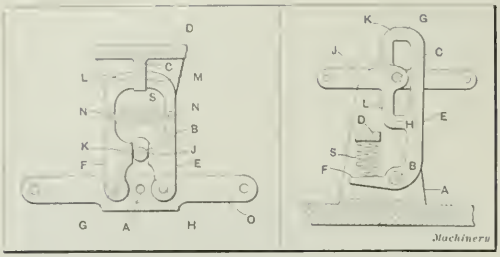
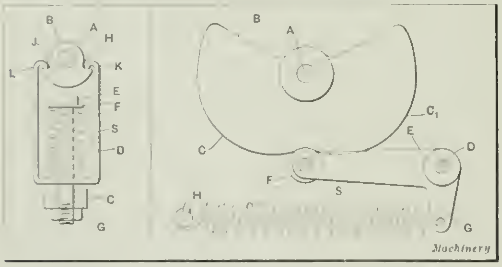


Figs. 6 and 7. Two Types of Centering Devices in which Sliding Contact of the Control Arms is employed

S and this will return the movable member to the central position when the action of the spring becomes effective. If the movable member H is rotated in a counter-clockwise direction, the action of the centering device will be exactly reversed, the arm D being held by the pin C while the boss F on the arm E engages the boss J on the movable member H, thus causing the compression of the spring S.

In the centering device shown in Fig. 5, the frame A is provided with a stop B and two pivots C and D. Two arms E and F are mounted on the pivot C, these arms being free to swing and provided with projections G and H at their upper ends. When the centering device is in its normal position, both of the projections G and H are in contact with the stop B, owing to the action of the compression spring S which forces the lower ends of the arms in opposite directions. It will be seen that the movable member J is mounted on a pivot D and provided with a projecting lug K on its lower side. This lug engages with the projections G and H, and when the member J is rotated in either direction, it swings one of the arms about the pivot C and compresses the spring S. When the action of this spring becomes effective, it returns the arm to the normal position; and the projection at the upper end of the arm acts on the lug K, causing the movable member J to be returned to the starting point.



Figs. 6 and 9. Yoke and Cam Types of Centering Devices

The centering device illustrated in Fig. 6 works on a somewhat different principle from that of the preceding types. Referring to this illustration, it will be seen that the frame D carries a stop C and a pivot A. The movable member O is carried by this pivot A, and, in turn, carries two arms E and F. The arm E is carried by the pivot H and provided with two sliding surfaces J and M which work in contact with the pin B and the boss C, respectively. The arm F is supported on the pivot G and has two sliding surfaces K and L which work in contact with the pin B and the boss C, respectively. The tension spring S is secured to the arms E and F at the points N. Assuming that the movable member O is to be rotated in a clockwise direction, the arm E will be pulled down by the supporting pivot H and in so doing, the surfaces M and J will slide on the boss C and pin B. For the same reason, arm F will be pushed up, the surface L sliding on the boss C and the surface K sliding on the pin B. This action increases the distance between the pins N to which the spring is secured, thus putting the spring S under tension, and when the action of this spring becomes effective, it will return the movable member O to the starting point.

In the device shown in Fig. 7, the frame A carries two pivots B and C, and a boss D to which one end of the spring S is secured. The arm E is pivoted at B and has a projection F which engages the opposite end of the spring S; this arm also has two sliding surfaces G and H, which work in contact with the projections K and L on the movable member J. This movable member is carried on pivot C. When the member J is rotated in either the clockwise or counter-clockwise direction, one of its projections causes the arm E to be rotated in a clockwise direction about the pivot B. When this rotation takes place, the projection F on the arm E compresses the spring S. When the movable member J is released, the action of the spring S becomes effective and returns it to the central position.

Fig. 8 shows a form of centering device which is limited in its application but has been found particularly effective in those cases where it can be used. It is only applicable for returning mechanisms which have a relatively small angular movement. Referring to the illustration, it will be seen that the shaft A has a hub B secured to it. An arm or other means of transmitting the motion may be secured to the shaft A. The hub B has two recessed surfaces H and J that receive the ends K and L of the yoke D, which is held in position by means of a bolt E. The opposite end of this bolt is carried by a lug C, and the bolt carries a spring S and washer F which supports the pressure of the upper end of the spring. When the shaft A is rotated in either direction, the hub B raises the yoke D, thus compressing the spring S, and when the action of this spring becomes effective, it pushes down the yoke and returns the shaft A to the starting point.

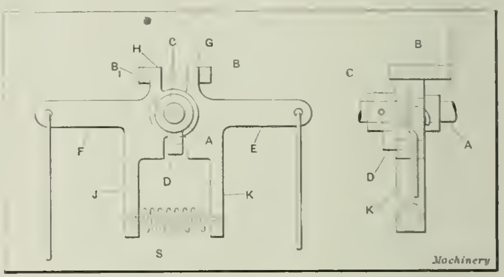
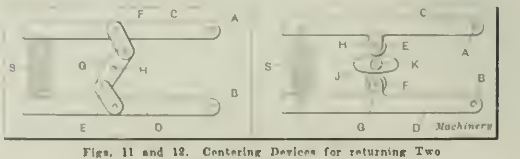


Fig. 10. Another Form of Double-arm Centering Device

One of the simplest forms of centering devices that can be used consists of the combination of a cam, bellcrank and spring illustrated in Fig. 9. Referring to this illustration it will be seen that the shaft A has the two-lobed cam B secured to it. The bellcrank E is mounted on the pivot D; and this bellcrank has the cam roller F mounted at one end and the other end secured to the spring S. The opposite end of the spring is secured at the point H. When the shaft A is rotated in either direction, the lobe C or C_1 of the cam pushes down the end of the bellcrank; and this causes the crank to rotate about the pivot D. The result is that the opposite end G of the bellcrank swings out and places the spring S under tension. When the action of this spring becomes effective, it rotates the bellcrank in the opposite direction and returns the shaft A to the starting point through the action of the cam roller F on the cam.

A type of centering device which finds wide application in the control of oil switches is illustrated in Fig. 10. In this illustration, A represents a shaft to which a hub C is secured. This hub carries a projecting lug D which extends between the two arms E and F of the centering device. These arms are free to swing about the shaft A. The arm E is provided with an extension K to which one end of the spring S is



Figs. 11 and 12. Centering Devices for returning Two Arms simultaneously secured, and a second extension G which limits the movement of the arm E in a clockwise direction through contact with the stop B. The arm F has an extension J, to which the opposite end of the spring S is secured, and a second extension H which limits the rotation of the arm F in a counter-clockwise direction through contact with the stop B_1. The tension of the spring S holds the arms E and F against their respective stops B and B_1. When shaft A is rotated, the hub C and its lug D are moved in either a clockwise or counter-clockwise direction as the case may be. This rotation causes either the arm E or F to be rotated against the tension of the spring S, and when this spring tension becomes effective it causes the shaft A to be returned to the starting point.

Figs. 11 and 12 show two simple devices for returning two levers to their normal positions. In the device shown in Fig. 11, the lever C is carried by the pivot A and the lever D is carried by the pivot B. An arm G is pivoted between these levers and connected to them by means of two links E and F. When arm G is rotated in a clockwise direction, it causes levers C and D to swing in about pivots A and B, thus placing the spring S under compression. When the force tending to bring the levers C and D together is released, the compression of the spring S will return the levers to their normal positions. The arrangement of the mechanism shown in Fig. 12 is quite similar to that of the preceding illustration, except that the levers C and D are provided with cam rolls E and F which are mounted on pivots H and G. When the cam J is rotated in either direction, by turning the shaft K, it causes the levers C and D to swing outward about the pivots A and B, thus placing the spring S under tension. When the torque tending to rotate the shaft K is released, the tension of the spring S returns the levers C and D to the starting point.

* * *

THE SAND-BLAST FROM THE USER'S VIEWPOINT[*]

The foundry sand-blast was developed for the cleaning of castings, and its many advantages for cleaning or surfacing in all branches of metal working, plating and finishing have been so fully demonstrated that it is today a fixture. Thoroughly sand-blasted castings can be machined more rapidly and at reduced expense. The value of the sand-blast in sheet and structural steel work has been thoroughly demonstrated, and the railroads generally demand the sand-blasting of steel cars before painting. A smooth surface results and the paint protects the metal better from corrosion. Metals to be plated, japanned, galvanized, sherardized, or treated with the various rust prevention processes, such as "Coslettizing," "Bower-Barff," "carbonium," etc., are thoroughly cleaned by the sand-blast preparatory to treatment. Bars, rods and plates to be electrically welded are freed from scale and rust in order to insure perfect contact.

A variety of sand-blast apparatus is available for foundrymen and other users; for small work adapted in size and shape for cleaning in the sand-blast barrel there can be no question of the economy of this type of machine. Pieces too large for successful barreling may be cleaned with the least labor on the round and reciprocating type table machines, but if the pieces are of such shape or design as to demand constant turning to bring all surfaces under the action of the nozzle, one of the small enclosed cabinets of the self-contained continuous feed type, with stationary or portable nozzle, may be found more efficient. The combination pressure blast and cabinet machine also affords at small cost efficient equipment for a small volume of work of varied character. It is safe to say, however, that the varied character and limited output of the majority of foundries and other plants requiring self-blasting equipment is best served by machines that will clean everything and anything. For these the hose type machine is most efficient. It is simple, having few working parts, and the up-keep cost is reduced to a minimum.

Under pressure of 80 pounds per square inch a 3/16 inch nozzle will discharge 48 cubic feet of free air per minute and 500 pounds of sand per hour; a ¼ inch nozzle discharges 85 cubic feet of air per minute and approximately 900 pounds of sand per hour; a 5/16 inch nozzle, 133 cubic feet of air per minute and 1300 pounds of sand per hour; a ⅜ inch nozzle, 191 cubic feet of air per minute and 1700 pounds of sand per hour; a ½ inch nozzle, 340 cubic feet of air per minute and approximately 3000 pounds of sand per hour.

What is the most satisfactory working pressure is a question much discussed, but to which there is but one answer, and that is the pressure at which the work can be done the cheapest, all other factors being considered. If it is required to remove loose sand from castings a working pressure of 30 pounds or less will undoubtedly be satisfactory even on iron or steel, and should provide a surface suitable for painting. If, however, the castings are to be machined, every particle of the fused sand should be taken off in order to expose the clean metal to the action of the cutting tool. This condition on steel can be secured only with sand-blast pressure up to 90 pounds in order to be economical. Removing all the fused sand will not only reduce tool expense materially, but in actual practice has demonstrated that the output of machine tools will be increased at least 15 per cent.

In order to determine the most economical pressure for sand-blasting apparatus there must be taken into consideration, besides the elements of labor and abrasive, the initial pressure at which the air is being delivered from the compressor. The majority of pneumatic equipment in use today requires about 80 pounds pressure, and in some installations of sand-blast apparatus we find the air supply is being delivered to the receiver at this pressure. While it might be demonstrated that the castings could be most economically cleaned at a lower pressure if the air were initially compressed to that pressure, it is manifestly cheaper to use the air at the full or standard pressure of 80 pounds if other requirements in the plant demand that pressure. The fact must not be lost sight of that every cubic foot of air used for sand-blast purposes which is reduced to the lower pressure costs the same in horsepower expenditure that it would if it were used at the initial pressure of 80 pounds.

Tests made by Prof. William T. Magruder, reported in a paper read before the American Society of Mechanical Engineers, to determine the amount of metal removed by a sand-blast showed that the time required to remove one pound of iron with 20 pounds pressure was 3.55 hours; 30 pounds, 2.77 hours; 40 pounds, 2.13 hours; 50 pounds, 1.52 hour; 60 pounds, 1.07 hour; and 70 pounds, 0.82 hour. In one instance it was shown that 230 cubic feet of free air requiring 73 horsepower to compress, was discharged through a 9/16 inch nozzle at 40 pounds pressure, and 120 pieces weighing 200 pounds each were cleaned in a ten-hour day. With a pressure of 80 pounds passing through a ½ inch nozzle, flowing 140 cubic feet of free air per minute, 156 pieces were cleaned in ten hours. In the first instance the air was compressed to 80 pounds and passed through a reducing valve to the sand-blast machine. Had the air in the first instance been initially compressed to 40 pounds the power saving would have been over 12 per cent of the higher pressure to say nothing of the greater output. The general proposition of the low pressure cleaning is volume of sand, which requires the large hose and nozzle, consuming air at low pressure and cost, while the high pressure provides a minimum of sand driven with high velocity through a small hose and nozzle with high pressure and cost of air. The horsepower cost is approximately the same for the same results by either operation with the air initially compressed to the operating pressure, and the determining factors will therefore be the volume of output with a minimum of labor cost.

* * *

USE OF WIRELESS FOR DISPERSING FOGS

Experiments are being carried out by one of the leading French railways with the use of wireless waves for dispersing mists and fogs. It is known that electric waves act upon the water particles which comprise fog in such a manner as to burn them into vapor. By this means it is claimed that as much as 600 feet can be cleared in front of the wires emitting the waves. This will obviously be of great value for railways and vessels at sea.

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[*] Abstract of paper read at a meeting of the Associated Foundry Foremen of New York and vicinity, by H. D. Gates, sales manager, sand-blast department of the De La Vergne Machine Co., New York City.

SOME AUTOMOBILE SHOP TOOLS

SPECIAL TOOLS USED BY THE HUPP MOTOR CAR CO., DETROIT, MICH. FOR LAPPING CYLINDERS, LINE-REAMING CRANK-CASES, ETC.

IN specialized manufacture, such as automobile engine building, it is necessary if an interchangeable product is to be secured, that the machining operations, especially the final ones, be carefully accomplished. It is also necessary that the machines be designed with the aim in view of obtaining uniformity of product and that all defects in previous operations be rectified. The Hupp Motor Car Co., of Detroit, Mich., takes particular pains with the final operations on its automobile engines, and a few of the most interesting machines used in this shop are illustrated and described in the following.

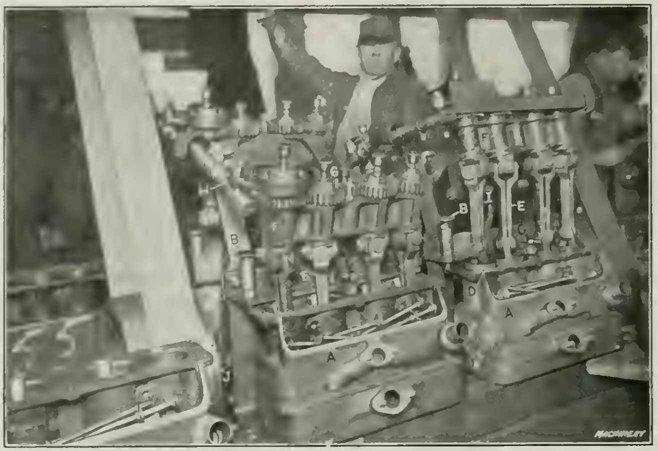

Fig. 1. Special Piston, Piston Ring and Engine Cylinder Lapping Machines of the Oscillating Type

Cylinder, Piston and Piston Ring Lapping Machine

An interesting machine used for lapping cylinders, pistons and piston rings is shown in Fig. 1. The cylinders for Hupp four-cylinder engines are cast *en bloc*, and after the bore has been machined to the proper dimensions, the castings are brought to the machines shown in Fig. 1. These machines lap the cylinder bores, pistons and piston rings simultaneously and make a perfect running fit. The machine used for this purpose has a double head, and laps two castings—eight cylinder bores—at the same time, one casting being placed on each side of the machine as indicated in the illustration.

In operation, the cylinder castings *A* are placed in the proper position on the table of the machine, being located by two plugs *B* fitting into previously drilled holes in the base of the cylinder castings, and held in position by clamping screws *C*. The pistons *D* are then connected by the regular piston pins to special connecting-rods *E*. These, in turn, are fastened by a universal joint to the oscillating driving shafts held in the head *F* of the machine, which are oscillated by the train of gears *G* and shaft *H*.

This yoke or head *F* which comprises one casting is operated by a connecting-rod *I* fastened to the lower extension of the yoke and receiving motion from a crankshaft similar to that used in an automobile engine. This single-throw crankshaft is driven by pulley *J*.

At the same time that the yoke is being oscillated, the pistons are also oscillated. This is accomplished by means of the ball-jointed arms *H* which are given a slight twisting motion owing to the oscillation of the yoke, and consequently give a slight back and forth movement to the arm *K*; this arm is connected to the first gear *G* in the row and through intermediate gears, drives all the other gears in the line which, of course, are connected to the universal joint that carries the special connecting-rods. The pistons are moved up and down at the rate of 150 strokes per minute, and it requires twenty minutes to lap eight cylinders, pistons and piston rings. In order to make 150 strokes, it is necessary that the yoke itself turn over 300 times, giving 150 strokes for each casting, there being two *en bloc* cylinder castings lapped at the same time.

The lapping mixture consists of a fine grade of ground glass mixed with kerosene, which is applied to the pistons by means of a brush In the machine shown to the right the pistons are raised, to show how the special connecting-rods are fastened to them, and the illustration also shows how the casting is located and held down on the bed of the machine. One man runs the two machines and turns out an average of twelve cylinder castings per hour, finish-lapped and ready for assembling. Before assembling, however, the ground glass lapping mixture is removed by immersing the casting in benzine.

Pneumatic Press for Inserting Valve Tappet Bushings

An efficient method of inserting valve tappet bushings in crank-cases for Hupp four-cylinder engines is shown in Fig. 3. This device is operated on the toggle principle, and is capable of exerting a pressure of 3000 pounds per square inch. It required 2800 pounds to insert the valve tappet bushing. Compressed air is supplied through the flexible tube *A* to cylinder *C* through valve *B*. The cylinder carries an extended boss which holds a foot member that locates directly under the point where the valve tappet bushing is to be inserted and above this is another extension that acts as a locating bracket for the device. The tappet bushing *D* when being inserted is located on a plug at the lower end of the toggle arm *E*, which is guided by the yoke *F* sliding on the post *G*. The pressure is then directed onto the bushing and the strain is taken on the lower extension of the cylinder, removing all strain from the crank-case when inserting the bushing. This method of inserting valve tappet bushings is superior to a screw or arbor press, because of the fact that no strains whatever are set up in the crank-

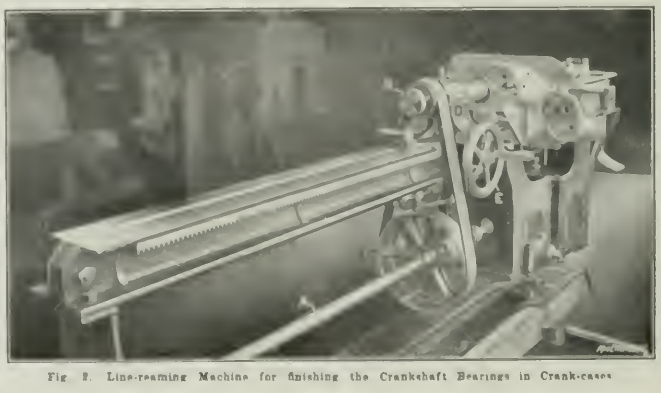

Fig. 2. Line-reaming Machine for finishing the Crankshaft Bearings in Crank-cases

case and the bushings are also set much more quickly. The device is suspended from an arm fastened to a post through a rope so that it can easily be swung around from place to place, or from bushing to bushing. It has greatly facilitated the insertion of valve tappet bushings in this plant.

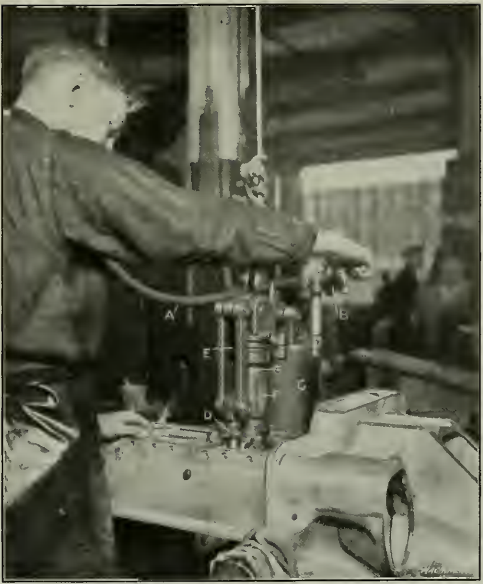

Fig. 3. Pneumatic Press for inserting Valve Tappet Bushings in Crank-cases without distorting the Crank-case

Line-reaming Crank-cases—Crankshaft Bearings

A unique type of special machine for line-reaming the crankshaft bearings in aluminum crank-cases is shown in Figs. 2 and 4, the latter illustration showing a closer view of the reaming end of the machine. This machine is driven by a 1½-horsepower motor, the power being transmitted to the lower shaft *A* through a worm and worm-wheel, thence to the spindle of boring-bar *B* by a belt as illustrated. The spindle which carries the boring-bar is operated at a speed of 300 revolutions per minute. The boring-bar carries single-point cutting tools.

The pulley *C* slides on the lower shaft and the head *D* is driven along the base of the machine by a lead-screw, which, in turn, is driven from the worm previously referred to by a vertical shaft and a pair of bevel gears. The handwheel *E* is used for operating this boring head by hand when setting up the machine.

As a rule, crankshaft bearings are finished by line-reaming, but instead of single-point cutting tools, reamers are used. It is generally conceded by those who have had experience in this class of work that a reamer does not in any case give as truly a cylindrical hole as does a single-point cutting tool. In fact, the single-point tool when properly held and operated, can be depended upon to give an almost perfectly cylindrical hole. It was for this reason that the Hupp Motor Car Co., in an endeavor to get truly cylindrically bored bearings, designed this special machine in which the boring-bar *F* carries three single-point cutting tools *G*. There are three bearings that have to be machined. The supports or arms *H* carry hardened and ground bushings in which the boring-bar *F* rotates. This boring-bar, as previously mentioned, is rotated at a peripheral speed of 300 revolutions per minute and traversed at a feed of about 1/64 inch per revolution.

D. T. H.

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EXTINGUISHING FIRES WITH SAWDUST[*]

At first thought it might appear absurd to attempt to extinguish a fire by sprinkling sawdust upon it. "Adding fuel to the flames" is a time-honored figure of speech. As a matter of fact, however, sawdust is quite efficacious under certain conditions, if properly applied; and it is particularly well adapted for extinguishing small fires in oils and other inflammable liquids.

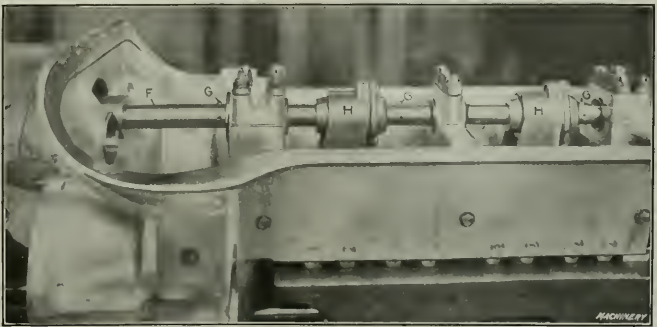

Fig. 4. A Close View showing Boring-bar of Line-reaming Machine illustrated in Fig. 2

It is well known that combustion cannot continue in the absence of oxygen, and nearly every one has at some time or other smothered a small fire by covering it with a heavy cloth or some similar object, and thus excluding the air. Anyone who has seen a fire in a pile of sawdust has doubtless observed that after the outer surface of the pile has burned over, the remainder merely smolders, and seldom shows a flame. This is due to the fact that the sawdust particles pack together too closely to allow air to penetrate the surface of the pile freely enough to support the combustion actively. It is this characteristic feature of sawdust that gives it value as an extinguishing agent. It smothers the flames in the same manner as a blanket, by excluding the air.

Sawdust may be successfully used for extinguishing burning gasoline that has been spilled upon floors or on the ground; but it is of comparatively little value in the treatment of gasoline fires in large tanks, because it is almost impossible to spread the sawdust over the entire surface before some of it sinks to the bottom, exposing the surface at these points and allowing the liquid to re-ignite. It is far more useful in connection with liquids such as heavy oils, lacquer, japan, and melted wax, because it floats upon the surface of fluids of this type, and blankets them quite effectually.

The value of sawdust as an extinguishing agent can be considerably increased by the addition of a certain proportion of bicarbonate of soda (familiarly known as "baking soda"). This substance when exposed to heat gives off carbon dioxide gas, which materially assists in preventing the access of air. A mixture composed of ten pounds of bicarbonate to one bushel of sawdust has been found to be satisfactory, and tests have shown that by the use of this mixture fires may be extinguished more quickly and with a smaller amount of material than when sawdust is used alone.

The character of sawdust appears to have little effect upon its fire-extinguishing properties. Wet and dry sawdusts, from both hard wood and soft wood, have been tried with equally effective results. The sawdust should not be too fine, and it should be applied as quickly as possible, so as to cover the entire surface of the liquid. The application may be most effectively made by the use of a broad, flat shovel similar to a snowshovel.

As a precaution against fire in sawmills and other plants where dry sawdust collects in considerable quantities, it may sometimes be advisable to sprinkle sodium bicarbonate upon the sawdust piles at intervals. If a pile so treated were to become ignited, the bicarbonate would be of material assistance in checking the combustion.

Other substances may be even more effective than sawdust for smothering flames, but few things could excel it in the features of cheapness or ease of application.

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[*] From the "Travelers' Standard," August, 1914.

PROFILING OPERATIONS AT FACTORY OF SAVAGE ARMS CO.*

INGENIOUS FIXTURES AND FORMERS USED FOR PROFILING RIFLE AND PISTOL PARTS

BY FRANKLIN D. JONES†

OWING to the irregular shapes of many rifle and pistol parts, a great many profiling operations are necessary in connection with their manufacture. In the plant of the Savage Arms Co., Utica, N. Y., the profiling practice has been developed to a high degree of efficiency and many ingenious fixtures and formers are used. This article is descriptive of some of the more important and unique operations.

Profiling Inside of Finger Lever

The method of profiling the inside opening of the finger lever (such as is used on the '99 model action) is illustrated in Fig. 1. A concave cutter is used to form a convex surface on the work The lever is held in the fixture by clamps *A* which are forced downward by the eccentric clamps *B*, and it is located by the two rods *C* and pin *D*. The latter enters the pivot hole of the lever and rods *C* extend beneath the left clamp *A* and bear against the left side of the lever. The opposite side, which has been rough-milled by a previous operation, is held firmly into contact with the fixture by rods *C* which are forced inward by an eccentric lever *E* that bears against a yoke connecting the two rods.

The former *F*, which is engaged by guide-pin *G* and controls the movement of the cutter, has a plain rectangular opening which, of course, conforms to the shape of the hole to be milled in the finger lever When the profiling operation is completed, clamps *A* are withdrawn by means of handles *H* so that the lever can be lifted off the locating pin *D*. As will be seen, the former can be adjusted laterally if for any reason this should be necessary.

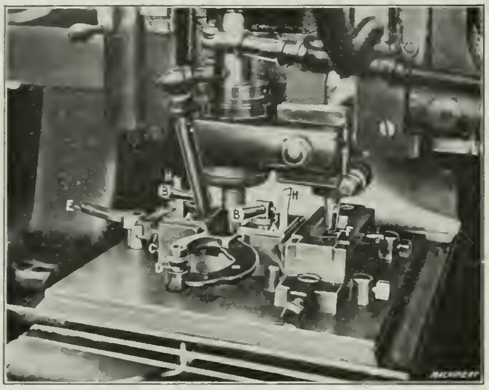

Fig. 1. Profiling Inside of Finger Lever for Rifle

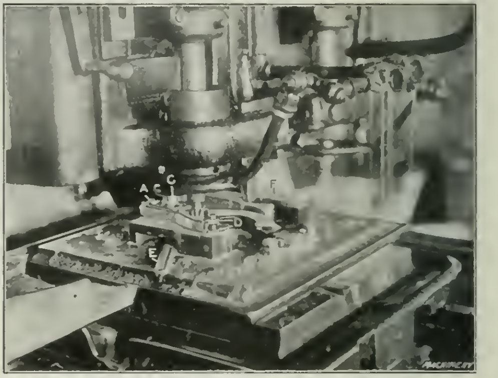

Fig. 2. Profiling Outside of Rifle Finger Lever

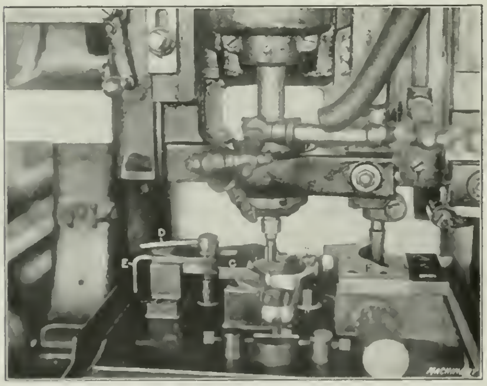

Fig. 3. Another Profiling Operation on a Finger Lever

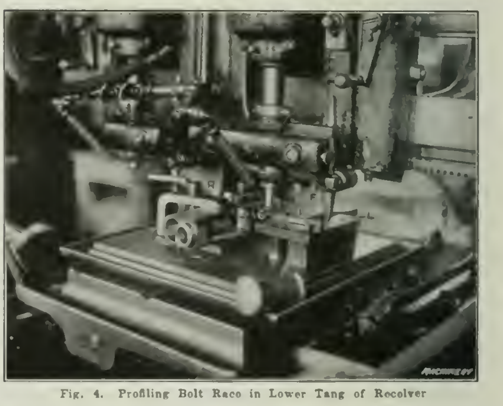

Fig. 4. Profiling Bolt Race in Lower Tang of Receiver

Profiling Outside of Finger Lever

After the inside of the finger lever is milled, as described in the preceding paragraph, the outside surfaces are finished as indicated by Fig. 2 and the diagram Fig. 5. As the finger hole end of the finished lever is quite narrow, it is necessary to have the lever accurately located laterally so that one side will not be thicker than the other. The lever is located in the fixture by the inside of the finger hole and the pivot pin hole. Block *A* accurately fits the finger hole and is located by pins *B* inserted in the base of the fixture. This block has a projecting flange at the top, which is forced down onto the lever by bolt *C*, thus clamping the lever firmly in place. The location and length of the profiling cut are indicated by the arrows *a* and *b* in Fig. 5, and the surfaces of the former *F* which are used are shown by the arrows a_1 and b_1. After a lever is profiled, it is removed from the fixture by loosening clamp lever *E* and turning bolt *C* until its flat sides are aligned with the slot in block *A*; the latter is then lifted off the locating pins. As the end *D* is cylindrical and has small shoulders, it is milled by a formed cutter in a Lincoln type milling machine.

Still another profiling operation on the finger lever is shown in Fig. 3 and by the diagram Fig. 6. One continuous cut is taken as indicated by arrow *a* to form the edges of that end of the lever which enters the receiver and connects with

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* For information on the manufacture of the Savage rifle previously published in MACHINERY, see "Manufacture of Savage 0.22 Caliber High Power Rifle" in the July and August, 1914 numbers.

† Associate Editor of MACHINERY

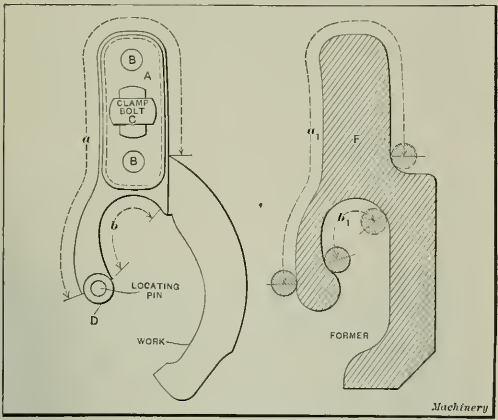

Fig. 5. Diagram illustrating Profiling Operation shown in Fig. 2

the breech-bolt. The surfaces at the extreme end must be accurately machined, as this end enters between the breech-bolt and a lug on the receiver (when the action is closed) to form a solid support for the bolt.

The lever is located by pin *A* which enters the pivot pin hole, and also by a small boss or pin at *B* (see Fig. 6) which is solid with the lever and enters a hole in the base of the fixture. (This pin engages a cam slot in the breech-bolt when the rifle is assembled.) The lever is held by a clamp *C* which is forced downward by a screw and lever *D*. The circular edge of the lever which is beneath this clamp is machined in a separate operation by a formed cutter, a Lincoln type machine being used. The former *F* is a plain type, shaped to correspond with the surface to be milled, and the path of the guide-pin is shown by the arrow a_1. To remove the finished work, clamp *C* is withdrawn by handle *E*, after being loosened, so that the lever can be lifted off the locating pin.

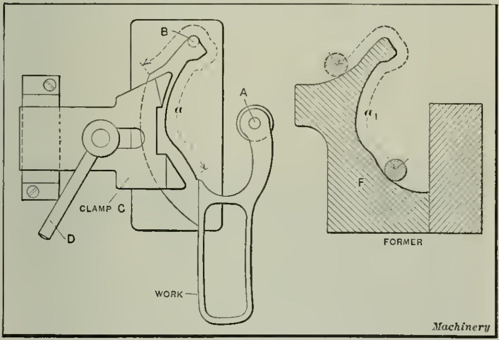

Fig. 6. Diagram illustrating Profiling Operation shown in Fig. 3

Profiling Operations on a Rifle Receiver

The profiling operation illustrated by the halftone Fig. 4 and the diagram Fig. 7 is on the receiver of a rifle of the '99 model. Two separate cuts are taken by different cutters held in the two spindles. One cut *a* forms a guide way for the breech-bolt when the action is being opened or closed, and the other cut *b* extends from the lever support back to the trigger slot. When taking the longer cut *a*, a cutter is used that will mill a slot of the required width and the path of the guide-pin along the former *F* is shown by the arrow a_1. The projecting part *C* of the former is simply a guard to prevent the cutter from striking end *D* of the receiver when it is being removed at the completion of the cut. Plate *L* also forms a guard and prevents the cutter from striking the tang *J*. Before taking the shorter cut *b*, the plate *G* is swung across the former slot (as indicated by the dotted lines) and acts as a stop for the guide-pin so that the cut will be started at the correct point. This plate swivels on screw *H* and rests against a pin *K*. A small screw in the end of plate *G* provides an accurate adjustment. The curve at the beginning of cut *b* is equal to the radius of the cutter used.

The receiver is located for this operation by a pin in the base of the fixture at *S* which enters the sear pin hole, and also by a pin at *M* which enters the lever pivot hole. The work is further supported and located by a plunger *N* which is pushed into the trigger slot by lever *O*. The plunger is clamped in position by the lever *Q* and the receiver is held down against the base of the fixture by clamp *K*.

Fig. 8 shows how the cartridge guide slot is milled in the receiver. This is a narrow, straight slot about 3/32 inch wide and 2¼ inches long, on the right side of the receiver, which holds the cartridge guide. (This cartridge guide, in conjunction with the magazine carrier and ejector, holds the cartridge in the proper position.) The receiver is located by the left side and the upper surface. The clamp screw operated by handle *A* forces the receiver against the vertical wall of the fixture and it is held upward against locating lug *B* by a bar *C* on the under side, which is raised by cam-lever *D*. As the slot is straight, the former *F* simply has a straight, rectangular opening. The cutter is located in the correct vertical position by bar *G* which engages a notch in slide *J* and is operated by lever *H*.

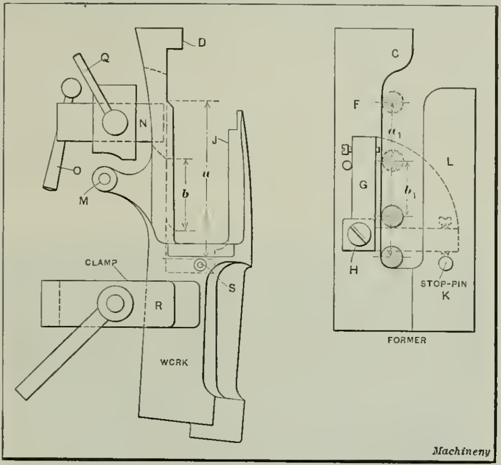

Fig. 7. Diagram of Profiling Operation illustrated in Fig. 4

The gage for testing the accuracy of this operation is shown in Fig. 9 with a receiver in place. The receiver is located in the gage by the same surfaces against which it was held in the fixture, that is, by the left side and top. After the receiver is placed in the gage, bar *A* is swung around and the slotted end engages the locking post *B*. The receiver is held

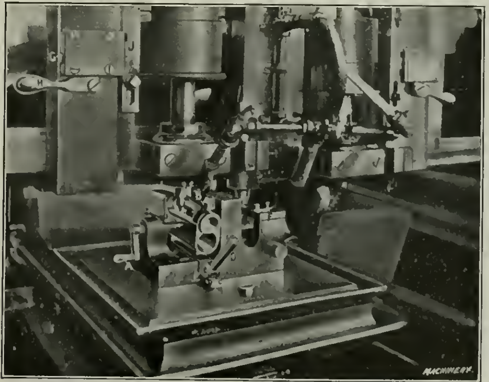

Fig. 8. Profiling Cartridge Guide Slot in Receiver

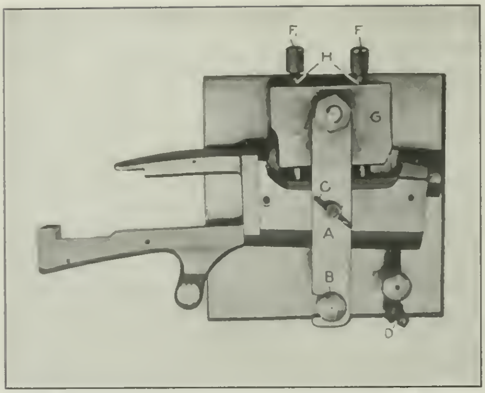

Fig. 9. Gage for testing Accuracy of Cartridge Guide Slots

downward and laterally by the screws *C* and *D*. The width of the slot and its location is tested by the combination finger and flush gages *F* and F_1. These gages have a cylindrical fitting in block *G* and the inner ends are provided with fingers which project at right angles and serve to gage the width of the slot when they are turned around in it. If the shoulders at *H* are flush with the gage body, they show that the slot is at the proper depth at both ends.

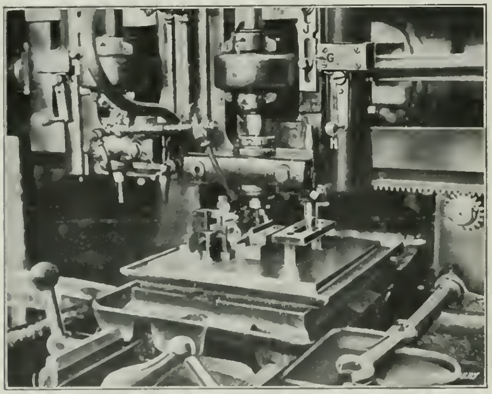

Fig. 10. Profiling Seat for Cartridge Ejector

The method of milling the mortise or slot which forms a seat for the ejector is illustrated in Fig. 10. This slot is slightly tapering and is at an angle with the side of the receiver; hence, the latter is held at an angle in the fixture as the illustration shows. The former *F* has a plain, tapering slot which gives the required shape. Before this seat is profiled, clearance holes are drilled at each end of the slot for the profiling cutter. Roughing and finishing cutters are used. The illustration shows the finishing cutter in position, the spindle and slide carrying the roughing cutter having been moved to the left. The depth of the cut is regulated by plunger *G* which engages the depth notch in slide *J* attached to the spindle slide. When plunger *G* is withdrawn by handle *H*, the slide is forced upward by a spring, far enough to clear the fixture so that it can quickly be moved away from the working position when the cut is completed.

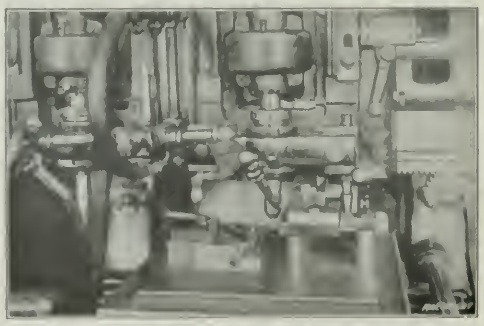

Fig. 11. Profiling Action Slide

Profiling with Combination Former

A very interesting and unusual profiling operation is shown in Figs. 11 and 12. The work is the action slide for an automatic rifle of the 1914 model. The operation consists in taking first a shallow cut as indicated by the shaded area at *A*, Fig. 12, and then a second cut as indicated at *B*. These surfaces must be accurately machined both as to location and depth. A combination type of former is used, and when taking the first cut *A*, plate *F* on the former is in the working position. This plate swivels about screw *G* and is located by a pin *H* which is inserted through the plate and into the former base. The path of the guide-pin is indicated by the arrow *a*. When the first cut is completed, plate *F* is swung back out of the way, and plate F_1 is placed in the working position as indicated by the dotted lines. The same pin *H* is also used for locating this plate. The second cut *B* is now taken, the guide-pin following path *b*. The hook shaped end *J* on the former prevents the cut from running out at *K*. The long guard plate *H* (see Fig. 11) at the side of the former prevents the operator from moving the cutter over into contact with the left side of the former base. By having guards of this kind, the operator can shift the cutter-slide rapidly and without fear of feeding the cutter against some part of the work or fixture. The slide is located in the fixture by pin *L* at the end and the three half pins along the right edge, and it is held by a single clamp which is cut away and beveled to clear the cutter.

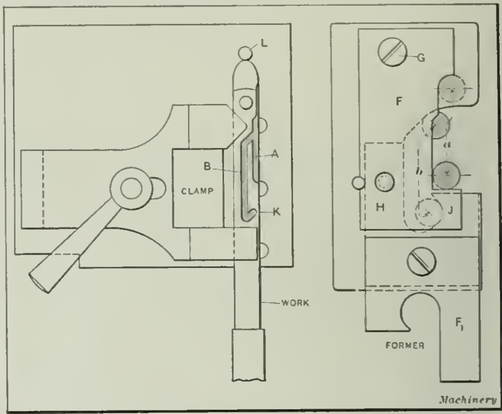

Fig. 12. Diagram showing Nature of Profiling Operation illustrated in Fig. 11

Fig. 13. Profiling Bolt for Savage Automatic Pistol

Profiling Bolt of Automatic Pistol

An interesting profiling fixture and former is shown in Fig. 13. The operation is on the bolt of the automatic pistol and consists of beveling the corners *M* (Fig. 17) of the opening and cutting a round groove, as shown by the shaded area *N*. The bolt is held between the plug *A* and the end *B* of the fixture, and it rests on block *C* which has a circular seat. End *B* is counterbored to receive the end of the bolt, and plug *A* has a pilot or small projecting end which enters the bore of the bolt. Lever *D* attached to plug *A* passes through a cam slot (similar in form to a bayonet lock) and is used to force the bolt back into the counterbored seat in block *B*. The opening or channel which is to be beveled is located in a central position by a close-fitting finger *E* which is turned down into the opening by lever *G*.

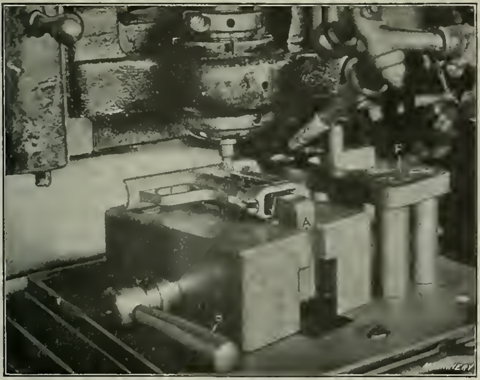

Fig. 14. Profiling Dovetail Seat for Side Plates of Pistol Frames

A double former plate is used for this operation. When beveling edges *M*, plate *F* is in the working position as shown by Fig. 13 and by the full lines in Fig. 17. This plate swivels about screw pin *H* and is located by pin *J* which passes through it. When the edges have been beveled by the tapering cutter used for this operation, the other spindle carrying a cutter of different shape is moved over to the working position and plate *F* is swung back as indicated by the dotted lines (Fig. 17). The lower slot in the main former F_1 is then used for profiling the seat *N* at the bottom of the bolt.

Profiling Dovetail Seat for Side Plates of Pistol Frame

The vulcanized rubber side plates for the handle of a Savage automatic pistol are inserted into close-fitting dovetail seats. Figs. 14 and 18 illustrate how these seats are milled on the profiler. The frame is located by two circular bosses on the lower side which enter holes in the base of the fixture. (These bosses are used to locate the frame for practically all operations, thus insuring accuracy as to the relation between the different surfaces. After the frame is finished the bosses are removed.) The frame is clamped downward against the fixture by hook bolts *A* (Fig. 14) at each end. These bolts enter the magazine opening and the lower ends are attached to a connecting bar that is forced downward by a cam lever *B*. An angular cutter is used and the cut extends across the bottom of the handle, then along the front side and out across the top. The former *F* is open on the right-hand side so the guide-pin can enter while the cutter is in the working position.

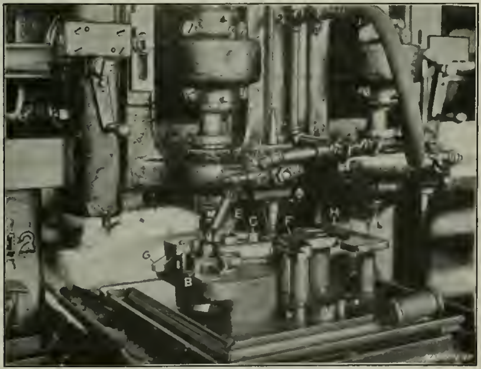

Fig. 15. Profiling Outside of Pistol Frame

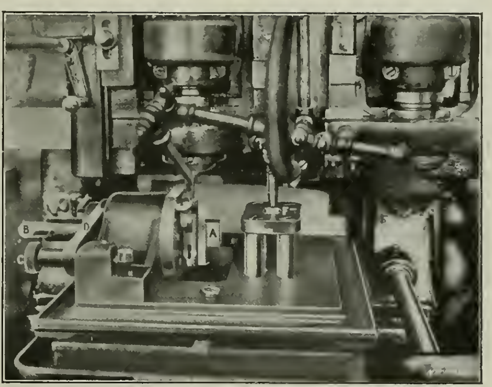

Fig. 16. Profiling Fixture of the Indexing Type

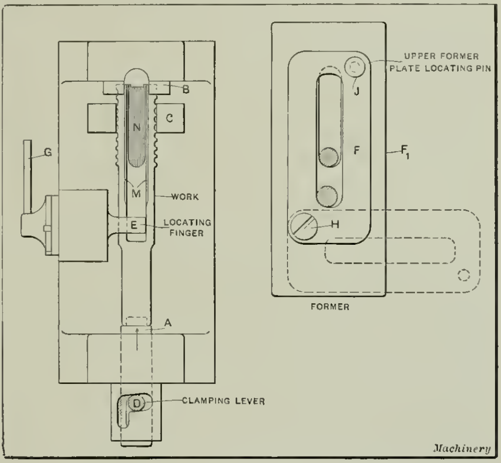

Fig. 17. Diagram of Operation illustrated in Fig. 13

The fixture used for milling the dovetail seat on the opposite side of the frame is similar to the one just described, except that the method of locating the work is different be-

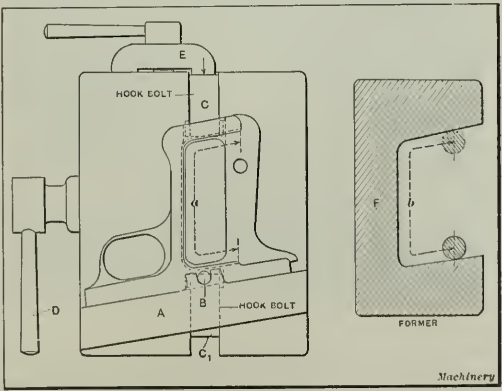

Fig. 18. Plan View of Fixture and Former for profiling Dovetail Seat on Right Side of Pistol Frame

cause the circular bosses previously referred to are now on the upper side. A plan view of this fixture is shown by the diagram Fig. 18. The frame is located by the angular strip *A* and the boss *B* on the side of the frame, which enters a circular seat in the projecting lug shown. The frame is clamped against the bottom of the fixture by two hook clamps *C* and C_1 which are operated by a cam lever *D* the same as the clamping bolts on the fixture illustrated in Fig. 14. To insure contact between the frame and the end strip *A*, bolt *C* and the work is forced against *A* (as indicated by the arrow) by tightening clamp *E*.

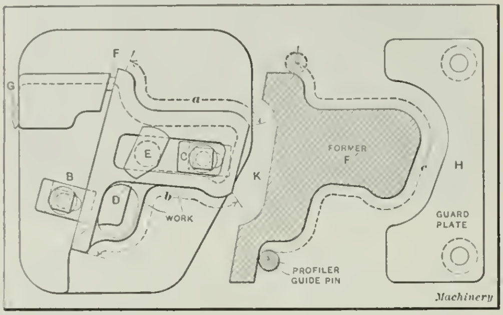

Fig. 19. Plan View of Profiling Fixture shown in Fig. 15

The path followed by the cutter is shown by arrow *a* and the movement of the guide-pin along the former *F* is indicated by arrow *b*. Roughing and finishing cuts are taken. The cutters are small and revolve very rapidly. The actual time required for taking one of these dovetail cuts is only about five seconds.

Profiling the Outside of a Pistol Frame

The former and fixture used for milling the outside of an automatic pistol frame are shown in Fig. 15. The cut extends down the handle on one side as indicated by arrow *a* (Fig. 19) and is then continued on the opposite side and around the trigger guard as shown by arrow *b*. (The side of the trigger guard and surface *D* is finished by a separate profiling operation.) The frame is located by the bosses on the lower side which engage holes in the fixture base, and it is held by clamps *B* and *C*, the T-head bolt *E* and the plunger *F* which is pushed in between the top sides of the frame by lever *G*.

The cutter is concave for producing round edges, and roughing and finishing cuts are taken. The former *F* has a guard plate *H* on the right side. When cut *a* is completed and the guide-pin and cutter are being moved past the end of the handle to the opposite side for taking cut *b*, this guard plate prevents the slide and cutter from being moved far enough to the right to cause the cutter to strike the former along the side *h*.

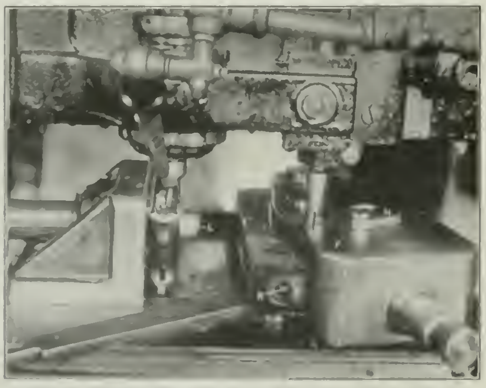

Fig. 20. Profiling Fixture equipped with Indexing Former Plate for Double Operation

Indexing Type of Profiling Fixture

A profiling fixture of the revolving or indexing type is shown in Fig. 16. The operation is that of milling the top and bottom ends of the magazine opening in the pistol frame, to a depth of about ¾ inch. The frame is located on the circular faceplate of the fixture by the locating bosses previously referred to and it is held by a T-head clamp bolt *A* which passes through it and is tightened by the handle *B*. When one end of the magazine is milled, plunger *C* is withdrawn and arm *D* with the work, is turned a half revolution by swinging arm *D* over to the opposite side of the fixture, where plunger *C* engages another hole thus locating the frame for the operation on the opposite end of the magazine opening. The profiling operation is simply that of forming a plain rectangular surface, former *F* being used to guide the cutter. The metal between these milled surfaces at the ends is afterward removed by a shaving operation in the shaper.

Profiling the Sear Trip Seat in Pistol Frame

The profiling operation illustrated in Fig. 20 is that of forming the sear trip seat in an automatic pistol frame, and the surfaces above the sear trip seat. The nature of the operation is illustrated by the diagrams *A*, *B* and *C* in Fig. 21, which also shows a plan view of the fixture. The sear trip seat, which is about ¼ inch deep, is formed by two separate cuts as shown by the views *A* and *B*; the surfaces above this seat, which are represented by the shaded area at *C*, are then milled.

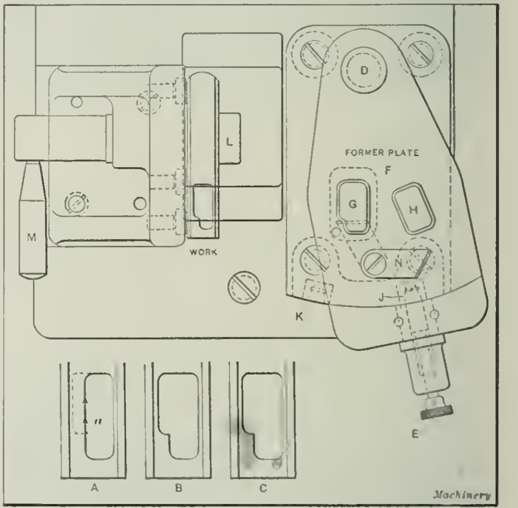

Fig. 21. Plan View of Fixture having Indexing Former Plate

A cutter in one spindle is used for the sear trip seat, and another cutter in the other spindle for milling the top surfaces. The former plate *F* contains two guide-pin holes *G* and *H*. Hole *G* is used when profiling the seat (as at *A* and *B*) and hole *H* for the other operation, the former plate *F* being indexed to locate either of these holes in the working position. This plate swivels about the screw pin *D* and is located by the spring plunger *E* which enters holes *J* and *K* in the former base.

The frame to be profiled is held against an angle-plate (attached to the base of the fixture) by T-head clamp bolt *L* which passes through the frame and is tightened by lever *M*. The bosses on the side of the frame engage holes in the angle-plate and locate the frame in the proper position. When milling the seat, the former plate is in the position shown in Figs. 20 and 21; that is, with plunger *E* engaging hole *J*, thus locating the former hole *G* in the working position. The cutter is dropped down to the proper depth by the vertical locating device for the spindle slide which was referred to in connection with Fig. 10. The guide-pin is then traversed around hole *G* but when it reaches the corner *a* (see detail view *A*) the movement is continued along a straight line, as indicated by the arrows, thus forming a rectangular slot as the diagram shows.

The auxiliary plate N on the former is then swung across the end of hole G, as shown by the dotted lines, thus blanking off this end. The seat is then finished as at B. If plate N were not used and the guide-pin simply followed the slot in the former, the corner at a would be rounding instead of square. The end of the plate N, however, causes the guide-pin and cutter to move straight in, thus milling a square corner.

When the sear trip seat is finished, plunger E is withdrawn and the plate is indexed to locate hole H in the working position, plunger E being engaged with hole K. A cutter in the opposite spindle, which is located at a higher level, is then used to mill the upper surfaces as indicated by the shaded areas in view C.

In practically all of the profiling operations described in the foregoing, both roughing and finishing cuts are taken. Some of the roughing cuts are quite heavy but the light finishing cuts which follow insure accurate and smooth surfaces. In the profiling department, as well as in other departments of the Savage factory, all parts are carefully inspected both by the "outside" department inspector, whose business it is to detect and prevent errors, and also by the regular inspectors, as was explained in a preceding article.

* * *

TAYLORISM AND THE BONUS SYSTEM*

BY FRANK RICHARDS†

I am glad to note that the industrial journals, which have done so much for the promotion of the efficiency of machine tools and of manipulative processes, are now disposed to turn their attention to the worker himself, upon whom the ultimate success of all methods must depend. Just now the American industrial fad—and it is practically confined to America and must have its run here as other American fads do—is scientific management. The beginning of the so-called scientific management, which is still much more written about than practiced, is Taylorism, which has been spoken of in *The Engineer*, London, as "a peculiarly hideous method of dehumanization," a characterization which I think fits it well. Far from having the ultimate effect of promoting industrial conditions in the interest of either employer or employe, it deliberately brings about the degradation and belittlement of the individual American workman, it is inimical to the development of skill and paralyzes all incentive.

It is fortunate for the system that it has had many and zealous advocates whom Mr. Taylor has hypnotized—I use the word deliberately—who have written voluminously concerning the workings of the system, and have spread their own stories as to what has been accomplished under it, while few or none have had the time or the interest to put forth their views and experiences in opposition, so that Taylorism and so-called scientific management stand before the public almost entirely upon *ex parte* testimony, and it would seem that any honest statements of opposing views should not be too hastily squelched.

Speaking now a little more precisely: Under the Taylor system the doing of all work is to be planned in detail for the workman, and every move he is to make in doing a certain job is prescribed for him, with or without the time in seconds for each motion. This schedule is to be followed absolutely. Mr. Taylor has said before the American Society of Mechanical Engineers that the workman should be required to do his work so exactly as prescribed, that if at any time he saw a quicker or a better way of doing the work, that way must be ignored. I do not know that Mr. Taylor has ever said that the less a man knows about his work the better, but the man who knows nothing at all would seem to be his ideal workman. What incentive could there be under the Taylor system for any man to do with his might what his hand found to do?

The Bonus System

Another fundamental feature of scientific management which is much bragged about is the "bonus system of rewarding labor." A self-respecting workman never wants to be rewarded, but just honestly paid for his work. The bonus system dodges the honesty. It is a singular fact that, so far as I know, only machinists and workers in trades allied to them, have been regarded as such simpletons as to make it safe to propose the bonus system to them. Of course, no one has ever had the hardihood to propose the bonus system of rewarding labor to the collar girls of Troy, to the glove workers of Gloversville, to the hat makers at Danbury, at the knitting mills of Cohoes, the textile mills of Lowell, Lawrence and Fall River, nor among the garment workers of New York. In such places as these the worker is paid for just what he does, and according to the amount of work accomplished. If he is paid a certain sum of money for a specified quantity of work he is paid 50 per cent more money for 50 per cent more work, and so on according to the work done.

Under the bonus system a certain rate of pay is fixed for a certain amount of work done in a given time, say a day; then if the man does more than the stipulated amount in the given time, entirely through his own exertions and with the employer getting the benefit of the increased productivity of his plant, he is not paid at the same rate for the additional amount of work done, but is given a "bonus" amounting usually to one-half—sometimes less and seldom more—or the additional amount fairly earned. To put it in plain figures: if a man is paid $3 for producing 100 pieces of a certain product in a given time, he should be paid $4.50 if he produces 150 pieces in the same time; and he would be paid at that rate under the system ruling in the factory towns above mentioned. Under the "bonus system for rewarding labor" he would be paid $3.75 or less. It is astonishing that such a system should have had even temporary acceptance anywhere. If I misrepresent the system in any way I would be glad to be corrected. If the system is essentially honest I would like to have it proved to me.

* * *

GRAPHITE AS A LUBRICANT FOR BALL BEARINGS

Experiments conducted by Prof. W. F. M. Goss indicate that a combination of graphite and lard oil makes a lubricating mixture which, when applied to ball bearings, will accomplish everything that lard and oil will do, and which, at the same time, gives a lower frictional resistance and permits a large increase in the load which the bearings will carry. Kerosene or light oil, when mixed with graphite, is stated to be an effective lubricant for ball bearings operated under light or medium pressures. An English ball bearing manufacturer points out, however, that in his experience the use of graphite for the lubrication of ball and roller bearings is detrimental, because graphite will, in the long run, lap away the surfaces of the balls and races and destroy the bearing. Ball bearings, he says, require no lubrication in the ordinary sense of the term, but it is very essential that a greasy film be present over the bright steel parts to prevent rust. Pure mineral grease of the consistency of vaseline is recommended by this manufacturer for that purpose. This grease must be free from acid and should not attract moisture from the atmosphere.

* * *

SUBMARINE POWER CABLE

The submarine cable recently laid between Sweden and Denmark will enable electric energy obtained from Swedish water falls to be sold in Denmark. The sound which divides the two countries is only between five and six miles wide at the narrowest point where the electric power cable is laid. The current is transmitted from the power stations to a point on the Swedish side of the sound at 50,000 volts. At this point it is transformed to 25,000 volts and transmitted by an underground cable three miles long to the coast line, where the submarine cable conveys the current across to the Danish coast; from there it is transmitted for about a mile by an underground cable and then again transformed to 50,000 volts. From this point, the current is carried to Copenhagen by overhead conductors.

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* For other articles on scientific management, the bonus system, and allied subjects published in MACHINERY, see also "Some Good Results Obtained by the Bonus Plan," by W. L. Myles, December, 1912; "Industrial Administration and Scientific Management," by F. E. Cardullo, July, August and September, 1912; "Scientific Management from a Social and Economic Standpoint," June, 1912; "Industrial Efficiency," by H. L. Gantt, May, 1912; "Task Work—the Basis of Proper Management," December, 1911; and "The Utilization of Labor," by H. L. Gantt, April, 1907.

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NOVEMBER, 1914

NET CIRCULATION FOR OCTOBER, 1914, 25,040 COPIES

NEW EUROPEAN TRADE ALIGNMENTS

Some statistics of the machine tool industry in Europe are particularly interesting at present, and induce us to consider whether this trade after the war will revert to its old channels or find new ones. The total value of German machine tools manufactured during recent years has been estimated at $55,000,000 annually, of which $15,000,000 represents the exports. Russia, Austria and France have alone taken about one-half of these exports Russia about $3,000,000, France about $2,500,000. Great Britain has also bought heavily of German machine tools.

The total exports of all kinds of machinery from Germany have recently exceeded $250,000,000 a year, and of these exports the largest proportion has gone to Russia. There being no Russian machinery manufacturers to compete with, the prices obtained there are unusually satisfactory. The Russian machinery building industry will develop slowly, so that country will continue to import both machine tools and general machinery for many years to come, and of all the foreign machinery markets none is larger nor more promising.

* * *

THE IMPORTANCE OF TOOL EQUIPMENT

During the past ten or fifteen years, in which machine tools and machine shop practice have been highly developed, many features have been introduced which have made it possible to obtain not only a greater output, but one with much closer limits of accuracy than before. In certain lines, the possible increase in output is so marked as to exceed all expectations of a dozen years ago. However, accuracy and capacity of machine tools are not the only requirements for obtaining the best results as regards both quality and quantity of output. The machine tool may be almost perfect, and yet comparatively little is gained if the methods of holding the work and presenting the tools to it are not up to the standard of the machine itself; but these factors are neglected in many machine shops, and the high quality of the product made possible by the machine is not obtained. It is true that many machine shops have planning departments where efficient tools are designed and where the methods and appliances which are to be used in the manufacturing work are carefully considered, but in most shops the workmen, with or without the assistance of the foreman, still are left to devise for themselves the methods by which the work is to be held and machined, especially in the case of turning and boring operations.

With exceptionally skilled workmen, this method may answer, but in the majority of cases, especially in interchangeable manufacture, where the men are trained in the use of but one machine, it is seldom possible for the machinist to obtain the experience necessary to consider both the accuracy required and the best means for rapid production. A designer especially detailed to do this work will be able to accomplish much better results.

Whether the planning of the tool equipment is done by a designer employed entirely on this work, or by the foreman and machinists, the articles on tools, arbors, chucks, fixtures and other holding devices, which have been published monthly in MACHINERY during the past year, will be found of great value. These articles describe fundamental principles and constitute the most nearly complete descriptions of tools and devices for turning and boring operations ever published. In addition to the articles applying specifically to lathe and boring mill work, attention will be paid in this series to the design of tools and holding devices with reference to their first cost and the cost of keeping them in repair —considerations which are of prime importance in economical shop management.

A very important feature of these articles is that the devices shown and described are examples of designs actually employed in practice and successfully applied to productive work in a great number of manufacturing establishments. There is nothing of the theorist in Mr. Dowd's methods of describing the tools, chucks and fixtures dealt with. The descriptions are plain, matter-of-fact statements, and should therefore appeal with especial force to the great body of men of practical training who are seeking specific and up-to-date information. The articles fill an obvious gap in existing mechanical literature and are of unquestionable permanent value.

* * *

IMPORTANT PATENT LEGISLATION

The Senate of the United States has amended the Clayton anti-trust bill, now pending, by forbidding contracts relating to patented articles that contain a provision requiring the purchaser or licensee of a patented device to use any article not protected by the patent, or restricting him from using any article not so protected. Parties to such contracts are liable to a fine of $5000 and imprisonment for one year. The object of this legislation is to prevent agreements between manufacturers, dealers or owners of patents and the users of same, by which such articles may be sold only on condition that the customer uses with them supplies that are also furnished by the manufacturer. The provision is partly an outcome of the famous Dick mimeograph patent case, in which it was decided by the Supreme Court that the users of the patented mimeograph could be prevented from using any other ink or supplies than those sold by the manufacturers. It is evident that if this decision were allowed to remain a precedent, owners of patents could control beyond reasonable limits the sale of supplies for use in connection with patented apparatus, and the amendment is a wise one. There is, however, a tendency toward legislation forbidding trade agreements which apply to patented articles, while similar agreements applying to non-patented articles are allowed. Legislative control should apply to both patented and non-patented products.

* * *

HIGH-SPEED DRILLING

A phase of drilling practice which has received comparatively little attention until recently is that concerning the production of very small holes. Plenty of drilling machines have been built for quickly drilling holes from one-quarter inch diameter up, but few that would drive a drill at efficient speed in the very small sizes. The law of efficient drill action holds approximately true for any diameter of drill. If a high-speed steel drill of one inch diameter should be driven at the rate of 300 revolutions per minute, or at a peripheral speed of 80 feet per minute, then a drill 1/32 inch in diameter should be run at the rate of nearly 10,000 revolutions per minute to attain the same peripheral speed. But this speed was practically impossible with the drilling machines having plain spindles, indifferently balanced pulleys, and other defects tolerable in comparatively slow-running machinery.

The new type of drilling machine capable of driving the smallest commercial twist drills at efficient speeds is a highly specialized tool, built with the precision of a watch and accurately balanced throughout. Ball bearings provided for taking thrusts rather than radial loads on the spindle are features of novelty to the machine designer and user. The result of intelligent design and high-grade workmanship is that holes so small that they can be drilled with ordinary machines only by painstaking care, and then at the cost of many broken drills, are being drilled at "punching machine" speeds. Girls working at piece rates which enabled them to earn $1.25 to $1.50 a day were able to double their earnings with the new machines.

A feature of high-speed drilling requiring accurate balancing is the drill chuck. The ordinary drill chuck balanced for speeds of 2000 to 3000 revolutions per minute was found to be out of balance at 10,000 revolutions per minute and great care had to be taken to secure perfectly balanced chucks before satisfactory results could be obtained. The case is interesting because the drilling machine has been regarded as a simple tool that could be built anywhere by cheap labor. The fact is that it is a machine requiring the best design and workmanship in order to produce efficiently, especially in the small sizes.

* * *

DOMESTIC BALL BEARING MANUFACTURE

The adage, "It's an ill wind that blows nobody good," applies to the European war with reference to several American industries, among which might be mentioned the manufacture of ball bearings. Previous to the declaration of war German makers possessed several advantages, including lower labor cost, and had become important factors in supplying the American trade. Our makers of automobiles and other products in which ball bearings are used then found their supplies suddenly cut off; but American manufacturers quickly rose to the situation and are providing for the manufacture of balls and ball bearings in America that will equal in every respect the best foreign products. Grinding machines of a semi-automatic character are being developed here which will greatly reduce manufacturing costs, and improved machinery is being made which will turn out balls as cheaply as the German product, and within limits of one ten-thousandth inch.

The advantage of low-priced labor formerly possessed by foreign manufacturers is likely to be lost with the conclusion of peace. Some of the least of the misfortunes which follow war will be increased living expenses and excessive taxation, which will work out in higher manufacturing costs.

* * *

ATMOSPHERIC CONDITIONS IN FACTORIES

More and more attention is being given by architects and factory engineers to the atmospheric conditions in shops, mills and factories, with special regard to their effect on the workers. The time is long past when manufacturers believed that employes could work efficiently in unheated shops during cold weather, or that they should hustle and keep warm by bodily exertion. Men produce the most and are best contented when working in comfortable surroundings; but heating a shop in winter is not all that can be done to contribute to suitable atmospheric conditions. Not only should the air be at a temperature of, say, 65 degrees in winter for comfortable work, but it should not vary much from that temperature in summer. In other words, the highest efficiency will be attained when the temperature conditions are practically equable throughout the year. To preserve uniform conditions, the windows and doors must be closed the year round and the air heated in winter and cooled in summer.

Not only should the air supplied to workrooms be heated or cooled, but it should be tempered also as regards the moisture content. A great deal of the bodily discomfort experienced in summer is caused, not by high temperature, but by humidity or mugginess. A highly humid atmosphere has low moisture-absorbing capacity, and perspiration dries slowly; hence the excess heat in the body is not rapidly dissipated. It is therefore desirable that the air be supplied to workrooms not only at a uniform temperature, but in a uniform hygroscopic condition.

An incidental advantage of a hermetically sealed workroom in which the air is supplied by forced draft through hygroscopic tempering appliances is the elimination of dust. Dust in factories is an annoyance, and has a serious deteriorating effect on many goods. It gets into the bearings of machines and causes excessive wear; it destroys fine finish and contributes to the ill health of workmen.

An ideal plant of the future evidently will be that in which windows are hermetically sealed and doors are always closed. The air, supplied at uniform temperature throughout the year, will be moistened when too dry and relieved of its excess moisture when too wet. Dust will be eliminated and the future workroom will thus be made a dustless place of ideal temperature and hygroscopic conditions.

* * *

STARTING RIGHT WHEN STANDARDIZING DESIGNS

The internal combustion engine is one of the most interesting of prime movers. Though simple in its essential make-up, it offers many unusual problems in design to both the theoretical and practical man. The one element of valve operation presents a valuable study in pure and applied mechanics. The engine of the multiple-cylinder type universally used in automobile construction presents problems of cam-shaft design and construction which have interested some of the best mechanical talent.

Cam-shafts having the inlet and exhaust cams integral with the shafts are ground to shape on grinding machines fitted with attachments that insure uniformity of outline and angular position. Not all designers agree on what are the best shapes and the most advantageous angular positions of the cams. These depend to some degree on the design of the cylinder valves and connections, but whatever form of cam-shaft is adopted efficiency of manufacture requires that a standardized product shall be produced. In short, every cam-shaft shall be alike and strictly interchangeable.

To produce accurately shaped and positioned cams by methods worked out by the grinding machine builders is now a comparatively easy matter, but the interchangeable product has not always given immediate satisfaction to the automobile manufacturers, strange as it may appear. The reason is that the standardizing process did not start from the right point. The manufacturer's method was to design and build a motor and adjust it so that its functions were performed as perfectly as possible. The cam-shaft was then taken as the pattern for the engine to be manufactured. Drawings specifying the shape and angular positions of the cams were submitted to the grinding machine builders with orders to design the cam grinding attachment so as to produce an exact copy.

The trouble with this procedure was that any lateral deviation of the roller or mushroom lifters in a plane at right angles to the cam-shaft would affect the timing. That is, a lateral displacement of the lifter was equivalent to a change of angular position of the cam. Hence it was necessary that the model engine should be built with the lifters dead in line in a plane parallel with the cam-shaft axis. If that condition did not exist in the model, the standardized cam-shaft would be bound to give results different from those obtained from the model.

This illustrates how necessary it is in standardizing any machine to make sure that all its working elements bear certain fixed relations to points, lines or planes that will be the natural ones to work to in manufacturing.

* * *

There are 3600 plants in the United States melting brass and bronze, and 1000 of these melt non-ferrous alloys exclusively.

MACHINE FORGING GEAR BLANKS*

DIES AND METHODS USED IN MAKING VANADIUM STEEL GEAR BLANKS IN THE FORGING MACHINE

BY DOUGLAS T. HAMILTON†

The working of high-speed and alloy steel in the forging machine is a comparatively recent development, and is one of the many indications of the universal adaptability of forging machines to the production of machine and miscellaneous parts. When a forging machine can be utilized, the production is much greater than when a steam hammer is used, and the manufacturing costs are also much less. Fig. 1 shows a vanadium steel gear blank that is produced in two operations in a 4-inch Acme forging machine in the plant of Dodge Bros., Detroit, Mich. This gear blank, as the illustration shows, is made from a 2½-inch bar of vanadium steel without any waste of stock whatever, at the rate of 1100 in eight hours. *A* shows the bar and gives some indication of the amount of stock necessary to form the gear blank, while *B* shows the blank after it is upset in the lower grooves of the forging machine dies, shown in detail in Fig. 4. *C* shows the completed gear blank and illustrates how it is produced without any waste of stock.

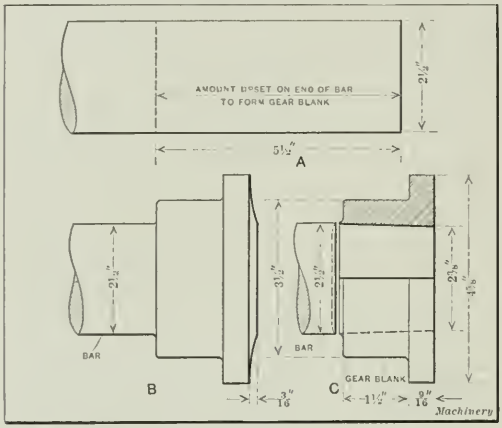

Fig. 1. Diagram showing Sequence of Operations employed in producing a Gear Blank in the Forging Machine

Methods Followed in Forging the Gear Blank

The method of forging vanadium steel gear blanks is to first heat the 2½-inch bar of vanadium steel in the furnace shown to the right in Fig. 2 to a temperature of about 1700 to 1800 degrees F. The bar is then quickly removed from the furnace and placed in the lower impression *A* of the forging machine dies shown in Fig. 3. The machine is then operated, and as the lower plunger *B* advances it upsets the bar and forms the gear blank on the end of it, as shown at *B* in Fig. 1. The upsetting of the bar cools it to such an extent that great difficulty would be experienced in punching the hole in this initial heat. The bar is therefore returned to the furnace and reheated. While it is being reheated, another bar is removed from the furnace, and the ends upset or the hole punched, depending on how far the forging operations have been carried.

Fig. 2. Acme Forging Machine in Operation on Vanadium Steel Gear Blanks. Eleven Hundred are turned out in Eight Hours

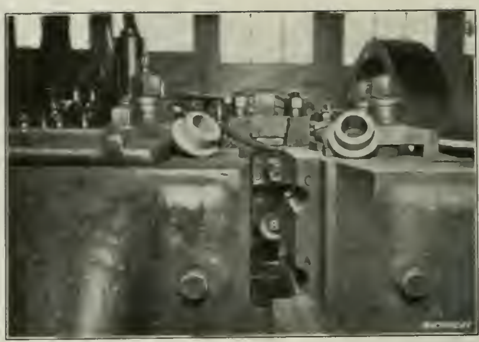

Fig. 3. A Closer View of the Forging Machine Dies and Tools

As soon as the upset bar has been reheated to the proper temperature, it is removed from the furnace and placed in the upper impression *C* of the gripping dies, as shown in Fig. 3. The forging machine is again operated, whereupon the ram advances and the top plunger *D* forces a hole in the end of the bar, and at the same time carries back the metal removed to form the hole, and attaches it to the end of the bar. This, of course, is done in one stroke of the forging machine. The upsetting generally requires two blows, the number of blows depending entirely on the temperature to which the metal has been heated before being placed between the gripping dies. The second blow on the blank compresses the metal and makes a more homogeneous mass. It also eliminates flaws or fissures in the forging.

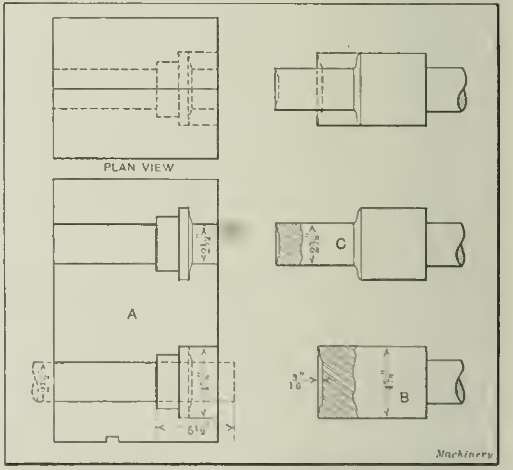

Fig. 4. View showing Construction of Gripping Dies and Upsetting Plungers for making Vanadium Steel Gear Blanks without Waste of Stock

Construction of Dies and Punches for Forging Gear Blanks

Fig. 4 shows an elevation and plan view of the forging machine gripping dies and plungers. By referring to this illustration it will be seen that the lower impression in the gripping die is made to the approximate size of the gear blank, the larger hole being counterbored considerably deeper than the thickness of the flange on the gear blank. This is to provide a support for the plunger when upsetting the metal. It will also be noted that the plunger *B* is cup-shaped or recessed on the front end. There are two reasons for making the punch in this manner. The first and most important is that it enables a gear blank with a straight front face to be produced. If the front face of the gear blank were made square when the bar was upset, it would then become concave when the hole was punched. The reason for this is that the hot metal would be drawn in by the piercing plunger *C*. By providing the upsetting plunger with a concave face, a convex boss is formed on the face of the gear blank. Then when this bar is reheated, and transferred to the upper impression in the gripping die, it is held rigidly as the illustration indicates, while the piercing plunger *C* advances and forms the hole in the gear blank.

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* For articles on machine forging previously published in MACHINERY, see "Forging and Machining Automobile Front Axles," December, 1913, and the series on machine forging published in MACHINERY, April, May, June, July, September, and October, 1913.

† Associate Editor of MACHINERY.

It will also be noticed that the concave impression in the upsetting plunger *B* also helps considerably in centering the bar, thus preventing it from buckling or pushing over more to one side than the other. The upper piercing plunger *C* is also provided with a concave face. The reason for making the piercing plunger in this manner is to reduce the amount of pressure required to force it through the heated blank. It also provides for a better shearing action of the plunger. It will be noticed that the plunger is ⅛ inch smaller in diameter than the hole in the gear blank or the diameter of the bar. This also reduces the pressure required to force the plunger through the heated blank. Fig. 1 shows very clearly the resulting gear blank. The hole at the larger end is 2⅜ inches in diameter, whereas on the rear face, where it was attached to the bar, the hole is the same size as the bar or 2½ inches in diameter. This makes a tapered hole, but as it greatly reduces the amount of power required to form the hole in the gear blank, the taper is of minor consideration; in any event, it has to be machined to the correct dimensions after forging.

The Possibilities of Machine Forging

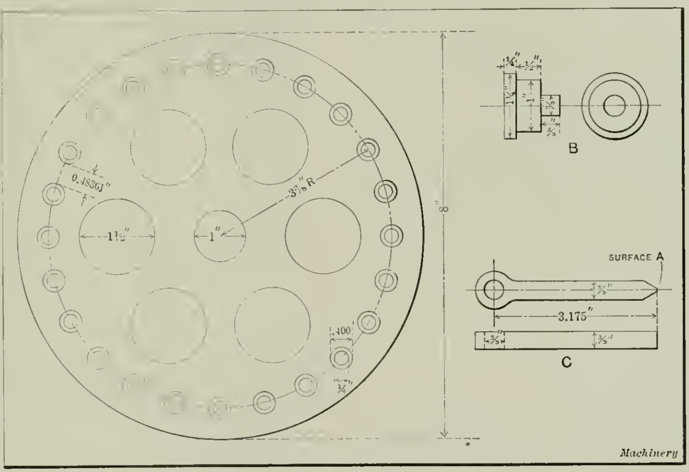
The producing of a vanadium steel gear blank in a forging machine is an indication of the possibilities of machine forging. While it is generally known that a forging machine is adapted to the making of wrought iron and soft steel parts, it has not been considered in the past practicable to produce high-carbon or alloy steel parts in this manner. Of course it requires a much more rigid and heavily constructed forging machine for working vanadium and alloy steel than it does for soft steel and iron. In the most up-to-date forging machines, however, of which the Acme is a good example, the bed of the machine is made from one solid steel casting. This is so proportioned that all strains are taken up in the bed itself, thus relieving any unnecessary strains in the dies or tools. If the gripping dies are not rigidly supported while the bar is being upset, they will spring away and produce flash or fins on the work. A positive gripping mechanism, therefore, is absolutely necessary if good clean work is to be expected from a forging machine. It will be seen from the two gear blanks lying on top of the machine in Fig. 3, however, that these are produced without any fins whatever, except a slight burr around the hole, which is practically unavoidable. The forging is just as clean as could be produced under a steam hammer, and furthermore, it does not have to be trimmed. There is also some waste of stock in a steam hammer, as considerable metal is lost due to the removal of fins and flashes that are formed in the striking up of the forging.

MAKING AN INDEX PLATE

BY JOHN MAHON

Various methods are employed for making index plates, and while most of these have certain features to commend them many are open to criticism on the ground of being exceedingly expensive, or else because the results produced are inaccurate. It is the purpose of this article to describe a method that the writer used in making an index plate which gave very satisfactory results, as regards both accuracy and cost of production. The common type of index plate with tapered slots is inaccurate in operation, because dirt is likely to get into the slots on one side of the plunger. Another drawback is the great expense involved in making a plate of this type where the wearing surfaces are hardened and where extreme accuracy is required. Such a plate must be made with segments fastened to one side of the outer edge, which entails a vast amount of work in grinding and locating the segments.

The index plate shown in the illustration is accurate, because any foreign matter is pushed out as the plunger enters the bushing. The plate is also comparatively inexpensive when its extreme accuracy is taken into consideration. In the event of the bushings becoming worn through use, they may be easily replaced at small expense and without impairing the accuracy of the index plate. This plate was made from the rough cast-iron blank and carefully finished to bring the sides parallel and the center hole perpendicular to the faces of the plate. Six holes 1½ inch in diameter were next laid out and drilled in order to lighten the plate and improve its appearance. The next step was to make the twenty-four bushings, which were hardened and lapped to a diameter of 0.250 inch on the inside, and ground and lapped on the outside to a diameter of 0.400 inch, great care being exercised to get all of the bushings exactly alike. The holes in the index plate were then laid out to approximately the required positions, using dividers for this purpose, after which the holes were drilled and tapped for each division to receive a 10 by 32 screw. The plan was to use the bushings as buttons and set all of them up at once.



Index Plate and Gage used for locating Bushings

A stud of the form shown at *B* was now made, this stud being hardened and then ground and lapped to an accurate fit in the hole at the center of the plate. A piece of the form shown at *C* was then made to be used in gaging the location of the buttons as regards their distance from the center of the plate. This gage was first made with a wing extending out on both sides of the center hole in order to facilitate measuring the surface *A* from the center. One wing was removed after the gage was finished. The gage was hardened and ground on one side and the hole was ground out while it was clamped to the faceplate on the finished side. The surface *A* was then ground on a universal grinder with the gage held on an arbor to bring the surface *A* exactly 3.175 inches from the center hole. This hole was made of such a size that it fitted accurately over the small diameter of the stud *B*. A size block 0.48361 inch in size was then made for use in spacing the buttons with exactly the required distance between centers.

The buttons were now set up on the plate and extreme accuracy was readily obtained, using the size block for measuring between buttons and the "feeler" or gage C for measuring the distance from the center of the plate to each button. A little variation in the "feel" of the size block between different buttons, and also between different buttons and the central stud, was readily detected. When the buttons were all set up, the plate was ready for boring. A stud was made 1/16 inch thinner than the plate and 7/8 inch in diameter. A hole was drilled through the center of this stud and tapped to receive a ⅝-inch cap-screw which was used to fasten the stud to the faceplate of the lathe at approximately the correct distance from the center of the spindle. The cap-screw extended through from the back of the faceplate and protruded sufficiently beyond the index plate to provide for using a strap and nut. The purpose of this stud was to facilitate changing from one button to another after completing successive holes, and to help eliminate the probability of buttons being accidentally moved. The stud was made a clearance size for the center hole in the plate in order to allow for truing up the buttons. This work was done with comparative ease, less than ten hours being required to bore the twenty-four holes, after which the buttons were pressed in and used as bushings for the index plate.

* * *

USE AND CARE OF CRUCIBLES

In a bulletin entitled "Brass-Furnace Practice in the United States," recently published by the Bureau of Mines, the author, H. W. Gillett, devotes a section to the use and care of crucibles. An abstract of this part of the book will prove of value and interest to all who have to do with the care of crucibles.

Although crucibles are free from moisture when removed from the kiln, they rapidly absorb it, and many take up 5 per cent of moisture during shipment from maker to user. If, instead of eliminating the moisture by a gradual annealing, the damp crucible is put directly into a hot furnace, or into a cold one and heated too rapidly, the moisture will be changed into steam so that the steam evolved will blow pieces of the crucible off bodily; that is, the crucible will "scalp." To prevent this, it must be raised from room temperature to a temperature somewhat above the boiling point of water very gradually, so that the moisture may be slowly driven off without "scalping."

Crucible Storage

There is always an abundance of waste heat that can be utilized for warming the place where the crucibles are stored. A common place for crucible storage in foundries using pit furnaces is just back of the battery of furnaces. The waste heat may also be led through a special oven, so provided with dampers that the heat may be gradually admitted for annealing a fresh batch of crucibles. After annealing has been finished, the oven may be utilized as a warm storeroom. Crucibles are sometimes stored above a core oven, or, in a rolling mill, above an annealing furnace, a good practice if the oven or furnace is run constantly enough to keep the crucibles dry.

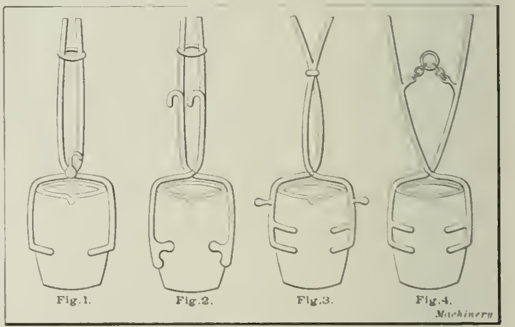
Tongs Used for Crucibles

Most foundrymen are fairly careful about annealing their crucibles, but many do not pay enough attention to the tongs used and the way in which the crucibles are handled with them. The greatest damage is done with improper tongs or with tongs improperly handled. There are several different types of crucible tongs for pit furnaces, some of which are shown in the accompanying illustration.

Fig. 1 is a one-prong type, mainly used in pit furnaces burning anthracite coal, as in rolling mills. The prong comes just below the bilge, because the difficulty of poking tongs through the anthracite and its ash is greater than through coke and its ash, so that tongs that come farther down the crucible are more difficult to use in coal furnaces. The handles are spread, the tongs squeezed into place, and a link slipped over them to seat them tightly. A mechanical hoist operated by hand, air, or electricity is fastened into the hook at the pivot. Fig. 2 is of the spade type. It is shown with hooks on the handles for lifting the pot by hand without mechanical hoist. An iron bar is passed through the hooks and the pot lifted by two men, one on each side of the furnace.

Fig. 3 represents a two-prong tong, one prong being above and one below the bilge, with trunnions for pouring. In Figs. 1 and 2 the tongs are used merely for lifting the crucible from the fire and setting it into the pouring shank. In Fig. 3 the crucible is held by the tongs during pouring, being carried on a shank of such form that the shank may be held horizontal while the tongs are tilted on the trunnions; or, a bail may be attached to the trunnions and the tongs and crucibles held by a traveling crane. In the first three forms the crucible is pinched tightly in the tongs and the tongs are held in place by a link slipped over the handles. To put on the link and get it tight is "hot work," as it must be done directly over the open fire. Hence the furnace-tender, instead of slipping the link down just tight enough to hold securely, is prone to jam it down, even driving it with a poker or a skimmer. The pinching of the crucible may in this way be very severe, as the hot crucible is soft and leathery and gives somewhat readily. It is common to see crucibles the mouths of which have been pinched into a distinctly oval shape. Every time the crucible is thus strained it is weakened and its life greatly shortened.

To prevent this excessive pinching of types Figs. 1, 2, and 3, each of which may be termed the "pinch" type, the "grab" type, Fig. 4, has been devised. This is intended for use with a mechanical hoist, and may be made with one prong or with a spade prong if desired. In using the grab type the tongs are hooked into the hoist and lowered into place, the tongs being spread, and gently seated in place; the hoist is then slowly started upward, when the tongs take hold and the crucible is held by its own weight. A toggle joint may be used instead of the chain illustrated, and in some cases hooks like those in Fig. 2 are put on and the hoist carries an equilateral triangle, vertex down, which is hooked into both hooks and draws them down by the weight of the crucible. For use in oil or gas furnaces the grab type with a toggle joint may be further improved by making the joint with a pair of stop lugs, so that the tongs can open only far enough to clear easily the bilge of the crucible. The handles of the grab type are often bent down at right angles just above the chain, hooks, or toggle joint, so that the tongs may be guided into place without getting the hands directly over the open furnace.



Figs. 1 to 4. Four Different Types of Crucible Tongs

Several foundries that use the grab type of tongs testify that with that type they can handle crucibles holding about 650 pounds of metal without difficulty. No instance of a crucible having been dropped by such tongs has been reported. Every firm using this type strongly favors it. This type seems to deserve a much wider use than it now has. No matter what type of tongs be used, if they lose their shape and do not fit the crucible at all points, excessive strain is put on the crucible at the points where they do touch. In the same way, the spade and two-prong tongs, having more bearing surface than the one-prong, divide the strain more evenly.

Some foundries have only one size of tongs, and if now and then they have to use a larger or smaller crucible than the size ordinarily used, they will use tongs that do not fit. This practice is fatal to the life of the crucible. A crucible grows slightly smaller with use, owing to oxidation and wearing away of the surface. One foundry that reports an exceptional crucible life, has three sets of tongs, differing slightly in size, which are selected according to the age of the pot. An easy way to keep tongs in proper shape is to have a cast-iron form just the size of the crucible used. As soon as it is seen that the tongs are slightly out of shape they can be heated and pounded back into shape over the iron form.

Care of Crucibles

An oxidizing atmosphere will burn the graphite from the outside of the pot and weaken it; hence for long crucible life in any furnace, especially in oil or gas furnaces, a reducing flame should be maintained. If an oxidizing flame is trained directly on the crucible, the crucible becomes badly scored at that point. As the burners requiring low-pressure air and high-pressure oil are more easily controlled so as to give a reducing flame, and as they usually give a wider cone of flame, as ordinarily operated, they are easier on crucibles than the burners using high-pressure air. If oil be allowed to spray strongly on a cold crucible before the burner is lighted, the oil will soak in, and "scalping" may result when the furnace becomes hot. Sulphur dioxide from fuels high in sulphur is said to be highly deleterious to the crucible.

Allowing the crucible to remain in the fire longer than is necessary, that is, not taking the pot out when the metal is ready, or allowing the metal to "soak," increases the wear on the crucible; hence promptness in taking out the metal lengthens the life of the crucible. The higher the temperature to which the metal is raised, the harder the wear on the crucible. In foundries in which alloys of several melting points are used, crucibles are usually used for part of their full life in melting an alloy with the highest melting point, and are then used for alloys with lower melting points. Thus a crucible might be used for a couple of heats of pure copper, then for phosphor-bronze, then for red brass, next for yellow brass, and finally, for aluminum. Used in this way, the total tonnage melted per crucible would probably be larger than if each crucible should be used for its full life on one alloy. Between changes in the alloy melted, it is necessary to clean the crucibles well from any adhering metal to avoid contamination from the previous charge. One way in which crucibles are injured is by wedging them full of cold ingots or scrap, which expand as they are heated to the melting point; the crucible does not expand so much, so that a great strain may be set up and the crucible be cracked, or at least, weakened. Crucibles may also be badly injured mechanically by carelessness in poking the fire or in knocking off slag and clinkers.

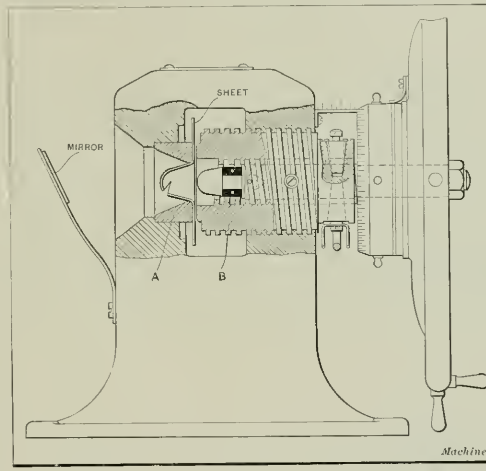
Protective coatings are sometimes used in an attempt to prolong the life of the crucible, such as a paint of finely pulverized carborundum fire sand mixed with water glass or boric acid. There is no doubt but that for certain purposes such coatings increase the crucible life. A protective coating of a nature somewhat similar to the foregoing is said to be largely used abroad and has recently been put on sale in this country. Reports from firms that are trying this are not based on long enough experience to be conclusive, but indicate that a saving may be effected in this way.

In a coal or coke furnace with proper fuel space for a given sized crucible, the use of either a larger or a smaller crucible decreases the crucible life; the life is also shorter in square furnaces than in round ones, owing, no doubt, to the less even heating. If the crucible is not allowed to cool down very far, but is kept hot continuously, so that there is less expansion and contraction, its life is lengthened. This is one reason for the longer life of crucibles in tilting than in pit furnaces. Continuous operation of brass furnaces for 24 hours a day is of course very rare. However, if the crucibles from a pit furnace, before they become cool, are promptly put back into the furnace after pouring, and if at night, after the last heat has been poured, the empty crucible is put back in the furnace and allowed to cool gradually with the furnace, the deterioration due to excessive expansion and contraction may be minimized.

METHOD FOR TESTING SHEET STEEL

The accompanying illustration, reproduced from *Stahl und Eisen*, shows a device intended for testing sheet steel, or sheets of other metals, with a view to determining its properties for drawing and stamping purposes. The quality tested has been termed the "drawing value" of the metal. The principle of testing is as follows: The sheet is inserted between the die *A* and the holder *B*, the latter being so adjusted that there is a uniform amount of play between the holder and the die. The sheet is thus free to move under the influence of the advancing ram and can be pressed forward, as indicated, until a fracture is started. The depth of the depression is then measured and constitutes the drawing value. This depth depends largely upon the tenacity of the material. With homogeneous material, these drawing values are comparable and give a fairly accurate indication of the value of the material when used for drawing purposes. Considerable differences are found with different materials, however, and direct comparisons are not possible with metals of different kinds.

The test pieces should be about 3½ inches square and the amount of play about 0.002 inch. It is stated that besides the depth of the depression, the following characteristics of the test piece should be noted: If the break is round the material is homogeneous, but if the break is irregular or appears at some special point only, the material is fibrous and is not suitable for drawing or bending. In this latter case, the drawing value will also be found to be low. If the surface of the depression is smooth like the original sheet, the material is of good quality, but if it is rough or wrinkled, the material is not suitable for deep drawing, as the rough surface offers increased resistance, and a premature break with repeated drawings would be the result, even if the material would otherwise appear to be in good condition. A rough surface produced by the test is often found in sheet steel and indicates over-annealing. In copper and tin, the surface of the depression sometimes shows very fine small cracks, indicating that the material is not suitable for drawing.



German Device for testing Sheet Steel for Drawing or Bending

The advantages claimed for the new device, which is protected by patent in Germany, are as follows: The test is simple and rapidly carried out; the test piece requires no preliminary preparation; the results are obtained by subjecting the metal to stresses similar to those produced by the actual drawing operation; the results of the test are clearly expressed and can be observed and measured by anybody with very little training; small differences in quality show themselves by relatively great variations in drawing value; and the appearance of the metal after testing permits definite conclusions to be drawn regarding the quality of the material and the degree to which it is adapted for the purpose for which it is intended.

THE ANGLE OF TORSION

DESIGNING SHAFTING OF COMPOUND GEARED MACHINES FOR EQUAL TORSIONAL STRENGTH

BY B. D. PINKNEY[*]

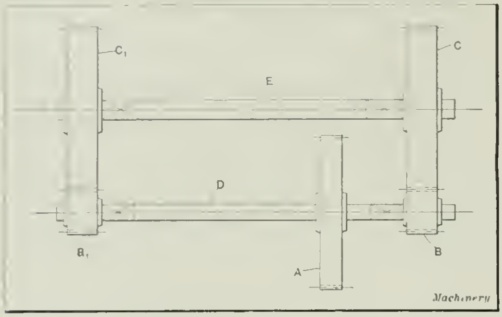


Fig. 1. Typical Arrangement of Compound Gearing with Power applied from within

CORRECTLY proportioning the shafts of double-geared or so-called compound-geared machines is often neglected, to the detriment of the driving pinions. It is my intention to show how the shafts of double-geared machines should be so designed that they are of equal torsional strength. The angles of torsion should usually be the same, but if that is unnecessary in point of stiffness, the driving pinion furthest from the point of application of the power should be advanced. This compensates for the difference of angular torsion, and permits equal loads to be transmitted by the pinions, resulting in an equal distribution of the wear. The two common forms of this type of drive are shown in Figs. 1 and 2, in each case the power being applied to gear *A*. With a uniform resisting load, there will be several times more torsional deflection in shaft *D*, Fig. 1, between gears *A* and B_1, than between gears *A* and *B*. These torsional stresses will be in proportion as AB_1 is to *AB* and the excess of torsion in AB_1 is called the "difference of the angular torsion." In shaft *D*, Fig. 2, the total torsion in BB_1 is the difference of the angular torsion, since the power is applied from without.

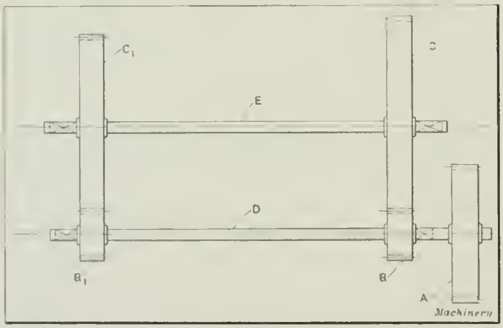


Fig. 2. Arrangement of Compound Gearing with Driving Gear on Outside

Experience has shown that the permissible angle of torsion of shafts varies according to the nature of the service, and is generally divided by machine designers [see Pencoyd, edition, 1900, page 239] into the three following classes: Class I shafts may have up to 0.05 degree per foot. These shafts are for very heavy service and, as such, are subjected to shocks or fluctuating loads and to reversal under full load. Class II shafts may have up to 0.075 degree per foot. These shafts are for regular service and, as such, will safely withstand shocks but must not be reversed under full load. Class III shafts may have up to 0.1 degree per foot. These shafts are for lighter service and not intended for fluctuating loads, unless the fluctuations are gradual; and they should not be reversed. This permissible angle of torsion is, of course, only applicable in proportioning shafts to resist torsion or, more strictly, for resisting torsion other than the predetermined torsion. Calculations for the angle of torsion are based upon the modulus of torsion of the material instead of the fiber stress, which is used in designing shafts to transmit loads irrespective of the effects of torsion, as long as the shaft is stiff enough to transmit the load. The table presented herewith gives the modulus of torsion for various materials commonly met with in machine design.

The principle of torsion is illustrated in Fig. 3 and the angle Δ is the angle of torsion referred to. The force *FR* is the statical torsional moment, or:

$$T = FR \qquad (1)$$

where T = statical torsional moment;

F = applied force in pounds;

R = radius at which the applied force acts, in inches.

The length of the arc of the angle of torsion a is found by the elementary Formula (2):

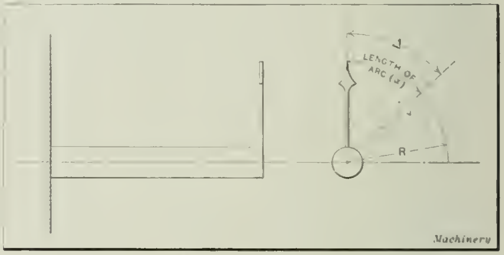


Fig. 3. Diagram showing Principle of Torsion

$$a = \frac{Tl}{JG} \qquad (2)$$

where a = length of the arc of the angle of torsion, in inches (radius = 1 inch);

T = statical torsional moment;

l = length of shaft in inches;

J = polar moment of inertia;

G = modulus of torsion (taken from the table below.)

A complete table of polar moments of inertia is given on page 448 of MACHINERY'S Handbook, the polar moment of inertia of a solid round shaft being:

$$J = 0.098\,D^4 \qquad (3)$$

where D = diameter of shaft in inches.

As it is more convenient to use the angle of torsion, Formula (2) may be expressed:

$$\Delta = 687.5\,\frac{TL}{JG} \qquad (4)$$

where Δ = angle of torsion for length of shaft subjected to torsion;

MODULUS OF TORSION FOR VARIOUS MATERIALS

Material	Modulus of Torsion
Medium carbon steel (0.15 to 0.3 per cent carbon) also called machine steel	10,500,000
High carbon steel (0.3 to 2 per cent carbon) also called hammered steel	11,500,000
Cold-rolled steel (that has not been turned down from the original diameter)	11,500,000
Wrought iron	10,500,000
Bronze (average)	5,000,000
Phosphor-bronze	5,500,000
Maple (average)	800,000
Hickory (average)	880,000

Machinery

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T = statical torsional moment; also (when the element of time is introduced) the torsional moment in inch-pounds;

L length of shaft in feet.

It frequently happens that the shaft E, Figs. 1 and 2, must be increased in diameter to withstand some great bending action, so that the angle of torsion as found by Formula (4) is much less for shaft E than for shaft D. If shaft D does not have to be reversed under full load, this defect is overcome by advancing pinion B_1 to coincide with the required difference of angular torsion. If, however, the shaft has to be reversed under full load, shaft D, Fig. 1, will have to be increased in diameter so that its angle of torsion is the same as that of shaft E; or shaft D may be designed as shown in Fig. 4, to have equal amounts of angular torsion in parts L_1 and L_2, and thus relieve shaft E from the effects of torsion. In the case of the gearing shown in Fig. 2, if shaft E has to be increased in diameter to withstand a bending action, shaft D must also be increased so that the difference of angular torsion is the same for both shafts, that is if the shafts are to be reversed under full load.

If it is required to find the angle of torsion of a shaft of different diameters as, for example, the cast-iron gage roll with steel journals, illustrated in Fig. 5, compute the angle of torsion for each length, L_1, L_2, etc., and the sum is the total angle of torsion.

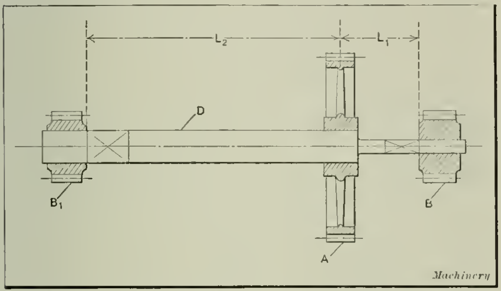

Fig. 4. Method of designing a Shaft for Equal Angles of Torsion

Introducing the element of time, we get from the elementary formula:

$$T = 63{,}025\,\frac{H}{N} \qquad (5)$$

where H = horsepower;

N = revolutions per minute.

Fig. 6 illustrates the driving pinions of a set of gearing similar to that shown in Fig. 1, which recently came to my notice. The outlines of pinions A and B were taken from the actual steel driving pinions which are for a double-geared gaging roll. The amount of wear, designated by the shaded portions of pinion B (exaggerated about three times, for clearness), should have been corrected when the machine was designed. The engineer in charge informed me that this wear occurred soon after installation and no further wear had been detected for at least four months. The arrangement of the drive was as illustrated in Fig. 7, the driving pinions transmitting a total of five horsepower. The angle of torsion of that part of shaft F designated L_1 is found from Formula (4) as follows:

$$\Delta = \frac{687.5 \times 900 \times 0.3333}{0.4185 \times 11{,}500{,}000} = 0.0428 \text{ degree.}$$

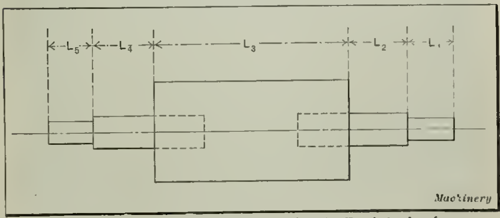

Fig. 5. Cast-iron Gage Roll for which the Total Angle of Torsion is required

The angle of torsion of that part of shaft F designated L_2 is found from Formula (4) as follows:

$$\Delta = \frac{687.5 \times 900 \times 5.1667}{0.4185 \times 11{,}500{,}000} = 0.664 \text{ degree.}$$

The difference of the angles of torsion of parts L_1 and L_2 of shaft F is:

$$0.664 - 0.0428 = 0.6212 \text{ degree.}$$

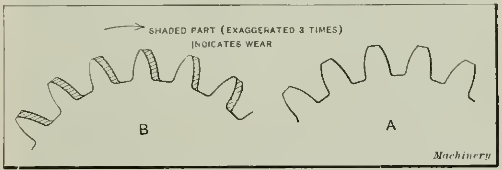

Fig. 6. Pinions of a Double-geared Gaging Roll, showing Wear due to Unequal Angles of Torsion in Shafting

For this variation, the key for pinion A should have been advanced 0.6212 degree to have insured an equal load on the teeth of each pinion. In this case, it is well to relieve the gage roll shaft G of all effects of torsion, and design shaft F for equal torsion, as shown in Fig. 4, the part designated L_2 to have an angular torsion of 0.0428 degree instead of 0.664 degree. From Formula (4) we have:

$$0.0428 = \frac{687.5 \times 900 \times 5.1667}{11{,}500{,}000\,J}.$$

From the preceding equation, we find that 2⅞ inches is the required diameter. Expressing 0.6212 degree in circular measure as the circumference of the shaft, and bearing in mind that 360 degrees $= \pi D = 3.1416 \times 1\,7/16$ inch, we get:

0.6212 degree = 0.0078 inch.

This is the distance the key should have been advanced for the 1 7/16-inch diameter shaft. While this amount appears small, it is of vital importance, since the alternative is to make the part L_2 of this shaft just double the diameter or 2⅞ inches diameter. There are cases that have come to my notice where the key had to be advanced ⅛ inch in circular measure, to produce equal wear on the teeth of the driving pinions. There are numerous cases, also where the error is too small to compensate in the driving pinions, and which must be taken into account by increasing the diameter of the shaft so that no variation in the amount of angular torsion of the shafts exists.

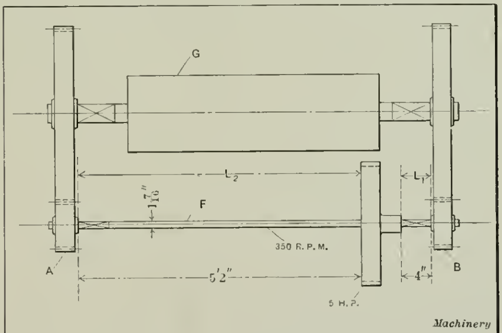

Fig. 7. Arrangement of Drive in which Pinions shown in Fig. 6 were used

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MACHINERY IN SWEDEN AND NORWAY

The total production of machinery in Sweden during 1912 is valued at $28,695,000. The imports of all classes of machinery into the country is valued at $5,175,000 and the imports of machine tools and small tools, at $800,000. The imports of machinery of all classes into Norway during the past year amounted to $7,500,000, and during the last six years the total imports of machinery into that country have amounted to $40,000,000. There are two hundred machine shops in Sweden employing twenty-five men each, or more. Of these, one employs 4000 men, one about 2000, five or six between 1000 and 1500, a dozen about 500, and upward of fifty shops 100 men or more.

PACKING MACHINE TOOLS FOR FOREIGN SHIPMENT*

CARDINAL POINTS TO BE OBSERVED AND POOR METHODS WHICH RESULT IN DAMAGED SHIPMENTS

BY J. A. FURER†

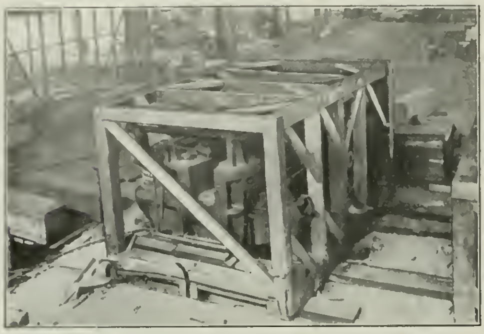

Fig. 1. Ideal Frame for a Shipping Box for a Heavy Machine

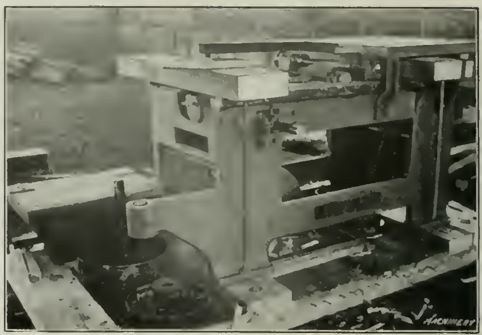

Fig. 2. Good Method of securing Machine to Skids under the Box

THE statement is frequently made, especially in comments on the export business of the United States, that American manufacturers do not exercise sufficient care in packing machines for over-seas shipment. It is quite possible that the export business of this country in machine tools has suffered somewhat, on account of frequent "bad order" deliveries. Consular and trade reports seem to bear this out as having been true, at least in the past. In recent years, however, much improvement seems to have been made in this respect. This criticism, even if exaggerated, is worthy of serious consideration by manufacturers, because a very large percentage of the bad-order deliveries in every ocean cargo can be avoided at little expense, by paying attention to correct packing.

The actual cost of making good transportation damage is usually the smallest item of the resulting inconvenience. Assume, for example, that a number of parts are found broken on a machine delivered inland in South America, which cannot be replaced locally. The purchaser must first of all go to the trouble of very carefully describing the broken parts, so that the manufacturer may make no mistake in supplying new parts. Generally it will be necessary to use the mails in order to insure proper description of the damage. If the plant where the machine was manufactured is located some distance from the coast in the United States, a rail transportation delay is first of all involved in shipping the replacement. Steamer connections must be made in the United States, and a further connection must be made to get the shipment by rail from the seaport in South America to the purchaser. Taking into consideration all of the normal delays, it is readily conceivable that the replacement of the damaged parts may take three or four months from the date of the delivery of the machine. All this time the purchaser loses the use of the machine, or at the very least his installation program is seriously interfered with. The inconvenience caused by these delays may be entirely out of proportion to the money value of the damage. The manufacturer, especially if the purchaser is in a position to lay the damage to poor packing, is naturally somewhat discredited by the occurrence in the eyes of the purchaser. The shipper usually blames the transportation company for all of the damage done in transit, as there is a fixed opinion in the minds of many people that freight handlers delight in dropping boxes from high altitudes, and that a gaping hole in the side of a case is very amusing to the stevedore. As a matter of fact, on many steamship lines, the officer who supervises stowing the cargo has to pay for the damage resulting from careless handling or due to improper stowing below. That officer, at least, may not find broken packages amusing.

The dock superintendent of a steamship company sums up the matter about as follows: "We have a right to expect that when a shipment is billed as machinery and is being carried at the machinery rate, it should be safe to pick up the boxes by means of slings without danger of crushing in the sides or having the contents drop out through the bottom. We feel, also, that swinging a box over the side of the ship at a slight angle from the horizontal, should not result in a $2000 lathe breaking its way through the end of the box and falling into the hold below, on top of innocent cargo. We also hope that the shipper knows that winds still blow and ships still roll. The only way to circumvent the evil effects of rolling on the contents of boxes, is to have everything tight and snug inside; all that we can do to prevent damage from rolling is to stow the cargo so that the boxes themselves cannot shift." The most ardent defender of the stevedore cannot claim that the business of

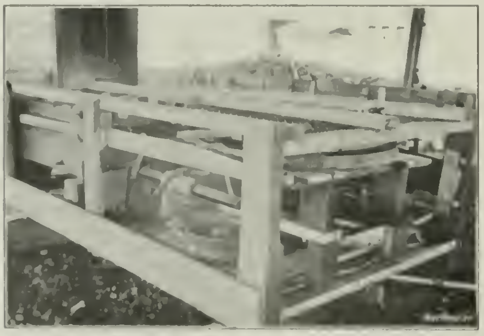

Fig. 3. Method of blocking to prevent the Machine from moving in the Box

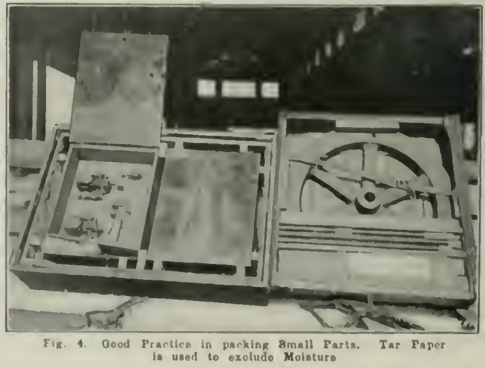

Fig. 4. Good Practice in packing Small Parts. Tar Paper is used to exclude Moisture

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* For other articles on the subject of packing machinery for shipment published in MACHINERY, see also "Packing Machine Tools for Export," February, 1909, and "Packing Machinery for Export," July, 1909.

† Naval Constructor, U. S. Naval Station, Pearl Harbor, Hawaii.

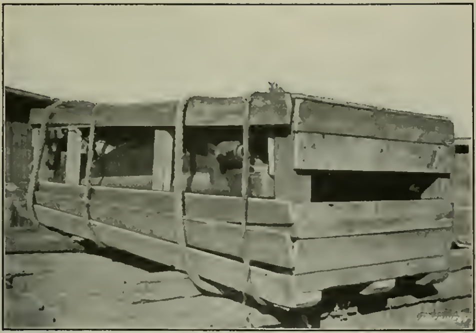

Fig. 5. A Packing Box that was racked by the Machine shifting

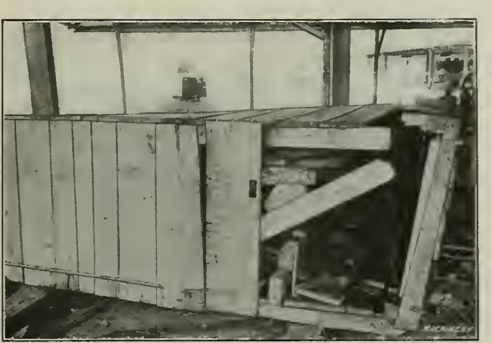

Fig. 6. Insufficient Bracing and Poor Strapping caused Breakage

stowing a ship's cargo is the gentlest profession in the world. No doubt the transportation companies are often at fault, but the chances of damage to machines are always minimized by good packing.

The United States Government recently purchased $500,000 worth of machines for the shops at the new naval station, Pearl Harbor, Hawaii. The contracts covered every class of tool used in the machinists', wood-working, ship-fitter's, foundry, blacksmithing, pipe-fitter's and allied trades. Practically all of the machines were manufactured in the United States. At least 90 per cent of the shipments went through New York and thence to their destination, *via* the Isthmus of Tehuantepec. As the amount of handling which a package receives is the governing factor in its liability to damage, these shipments may be said to have been subjected to an unusually large damage risk. In the first place, the machines had to be shipped by rail from the manufacturer's plant to Jersey City, or to one of the other New York Harbor railroad terminals. From this point they were lightered to the docks of the steamship company in Brooklyn. From there they were carried by steamer to Puerto Mexico, unloaded, transported by rail to Salina Cruz, reloaded on steamers and carried to Honolulu, unloaded on the docks and finally shipped by rail to the naval station at Pearl Harbor. More than 300 machines or groups of equipment were covered by the contracts, consisting in all of many thousands of packages. The equipment for one of the 300 groups alone, was composed of over 800 individual packages. Taking into consideration the length of the route from the manufacturer's works to Pearl Harbor, the number of transfers involved and the large number of packages in the shipments, remarkably few machines were found damaged on arrival. But even at that, the damage to some of the shipments might have been avoided by good packing, although the transportation companies unquestionably contributed their share of the breakage in handling.

The requirements for packing machines for foreign shipment so as to reduce the chances of damage to a minimum may be briefly summarized as follows:

1. A crate is less than no protection to a machine, because the freight handler is always tempted to hook onto a slat in order to lift the package. Furthermore, a crate is bound to rack if the contents are heavy. Then again, all foreign shipments run the risk of being exposed to water damage; and if so exposed, a crate offers no protection. There are a few classes of goods which go more safely if crated, such as fire brick, because the stevedore can see that the contents are fragile and must be handled with unusual care, but this does not apply to machines. A substantial box is therefore the first requisite to safe packing.

2. The box should always be built on skids. Skids serve a number of purposes. They invite attention at once to the side on which the box should be landed; they distribute the load uniformly on the whole structure of the box; and they provide a continuous and heavy foundation to which cross-pieces can be bolted for carrying the machine. Skids are to the box what sills are to a house.

3. If the box is at all bulky and the machine is heavy, corner posts, studding and cross bracing should be fitted so as to prevent all possibility of racking.

4. The machine should be bolted (not secured by lag screws) to the cross timbers fitted on top of the skids. In addition, the machine should be braced and chocked to the sides, ends and top of the box, so that no matter which way the box is landed the machine cannot shift and break through it.

5. Nothing should be placed in the box loosely. If small parts form a part of the shipment, for which there is room inside of the large box, they should be separately packed and the small box secured inside, or the parts should be individually secured inside of the large box.

6. The box should be lined with tar paper or other water-excluding material.

7. The boarding should be sufficiently heavy to reduce the chances of local damage to a minimum. In spite of every precaution, boxes are occasionally dropped on top of other packages in handling. If the planking of the box underneath is heavy, the contents stand some chance of escaping without damage.

8. Strap iron of generous width and thickness should be

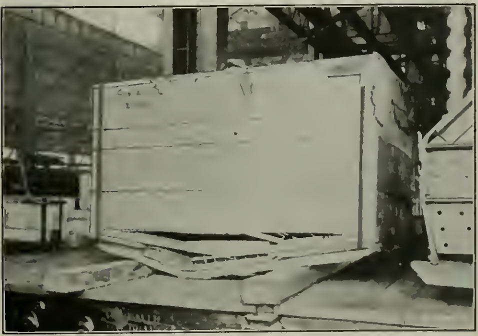

Fig. 7. Box broken from the Use of Skids that were too Light

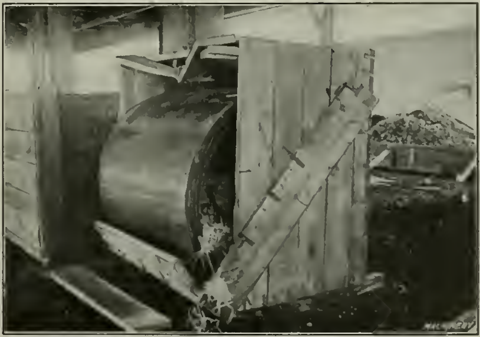

Fig. 8. Damage caused by packing Fittings loosely in the Box

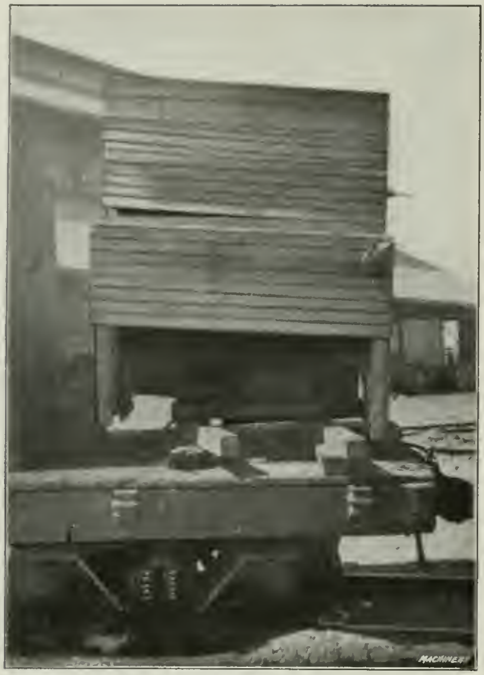

Fig. 9. An Example of Packing that is Defective in almost Every Respect

fitted around the box in both directions, both lengthwise and crosswise. The strapping should go all the way around the box and should not be fitted merely to the corners, as is sometimes done. The cost of adequate strapping is a small item, but adds very considerably to the strength of the box.

9. Adequate protection of machined surfaces against corrosion, while in transit, should not be neglected. The practice of shippers differs widely in this respect. Some manufacturers give machined surfaces merely a coating of heavy oil. This is altogether inadequate for a shipment that is going to be in transit several months. A very thick coating of petrolatum usually affords sufficient protection. White lead and tallow is still better, but is difficult to remove. A number of slushing compounds are on the market, which form a coating similar to a layer of paint; they can be removed readily by means of kerosene and are in this respect superior to white lead and tallow. Some of these compounds are, however, worthless, as they become brittle and flake off in a few weeks.

The accompanying illustrations show examples of both good and poor packing. Fig. 1 shows the framing of a box for a heavy machine with the planking removed. The gross weight of the machine was 34,300 pounds. The box was 11 feet 8 inches long by 7 feet 5 inches wide by 6 feet 9 inches high. It will be noted that there are three 6 by $8\frac{1}{2}$-inch skids provided, and that 3 by 6-inch cross sills are bolted on top of the skids. The machine is bolted to these cross sills. The main framing consists of 6 by 6-inch timbers. The box was, in addition, securely strapped by 2-inch band iron 1/16 inch thick. The planking was $1\frac{1}{2}$ inch thick. In general, this box was ideally constructed. The shipper failed, however, to line the box with heavy paper, and consequently the machine was found considerably rusted because spray or rain water had evidently found its way through the cracks of the planking. The shipper also placed a large number of parts, such as wrenches, fittings, etc., loosely inside of the box. If the box had been turned over in transit these loose parts would have done considerable damage to lubricating pipes, oil cups and other more or less delicate fittings. Attention to these two neglected rules of good packing would not have increased the cost of preparing the machine for shipment very much, and would have insured its perfect condition on arrival.

Fig. 2 shows a good method of securing a machine to the skids so as to prevent movement. This machine is comparatively light, the gross weight of the package being only 2000 pounds. It will be noted that timbers have been fitted across the top of the machine, and that long bolts clamp the upper to the lower timbers. Any possible movement of the machine in the box was in this manner forestalled. The box was braced diagonally so as to prevent racking.

Fig. 3 shows how similar results can be obtained by proper blocking where the machine is not so compact as the one shown in Fig. 2. This machine is also comparatively light, weighing only 3500 pounds. The left-hand portion of Fig. 4 shows a box containing two starting panels for motors. It will be noted that a double box has been used for packing these panels. Tar paper was fitted inside the inner box so as to keep out moisture. Better results would probably have been obtained if the tar paper had been fitted between the two boxes. All movable parts inside of the panels are chocked and braced. The right-hand box in this illustration shows small parts excellently packed.

Illustrations are also presented of some of the machines which were received in damaged condition. In all cases, defects in packing will be noted. Of course, the statement cannot be made that negligence in packing was entirely responsible for the condition in which these machines arrived, but it is more than a coincidence when shipments are generally found damaged, in the preparation of which all the rules of good packing have not been observed; whereas those which have been correctly packed are seldom found damaged. These illustrations are not published in a spirit of criticism, but because they may be of value to shippers at large in correcting their packing methods. It is always difficult to visualize the hazards to which shipments are subjected in transit. It is particularly difficult for the manufacturer to comprehend just wherein his shipping department fell short, when he receives a report of damage, because he very seldom has an opportunity of seeing an over-seas shipment when it arrives at its destination.

Fig. 9 shows a machine weighing 4700 pounds, packed in a

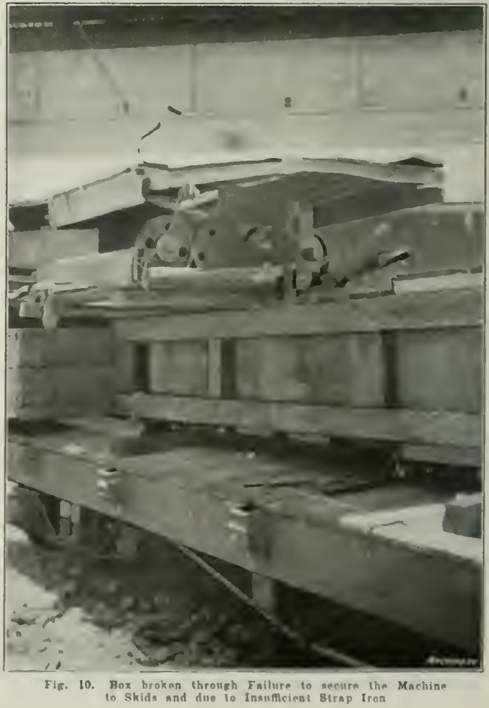

Fig. 10. Box broken through Failure to secure the Machine to Skids and due to Insufficient Strap Iron

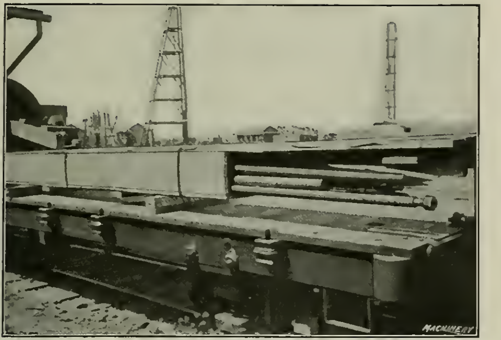

Fig. 11. A Box that broke open because the Shafting was not chocked

box 6 feet 6 inches long by 7 feet 1 inch high by 5 feet 2 inches wide. The box was not built on skids and was not strapped with band iron. Consequently, the machine dropped through the bottom. The outside of the box was made of ⅞-inch tongue and groove boards, which were entirely too light for this purpose, especially because the box was not rigidly framed. The box was not lined with tar paper, and as a consequence the machine was found badly rusted. The gross weight of the machine shown in Fig. 5 is 6000 pounds. The box was 8 feet 10 inches long by 44 inches wide by 33 inches high. In preparing this shipment some of the rules of good packing were observed, but others were neglected. Adequate skids were provided, but the main frame of the tool was not bolted to the skids. The corner posts were sufficiently heavy, but the boards, consisting of ⅞-inch tongue and groove stuff, were only lightly nailed thereto. Furthermore, no strap iron was used to reinforce the sides. A number of parts were also placed loosely in the box; consequently the contents shifted, which resulted in loosening the boards, as will be noted from the illustration. Enough money was undoubtedly spent on this box to have made a good job, but inattention to such comparatively small details as proper nailing, bolting the base to the skids, and fitting strap iron, resulted in the machine being delivered in bad order.

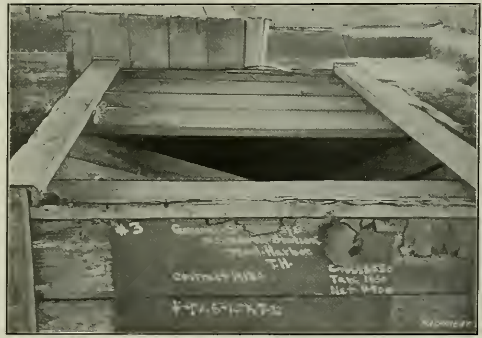

Fig. 12. Damage done by dropping a Heavy Article on Top of the Packing Box

The machine shown in Fig. 10 weighed 9365 pounds. The main frame was not bolted to the skids and no chocks were provided to prevent movement of the contents of the box; consequently the machine punched its way through one end. Also, the box was strapped in only one direction. If strap iron had been carried around the box in both directions the end planking might have held, as the boards were 1¼ inch thick. The gross weight of the machine shown in Fig. 6 was only 3080 pounds, but due to insufficient bracing and lack of adequate strapping, the machine shifted and broke through the end of the box. The ¾-inch strap iron was carried beyond the corners only about 6 inches. If it had been carried entirely around the box, and if it had been somewhat heavier, it is likely that no damage would have resulted in transit, as the framing of the box was otherwise adequate. Fig. 7 illustrates a good example of the consequences resulting from the use of light skids. The gross weight of the machine was 5150 pounds; and the size of the box was 6 feet 2 inches by 3 feet 7 inches by 3 feet 7 inches. The dimensions of the skids should have been given special consideration because all the weight in the case of this machine is concentrated practically at the middle. The skids were only two in number and consisted of 2 by 6-inch scantlings. An additional band of strap iron around the middle of the box might possibly have compensated for the weakness of the skids.

Fig. 8 shows an excellent example of the damage which can result from packing fittings loosely. The gross weight of the box was 6000 pounds; and the size, 60 inches by 66 inches by 53 inches. Inside of the circular plates were packed a large number of heavy castings. An attempt was made to wedge these castings by means of straw, which matted up and soon permitted free movement. It will be noted that the strap irons are only corner pieces, consisting of 1-inch bands extending about 3 inches beyond the corner. Each strap was held by only two nails. If the strap iron had extended entirely around the box, and if the castings had been chocked inside so as to prevent movement, there could have been no damage, as the box was strongly built of 2-inch boards. The box shown in Fig. 11 broke open because the shafting was not chocked, thus permitting endwise movement. The box was furthermore weak at the butt joint of the planking. The boards should have been in one piece the full length of the box. This was quite practicable, as the box was only 19 feet long. In any event the butt joints of adjacent boards should have been staggered. One of the pieces of shafting was lost from this box.

Fig. 12 shows the kind of damage which is not serious if the shipper has taken the precaution of building a good box around the machine. A heavy package was apparently dropped on top of this box, which resulted in breaking through two of the planks. The box was, however, so well built that no further damage was done, and the machine arrived in good condition. The box was made of 1⅝-inch boards, built on heavy skids, well framed and sufficiently strapped. A lightly built box would, no doubt, have been badly crushed by anything heavy enough to break the planks as shown. The weight of the package shown in Fig. 13 was 3000 pounds. The box was 98 inches long by 44 inches wide by 33 inches high. It was well constructed, in general; but the machine was not properly secured inside, permitting end movement which resulted in breaking the box. The strap iron was also very light. Heavy strap iron carried around the box in both directions might have saved the shipment from damage.

* * *

The total value of the machinery imports to Japan during 1913 amounted to $17,119,000, of which 25 per cent came from Germany and about 21 per cent from the United States.

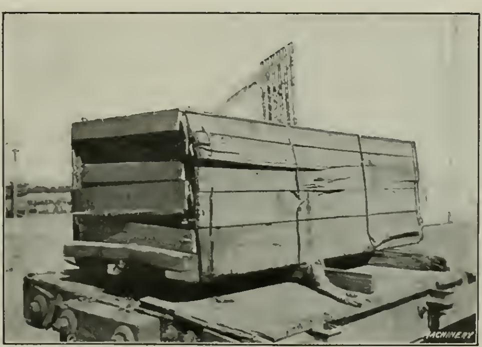

Fig. 13. This Box was damaged due to the Use of very Light Strap Iron and Failure to bolt the Machine to the Skids

INSTALLATION OF A GAS ENGINE*

There are a number of points that should be considered before purchasing a gas engine, one of which is the amount of power required for the work to be done. It is generally advisable, no matter what style of engine is to be purchased, to buy a unit somewhat larger than may at first seem necessary. It is always well to have some power in reserve, because an engine working under an excessive load is inefficient and involves a money loss to the owner on account of the wear and tear on the engine.

The style of engine to be used is determined by the location and the nature of the work to be performed. If the engine is used in a fixed location a stationary type should be selected, whereas the portable type and the traction engine must be selected when the engine is for use at various points and when loads are to be hauled. The selection of the right type is fully as important as the selection of the right make; also, while attractive paint and a high polish are desirable, these tell very little of the real value of the engine.

When repairs are necessary, the importance of having an engine which has been standardized is fully realized by the purchaser. Repair parts should be obtainable at convenient points within a few hours, because delays in waiting for repair parts usually prove expensive.

It is important to bear in mind that the rated horsepower of an engine is not always a reliable basis for comparison with the actual power that the engine will deliver. There are many gas engines on the market rated at five horsepower, for example, that will hardly have a maximum output of as much as five horsepower under regular operating conditions. Again, there are engines built by reputable manufacturers that deliver continually an overload of as much as 20 per cent above their rating. If there is any doubt in the mind of the purchaser as to the power that it is possible to obtain from an engine, he should insist upon proofs of the actual brake horsepower.

When the engine has been purchased, the next thing to consider is where it is to be placed. In selecting the position for the engine, note that it ought to be placed in the cleanest, driest and lightest spot obtainable. If it is to be belted to machinery that is already in place, it is necessary to decide where the flywheel will be located, and the foundation should be made with this in mind. If the machinery is to be installed later, suitable position for it must be determined at the time the engine is installed in order to insure that no difficulties will be met with in transmitting the power. If the engine is installed in a large room, a small room or space should be partitioned off around it in order to keep out dust and dirt. Under all circumstances, never allow a gas engine, or any other engine for that matter, to run in the same room with emery or polishing wheels.

Assuming the engine to be of the stationary type, the purchaser should obtain a templet and anchor bolts, generally furnished with each engine. The templet is a wooden frame of the size of the bottom of the base of the engine, having holes in it to match the holes in the base of the engine frame.

The Foundation

The dimensions of the foundation at the bottom should be at least twice the length of the engine base and not less than two and one-half times the width, and the depth of the foundation should be equal to its length. The shape of the foundation is then made in the form of a frustum of a pyramid, sloping up toward the top, where it is only about three inches larger on all sides than the base of the engine. When the hole has been dug in the ground, a form for the concrete must be made and then the concrete is mixed as follows: one sack of good cement, two wheelbarrows of sand, and three wheelbarrows of crushed rock or small gravel, well mixed with water to make it easy to handle. When putting the concrete into the form it is advisable to use old scrap iron of all kinds, chains, wire, etc., to reinforce the concrete and keep it from cracking. Put in the concrete and scrap iron together, tamping it tightly into the form. Before putting in the concrete, however, place the anchor bolts in the bottom of the hole, with large heavy washers on their heads, and use the templet to locate them properly at the bottom; then run the nuts down on the anchor bolts far enough to allow the templet to rest upon them while locating the bolts at the top at about the level where the engine will be set on the foundation. Then fasten the bolts in some way so that they will not move while the concrete is being put in place. The wooden templet is left on the top of the foundation, the nuts, of course, being removed when the foundation reaches them, and the engine is set on the top of the templet, as it is advisable to use a thin strip of wood between the concrete and the cast iron of the base. The foundation should be left to set at least four days before the engine is placed on it.

Removing an Engine from a Railroad Car

The foundation now being ready, we will assume that the engine has arrived in a railroad car at the station, and that it is to be removed from there by the purchaser. A few points relating to this operation will prove of value. The engine has been delivered to the transportation company by the manufacturer or dealer, properly packed for shipment. The responsibility of the manufacturer or agent stops at this point, and the transportation company is supposed to deliver it to the purchaser in perfect condition. The engine, if of a heavy type, has been transported in a separate car, and is left on a side track accessible for teams. The first thing to do is to have the local station agent make an inspection of the engine in the presence of the purchaser or his representative, to see if it is in good condition and that no damage has been done to it in transportation. Should any damage be revealed at this inspection, the station agent should be required to make a notation of the damage upon the expense bill before the freight is paid. After this is done, the transportation company is liable for the damage, if any, and the buyer is safe in unloading and taking charge of the engine.

If any timbers or assistance is needed in unloading the engine from the car, the transportation company, through its agent, is supposed to furnish them. If the transportation company furnishes bad timbers for this purpose and an accident is caused thereby, the mere acceptance by the purchaser of the bad timbers does not place the responsibility upon him. The engine should preferably be moved onto a flat top dray wagon without springs. In moving the engine, take care to see that it is properly supported at all times, and see where each step in the moving is going to leave it. If any accident happens to the engine before it is clear of the car or before it is taken off the skids conveying it from the car to the wagon, the transportation company is liable for the damage, because being a local shipment, the company is supposed to remove it from the car and the purchaser is merely acting for the company when taking the engine from the car. After the engine is placed on the wagon, the purchaser is entirely responsible for it.

As an example of what may be encountered in unloading an engine, the following experience may be mentioned. An engine arrived at its destination in good condition and the car was set on a siding near a pile of ties that were to be used in unloading. Some other timbers were also necessary which the agent of the railroad company furnished, but these were not as strong as the man unloading the engine required; however, the station agent informed him that he would have to use them. He went on with the operations, taking extra precautions to brace the weak timbers, but just as the engine was about half way between the car and the wagon, one of them gave way and the engine went into a ditch upside down. The man in charge of the unloading went to the long-distance telephone and called up the general agent of the manufacturing company, stating the circumstances and asking for instructions. He was told to inform the station agent that the engine could not be used, and that it would be left on the railroad company's hands. A new engine was loaded at the factory the same day and shipped, and in that case ample assistance ws rendered in unloading the new engine. The first engine was loaded by the railroad company onto a car and returned to the factory free of charge; the bill for the necessary repairs was rendered to the railroad company, and was paid without a damage suit.

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* This article is prepared mainly from a series of notes by J. L. Hobbs, gas engine expert

After the engine is safely placed on the wagon it should be conveyed by the safest and easiest road to the place of installation. Avoid uneven ground and bad street crossings; take plenty of time and be sure of every move. Always release the team from the wagon while loading and unloading the engine. The unloading is greatly simplified if two trenches are dug for the wheels of the wagon so that the axles almost touch the ground. In this case, the timbers on which the engine is handled will be more nearly level. If they are entirely level, rollers may be used under the skids to which the engine is fastened. If, however, the timbers slope at all, rollers should not be used. The main thing is to avoid haste, and not to permit anything to interfere until the engine has been placed on the foundation.

Installation of Auxiliaries

The next thing is to select a suitable place for the battery box. This place should be dry and free from vibration. The wiring is now connected. If natural gas is to be used as a fuel, it is necessary to have a special mixer, which will be furnished by the manufacturer of the engine. All that is necessary is a gas bag or tank and piping to allow the charge to be drawn quickly into the cylinder. Some engines use gasoline for a start and then switch onto the natural gas, while others start directly on the gas. If the engine *will* start on the gas, there is no good reason for using gasoline.

If liquid fuel is to be used, it is advisable to place the fuel tank outside the building and it is still better to bury it in the ground. After the tank has been buried in a suitable place, it is an easy matter to arrange the piping to the fuel pump on the engine. As far as possible, this piping should be underground, as it is out of the way. A pipe for the fuel, passing from the pump to the mixer, and a pipe for the overflow to return from the mixer bowl to the tank, must be provided. If the overflow pipe stops at the top of the fuel tank, it will not be necessary to have a vent hole at the top of the tank, as the air will flow into the tank from the overhead pipe which will not always be full of gasoline. The pump pipe should pass to the bottom of the tank and should be provided with a light screen to prevent foreign substances from passing into the mixer.

Starting a New Engine

After the engine is properly installed, the first thing is to start it running. This is done by turning on the battery switch, setting the needle valve in the starting position, turning off the air damper, releasing the compression, and giving the flywheel a few turns, which will put it in motion. After the engine has made a few revolutions, open the air damper, close the needle valve to the running position, put the relief cam back into place, and let the engine run, watching for developments. It is, of course, presumed that all the oilers and grease cups have been filled, and that all movable parts have been oiled with the oil-can. Now see that water enters the cylinder cooling jacket within five minutes, or stop the engine, as it is not safe to allow it to run without cooling water on the jacket. It is best to allow the engine to run an hour or so without any load, and to watch the bearings to see that they do not become overheated. In case of doubt on any point, stop the engine and examine it.

In cold weather, a gasoline engine is more difficult to start than in warm weather, the reason being that gasoline, in changing from a liquid to a vapor, reduces its temperature about 30 degrees F. If the air is cold on the outside of the cylinder and the mixer has taken in vapor 30 degrees colder, it is easy to understand that this would interfere with the proper vaporization. Hence, it will be difficult to start the engine. There are several methods of overcoming this difficulty, either by warming the gasoline, warming the air, or by using one part ether and four parts gasoline for a start; this will make a liquid that will vaporize readily several degrees below zero. To warm the gasoline is a process which is dangerous and should only be attempted as a last resort. It can be done safely only by using hot water or a hot cloth. The air may be warmed by heating a piece of iron red-hot and holding it at the mouth of the intake pipe, allowing the air to pass over it as it goes into the intake pipe, after which it joins the gasoline vapor and heats it.

HYDRAULIC BROACHING

Up to within a few years ago, broaching was looked upon as a "fussy" operation, always to be avoided if possible, but of late it has been so highly developed that it is now on a par with other machining operations. When we speak of broaching, we usually think of horizontal broaching, as that is what has been most commonly done, but another kind of broaching which is coming more and more in evidence is vertical broaching in hydraulic presses.

The Watson-Stillman Co., of Aldene, N. J., has made many presses for hydraulic broaching and uses several in its own shops for broaching operations on manufacturing work. These machines are all of the vertical type and they have been found to be easier to handle with certain classes of work than the horizontal type. One of these presses is shown in Fig. 1. Again, in Fig. 2 is shown a closer view of the press, that illustrates the facility with which the work may be handled. In the horizontal type of broaching machine the force required to drive the broach is applied through a driving screw, but with a hydraulic press it is applied through a ram driven by a pump.

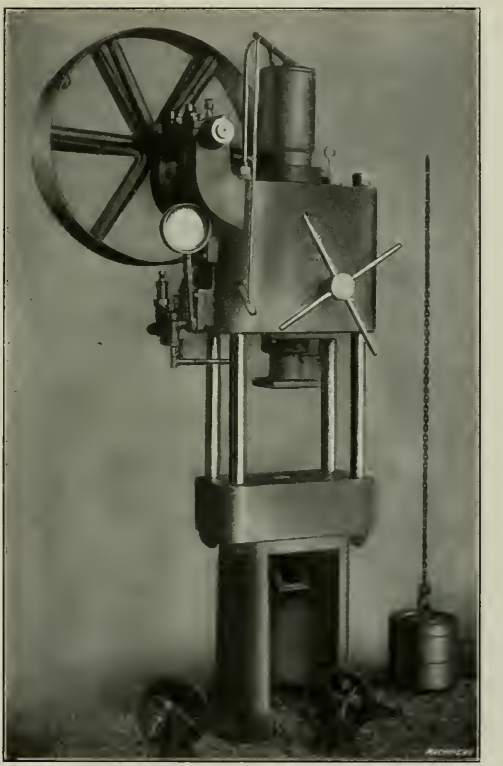
Fig. 1. Watson-Stillman Hydraulic Press used for Broaching

Another advantage claimed for hydraulic broaching is that short broaches may be used—from one-fourth to one-sixth of the length of broaches for horizontal use. On this account, there is much less danger of breakage in hardening or in use, as the steel is under compression while in use, rather than under tension. When the work will permit it, the broaches are driven clear through the hole and dropped out on the under side. In Fig. 3 there appears a set of four broaches for finishing a hole for a square shaft. The economy of using short broaches is also apparent when it is stated that when the full-sized broach wears small it may be ground down to the next smaller size, and so on until the size of the last broach in the set is reached. Therefore it is only necessary to replace one broach each time the entire set is normally worn out.

An idea of the amount of metal removed in broaching with vertical or "push" broaches, as they are sometimes called, may be obtained from the table of sizes given for the four broaches, *A*, *B*, *C* and *D* shown in Fig. 3.

	Broach A	Broach B	Broach C	Broach D
Start	1.075	1.100	1.125	1.145
Finish	1.105	1.130	1.155	1.156

From these figures it will be seen that each of the broaches removes practically 0.030 inch of metal except the last broach, which only has 0.001 inch to take off to finish the work, and is therefore more in the nature of a smoothing broach.

An interesting hydraulic broaching operation is the one illustrated in Fig. 2. This shows the planish-broaching of a hole that has been previously drilled and reamed in the casting shown on the bed of the machine. The broach removes no metal, but planishes the stock on the surface of the hole, leaving it to size; and, moreover, because the metal is compressed, the finish is much better and the wearing surface much harder.

The broach for this operation is shown at *E* in Fig. 3, and in Fig. 4 the details of the broaching end are seen. The broach has four different sizes as shown. The reamed hole is 0.003 inch under size and the entering part of the broach is made just to size. The corners, however, are well rounded so that the broach will start without difficulty. The first raised rib on the broach end is made 0.002 inch over size. The next rib is left 0.003 inch over size, and the body of the broach is made 0.001 inch under size. The object of this broach is to planish the metal out to a size enough larger than the finished size to allow for the "spring-back" of the metal. The amount of "spring-back" depends, of course, upon the thickness of the wall and the character of the metal.

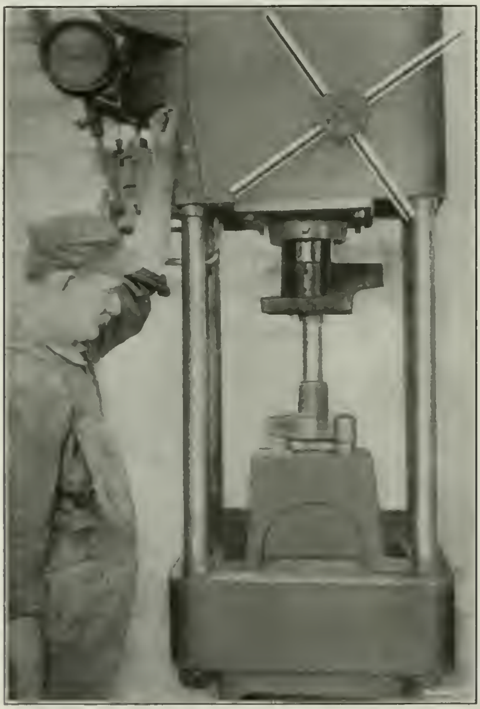

Fig. 2. Planish-broaching in a Hydraulic Press

In hydraulic broaching the amount of pressure that is being applied to the broach at all times is shown by the hydraulic gage. This is important as it tells the exact time at which an overload is being put on the broach and, the safety point of the broach being noted, it is easy to keep on the safe side. Any range of speed may be secured in hydraulic broaching, and this speed is only limited by the capacity of the broaching tool for doing the work. Less floor space is required for hydraulic broaching machines than for the horizontal type of broaching machine. The horizontal broaching machine is a single-purpose machine tool, in that it can only be used for broaching, but the hydraulic press, in addition to being used for broaching, may be used for forcing on arbors, forcing gears on and off shafts, straightening, and for various other machine shop jobs requiring pressure.

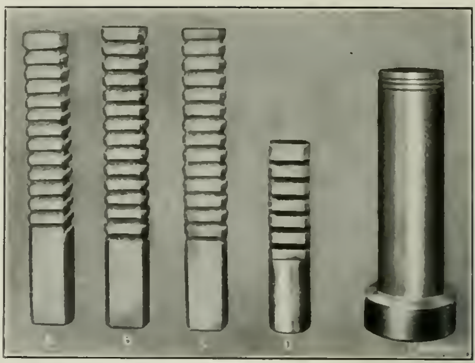

Fig. 3. A Set of Push-broaches

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INTERESTING TELEPHONE STATISTICS

According to recent statistics, there are 9,200,000 telephones in the United States and Canada, and 3,700,000 in Europe. On an average, this means one telephone for each eleven inhabitants in the United States, while there is only one telephone for each 125 inhabitants in Europe. With regard to the distribution of the telephones in cities and in the country, we find that in cities of more than 100,000 inhabitants there is, in the United States, one telephone to every nine persons, whereas, in the country districts, there is one telephone to every thirteen persons. In Europe the difference in the number of inhabitants per telephone is very marked dinavian countries. Thus, we find that in the three Scandinavian countries, Sweden, Norway and Denmark, there is one telephone to every twenty-five inhabitants, while in Germany there is only one telephone to every fifty-two inhabitants, in England one to every sixty-two inhabitants, and in France one to every 140 inhabitants. Of all the cities in the world, Stockholm leads with the number of telephones per capita, there being at the present time one telephone for every 4.4 inhabitants. Another interesting comparison is made between the number of telephone conversations and the number of letters transmitted by mail. In the United States, there are sixty-one telephone conversations to every thirty-nine letters. In Germany, there are thirty telephone conversations to seventy letters; in England there are twenty-three to seventy-seven letters; while in the Scandinavian countries there are sixty-six telephone conversations to thirty-four letters.

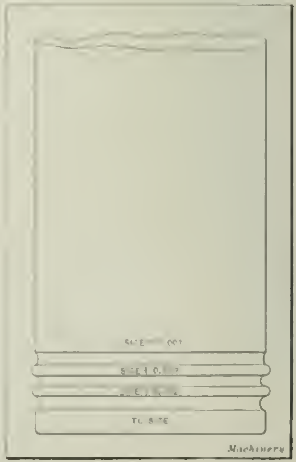

Fig 4. Dimensions of the Planish Broach

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The total exports of belting from Germany in 1912 were valued at $3,675,000, of which over $1,000,000 worth was exported to Russia.

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Universal formula for the prevention of warfare: Never start a fight with a customer

PROVIDING FOR UP-KEEP IN THE DESIGN OF CUTTING TOOLS

EXAMPLES OF TOOLS AND DEVICES THAT HAVE PROVED EFFICIENT IN PRODUCTION AND INEXPENSIVE IN MAINTENANCE

BY ALBERT A. DOWD[*]

Albert A. Dowd[†]

It is of primary importance in the designing of all kinds of cutting tools to bear in mind the fact that all cutting edges must be occasionally sharpened by grinding, and that the re-grinding of the tools brings into use portions which have previously been inactive. This matter deserves the most careful consideration, in order that the design may be such as to give the longest life to the tools consistent with reasonable first cost. In the majority of cases the conditions are such that a little forethought will result in a material improvement in the "upkeep." There are occasional instances, however, when it is very difficult to construct tools so that they will not be seriously affected by re-grinding, as for instance when certain kinds of forming tools are required. A final finishing tool taking a light scraping cut may sometimes be found necessary in cases of this kind, and as this tool will seldom require re-grinding because it has so little to do, the work can be held very close to size.

The designer of cutting tools should have a wide experience and a broad knowledge of the actual conditions under which tools are to be used. He must be capable of thoroughly analyzing the situation and determining the type of tool best suited to the work in question. Examples which illustrate the various types of cutting tools in common use will be described in the following, and attention will be called to features in which there is a chance for improvement, with suggestions tending toward increased life in the tools.

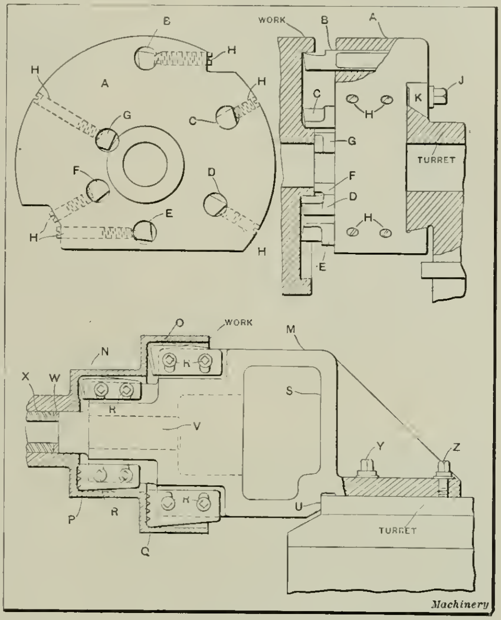

Fig. 2. Two Types of Cutter-heads

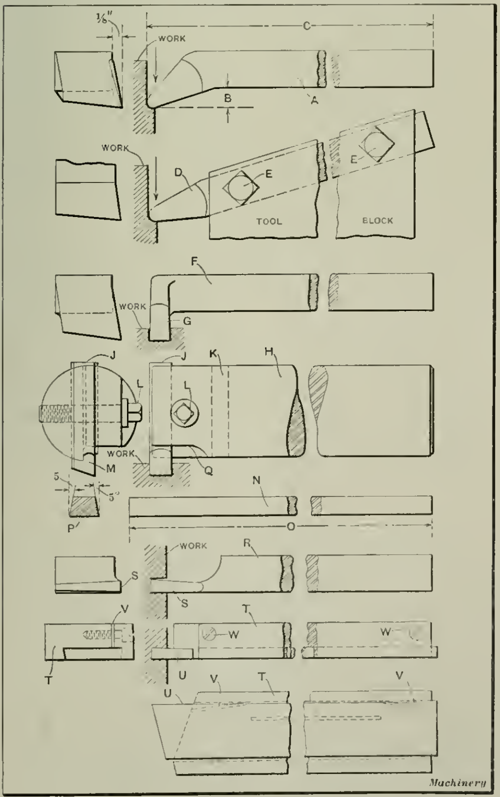

Fig. 1. Forged and Inserted-blade Turning and Cutting-off Tools

Points in General Design of Cutting Tools

1. The number of pieces to be machined is one of the first things to be considered, as it has a decided influence on the type of tool to be used. A tool designed for machining a small number of parts should be made as cheaply as possible, and the upkeep is not of great importance; but if a great many pieces are to be handled the first cost is not as important as rapidity of action and provision for upkeep.

2. The various materials to be cut—steel, cast iron, brass, etc.—require tools of different shapes, and the clearance angles must be such as to turn the chips to the best advantage.

3. Sufficient clearance for chips is essential in all cases, but should receive special attention when tools are to be used on steel. Internal cutting tools are naturally more subject to chip troubles than those used externally.

4. A copious supply of cutting lubricant is of great assistance in prolonging the life of the tool, as it carries away the heat generated by the cut. If surfaces which are to be machined are so situated that they cannot readily be reached by regular methods of lubrication, it may be found advisable to provide oil channels in the tools themselves.

5. Particular attention should be given to portions of tools subject to slight changes in contour due to re-grinding. Forming tools, shoulder tools, taper reamers, etc., are especially subject to these variations when re-ground. Methods of overcoming these difficulties will be cited in this article.

6. The use of standard sections is advisable when tools of rectangular stock are required, as machining is thereby obviated. It is good practice to use sections such as are carried in stock in the factory where the tools are to be used, so that replacements can be quickly made.

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[*] Address: 221 Grove St., Bridgeport, Conn.

[†] For biography, see article "Floating Reamer Holders," July, 1913.

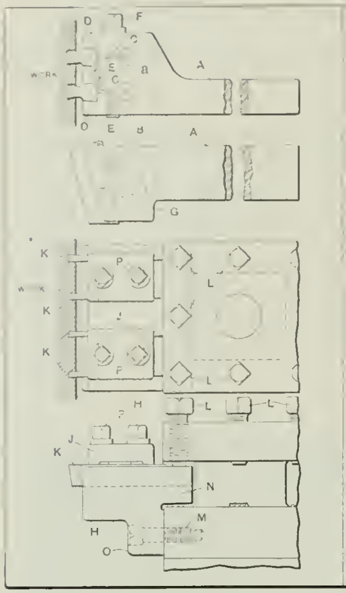

Fig. 3. Two Types of External Grooving Tools

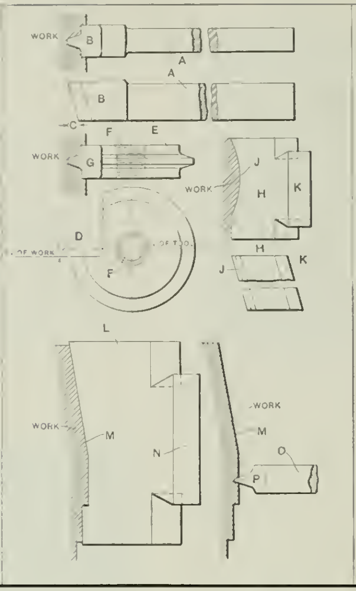

Fig. 4. Different Types of Forming Tools

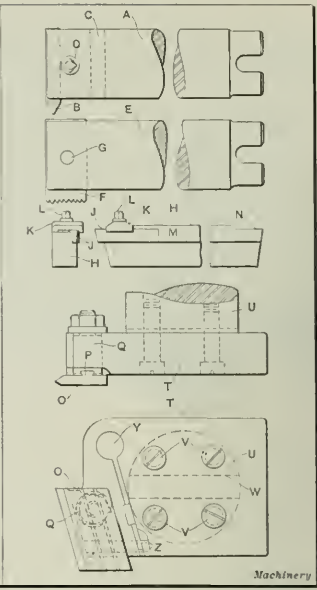

Fig. 5. Various Forms of Threading Tools

7. It should be remembered that "sledge-hammer" methods of adjustment are not conducive to accurate work. Backing-up screws should be provided wherever possible, so that fine adjustments can be made by means of the screws.

8. Generous sizes of stock should be used for cutters whenever possible, as heavier cuts can be taken with tools of large size and they radiate the heat more rapidly, so that the production is increased and the upkeep facilitated. It is obvious that finishing tools may be made much lighter than those used for roughing, as the cuts taken are correspondingly less.

9. Rigidity is an important point and must be carefully considered in regard to the tool itself, its overhang, and the method of holding it. Chatter is fatal to any kind of cutting tool.

10. The original cost of the tool is influenced by many factors. There are many instances when it is advisable to make two or more tools of the same kind, so that replacements may be quickly made in case of accident and so that the cost will be less for each tool than if made at different times.

Forged Tools and Similar Types

Although forged tools are the simplest of the many varieties of cutting tools, they are greatly abused at times in their application, and much unnecessary expense is incurred by designing them in such a way that re-forging is the only salvation after the tool has been ground a few times. Take, for instance, the forged tool *A* in Fig. 1, which has an offset *B* of ¾ inch and a length *C* of 6 inches. Tools of this general type are frequently used on both horizontal and vertical turret lathes. They are very useful at times on account of the facility with which they can be used to cut in either direction. The operation of re-forging tools of this type is simple and comparatively inexpensive. A substitute for this tool may be made as shown at *D*, this type being straight and set angularly in a special tool-block and secured by two screws *E*. The upkeep is thereby made much simpler, as straight stock is used. It may be argued that the cost of the special tool-block will more than offset the extra forging required on tool *A*, and this is true to a certain extent, but when multiple cutting tools are used, a special tool-block is necessary in any case, and it is no more trouble to make it this way than straight. For horizontal turret lathe work, facing and turning tools of this type are much used.

Tool *F* is another type frequently used for cutting an internal recess or groove as shown at *G*. The size is soon lost by re-grinding so that re-forging becomes necessary. In equipments designed for machining a large number of pieces an efficient substitute may be provided as shown by the bar *H*. The end of this bar is cut out in the form of a five-degree dovetail and a tool *J* made to fit it. The bar is split as far back as the drilled hole *K*, and screw *L* is used to draw it together, thus securely binding the tool in any desired position. Attention is called to the manner in which the bar is cut away at *Q* for chip clearance. Tools may be planed up in a strip, as shown at *N*, with a length *O* from twelve to twenty inches and afterward cut off in lengths to suit. The section *P* shows the shape of the strip before grinding. Very little grinding is necessary to produce the required shape. A decided advantage in the use of a bar and tools of this type is the ease with which cutters of various sizes may be made, and the cheapness of upkeep.

One of the most common types of tools is shown at *R*; this is generally spoken of as a parting or cutting-off tool. The life of a tool of this kind is longer than some of the others mentioned when used on small bar work or thin castings, because the cutting portion *S* is quite long and will stand a good deal of grinding before it becomes necessary to send the tool to the blacksmith shop. Another cutting-off tool is shown at *U* and consists of a strip of high-speed steel, ground to fit a special holder *T*. This holder is split at each end at *V*, and two screws *W* hold the tool in place. Considerable economy results from an arrangement of this kind, and the holder may be bought in various sizes. It is one of the products of the Pratt & Whitney Co., Hartford, Conn., and is protected by patents.

External Grooving Tools

External grooving tools may be required for wide or narrow grooving and may be spaced close together or several inches apart. They may be used in groups of from two to eight or ten, and may be all alike with equal spacing, or entirely different from each other. The writer has selected two designs to represent this type of tooling, both of these being shown in Fig 3. The one shown at *A* is designed to make two wide grooves on the exterior of a large cast-iron drum as indicated in the illustration. The tool-holder is of tool steel and has a shoulder at *G* which can be brought up against the tool-block, thus acting as a support and giving additional stiffness. Two holes are drilled at *B* and slots *C* are cut to permit a clamping action through screw *F*. Attention is called to the fact that the slots are not cut entirely through the holder, so that

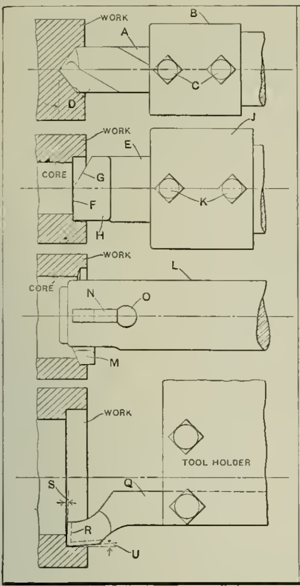

Fig. 6. Starting Tools of Different Kinds

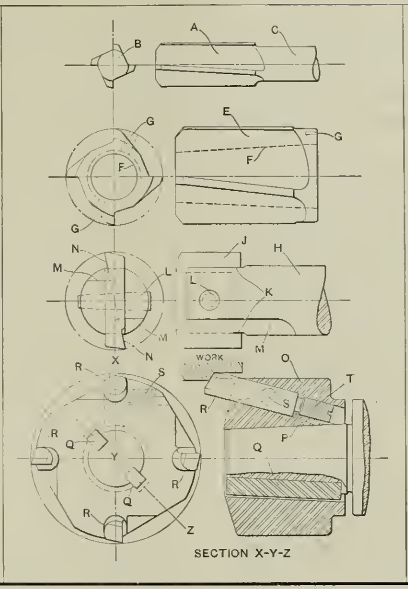

Fig. 7. Core Drills

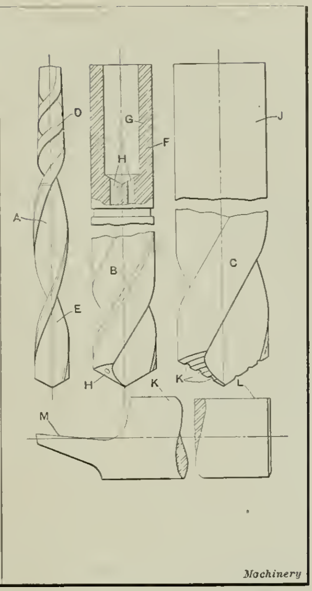

Fig. 8. Twist Drills and Drill for Brass

the lower part remains tied together. The tools *D* are of high-speed steel and are set in the holder at an angle of 15 degrees to give the necessary clearance. The screws *E* permit of easy adjustment. An arrangement of this kind is very economical as far as upkeep is concerned, as tools may be made up in a strip and replaced without trouble when necessary. No grinding is required except on the upper faces.

The lower portion of Fig. 3 shows a group of four narrow grooving tools *K* which are evenly spaced and secured in the block *H*. This block is designed for use in the side head of a Bullard vertical turret lathe. The portion *N* takes the position normally occupied by a forged tool and is secured by the same screws *L* that are ordinarily used to hold the tool. Additional strength is obtained by the extension *O* of the block and the screws *M* which are threaded into the side-head turret. The tools *K* are of high-speed steel and are ground flat on the sides to fit the slots in the block. The steel clamp-blocks *J*, with screws *P*, are used to hold the tools in place. The under side of the clamping block is relieved to gain a good bearing on the tools. Blocks and tools of similar arrangement will be found useful for many purposes, and the cost of upkeep is low.

Forming Tools

Tools which are so shaped as to produce forms of various kinds are more subject to changes caused by re-grinding than any of the other types. Take the example shown in the upper portion of Fig. 4, in which tool *A* is formed at *B* to cut an angular groove and recess. It will be seen that this tool must be re-ground on the face, and as there must be a slight side clearance to prevent rubbing on the side of the tool, changes in the width of the grooves will take place after the tool has been ground. In addition, there will also be changes in the angle of the groove unless the tool is shimmed up to bring the cutting edge on the center. For a very few pieces a tool of this kind can be used with satisfactory results, but if much work is to be done it is better to make a circular forming tool as shown at *E*. For turret lathe work a special toolpost for either the front or rear of the cut-off slide is used in connection with this type of forming tool. A screw in the tapped hole *F* is used to draw it back and hold it against the finished surface of the toolpost. In order to give proper clearance the cutting edge is offset at *D* an amount varying from 1/8 to 1/4 inch, depending on the machine and the size of the work.

For work of larger size, such as that shown at *J*, the dovetail type of tool may be used. Tools of this kind are planed or shaped to the desired form and are set in a special toolpost at an angle of 15 degrees to obtain the necessary clearance. The dovetailed portion fits the tool-holder at *K* and is clamped in position by dovetail hook-bolts. It can be raised or lowered to bring the cutting edge on the center. A form such as that shown can be readily shaped and held to size without trouble if a tool of this type is used. Another dovetail tool is shown at *L*, where the form *M* is to be produced. The dovetail portion *N* fits the toolpost as in the former case. There is a groove to be cut in the work in addition to the form generated by the dovetail tool, but it is not advisable to incorporate this in the same tool, as it might be blunted before the wider faces become dull, so that the whole tool would require re-grinding on this account, which would lessen its life to a great extent. The tool *O* is therefore made to take care of the groove *P*, and is used in the rear toolpost of the cut-off slide. In all cases of forming tools which have to be used for work of a similar kind, an arrangement of this kind is desirable.

Threading Tools

Tools used for cutting threads are of many kinds. A plain forged tool is frequently used, but its upkeep is expensive when many pieces are to be threaded. On small diameters requiring internal chased threads a forged tool is sometimes necessary on account of the size of the work, but when the work is sufficiently large to permit it, other methods are preferable. For vertical turret lathe work the bar shown at *A* in the upper part of Fig. 5 is furnished by the manufacturers for either outside or inside chasing. The end of the bar is drilled at *C* and a slot cut to provide a means of clamping tool *B* in any desired position through the screw *D*. The tool itself is dovetailed to fit a slot at the end of the bar. The cost of upkeep of a tool of this kind is very small.

The bar *E* may also be designed for use in the vertical turret lathe, but the tool *F*, in this instance, is threaded to the correct pitch for the thread to be cut. A slot in the end of the bar receives the tool, and it is secured in place by the taper pin *G*.

A very useful tool for square threads is shown at *H* and is one of the products of the Pratt & Whitney Co., Hartford, Conn. The holder is of steel and is designed for use in the engine lathe toolpost. The cutters *J* may be obtained for any pitch of thread, and are ground for side clearance. The cutters rest on the shelf *M* on the tool-holder and are clamped in place by means of strap *K* and screw *L*. An elongated hole in the strap permits adjustment for various widths of tools. Either right- or left-hand threads may be cut with the same holder by simply turning it end for end. If it becomes necessary to sharpen the tool during the progress of the cut, it may be removed from the holder and replaced without disturbing the setting. For high-grade work a roughing cutter of a size slightly smaller than the finishing tool can be used with excellent results. The cost of upkeep of a tool of this kind is very small.

A "goose-neck" holder for a lathe is frequently seen, but is seldom used for turret lathe work. The purpose of a goose-neck holder is to prevent chatter by permitting the tool to spring slightly away from the work. In Fig. 5 a special block of steel *T* is tongued at *W* to fit a slot in the end of the bar *U*, which enters a tool-holder on the turret. The block is secured in place by four screws *V*. The threading tool *O* is dovetailed at *P* to fit a corresponding slot in the block. This slot is planed at an angle to give the necessary clearance to the tool. A binder stud *Q* is dovetailed to fit, and is drawn back by the nut shown. The tool is ground across the upper face only and therefore no change in shape is caused by grinding. A hole *Y* is drilled and slot *Z* cut to allow for spring. A U-shaped spring is adjustable up and down in the slot to give more or less flexibility to the "goose-neck" portion.

Starting Tools

When a hole of any length is to be drilled in solid stock on a turret machine, it is best to use a short drill to start the hole, afterward following with the regular drill which completes the work. This short starting or spotting drill, being somewhat stiffer than a long one, starts a hole more nearly true and saves wear and tear on the more expensive twist drill. Fig. 6 shows a starting drill at *A* held in a tool-holder *B* by the two set-screws *C*, the shank of the holder being secured in the turret hole. The angle *D* on the end of the drill should be approximately 40 degrees, instead of 31 degrees which is the regular twist-drill angle. By grinding in this way, the lips of the following drill will start to cut before the point, thus giving them a chance to get well into the work before the point begins to guide.

In cast work, when a core drill is to be used, it is advisable to start the hole a trifle smaller than the core drill size with some sort of single-point tool, in order that the drill may start true and not be influenced by variations in the cored hole. There are several varieties of tools used for this purpose, one of these being shown at *E*. This is preferably made of high-speed steel, bright drawn if possible and is cut down to half its diameter at *F*. It is beveled at *G* and slightly back-tapered at *H*, for clearance. It is held in a regular turret tool-holder *J* by two set-screws *K*. A tool of this kind does not deteriorate rapidly.

A chamfering tool is often used prior to a boring-bar and answers the same purpose as the tool just referred to. A combination boring and reaming bar is made by the Bullard Machine Tool Co., Bridgeport, Conn., for use in the vertical turret lathe. A portion of this bar is shown at *L*. The chamfering cutter *M* is of rectangular section and fits a slot in the bar at right angles to the slot *N* which is used for the floating reaming cutters. Pin *O* is flatted to act as a bearing for the latter. All cutters for this bar are of the "slip" variety, and can be readily removed or replaced by the fingers. The cost of upkeep for an arrangement of this kind is small.

When the cored hole is of fairly large size, a forged tool may be used for starting, as shown at *Q*. A tool of this type should be back-tapered at *R* to an angle of 5 degrees and should also have a slight angle at *S*, so that it will not have a tendency to ride up on the scale of the cored hole. The tool is held in a regular tool-holder by set-screws. It should be so set that it will cut slightly smaller than the tool which is to follow it. It may be re-ground a number of times before re-forging becomes necessary.

Core Drills

A type of core drill much used for small work is shown in the upper part of Fig. 7 at *A*. The shank *C* is integral with the cutting portion. The end view *B* shows one method of milling the flutes. A milling cutter should be selected which has a slightly rounded corner so that the danger of hardening cracks will be lessened. The outside of the fluted portion should be back tapered from 0.006 to 0.010 inch per foot, in order to give the necessary clearance. Tools of this type are greatly abused in the average shop by improper grinding and by allowing them to become so dull that they cut in such a protesting manner as to be heard all over the factory. Frequently they are so re-ground that only one or two lips are cutting, thereby producing very unsatisfactory results. The shell drill shown at *E* is of the same general type, but it is made so that it fits a taper arbor at *F* and is driven by the slot *G* in the end, which engages with a tongue on the arbor.

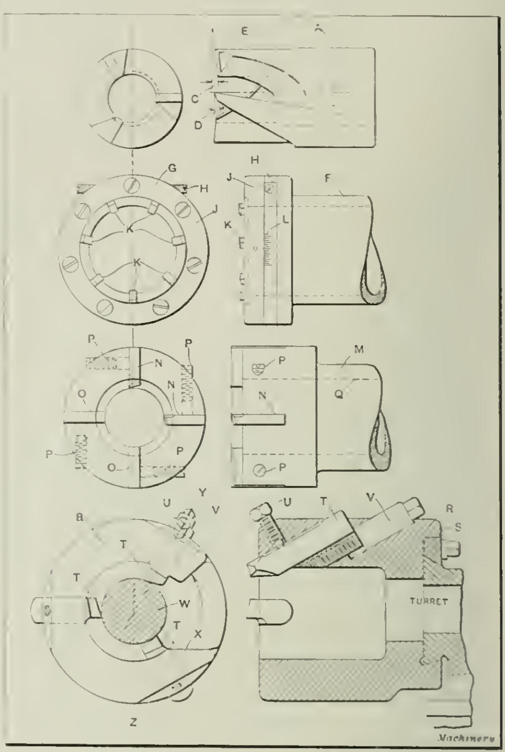

Fig. 9. Types of Hollow Mills

Another type of tool used for the same purpose is shown at *H*. The steel shank is slotted at the end to receive the flat cutter *J*, which is shouldered at *K* to fit the flatted portion of the bar by which it is centrally located. The cutter is held in place by taper pin *L*, and is ground at *N* to bring the cutting edges on the center, or a little ahead of the center which is preferable. The bar is milled out at *M* for chip clearance. The cutter is slightly back-tapered as on a core drill. Tools of this type are much cheaper than core drills and cost less in upkeep, but they will not cut as rapidly as the four-lip type, nor will they produce work as close to size.

The cutter-head shown at *O* is of steel, and was designed for rough-boring automobile cylinders. The action of this tool is much the same as that of a core drill, but replacements are much easier and cheaper. A special grinding arbor is necessary, however, so that the adjusting screws may be more accessible. The body is tapered at *P* to fit the regular arbor shown, and two keys *Q* are provided for driving. The four tools *R* are set angularly in the body, held in place by the screws *S*, and adjusted by screws *T*. The cutting lips *R* are 1/8 inch ahead of the center. The body of the tool is cut away as shown, for chip clearance.

Types of Drills

In the upkeep of drills a great deal depends upon the care used in grinding and the speeds and feeds used in their operation. The selection of the proper kind of drill to use for a particular job is also of great importance. The flat twisted drill shown at *A* in Fig. 8 is one of the products of the Pratt & Whitney Co., and is adapted for work requiring high speed and rapid production. The chip clearance on this type of drill is very generous, so that it is especially desirable for steel work. The portion *D* has an increased twist and is ground to fit a regular taper socket.

For deep-hole drilling in steel an oil drill such as that shown at *B* is useful. In this type of drill the shank *F* forms an oil pocket from which the two holes *H* lead to the drill lips. The cutting lubricant system of the machine is piped to the rear end of the drill and the lubricant is forced through the holes. This greatly assists in carrying away the heat generated and also forces the chips out along the flutes. It is sometimes necessary to speed up the pump in order to obtain sufficient pressure to force out the chips. The life of one of these drills is very long. They are one of the products of the Morse Twist Drill & Machine Co., New Bedford, Mass.

When drills are of large size, as shown at *C*, considerable power is required, and they may be made to cut to better advantage if stepped on the lips as shown at *K*. This breaks up the chips so that an easier cutting action is attained. Drills of special form, such as are used on gun barrel drilling machines, are stepped to break the chips in somewhat the same manner as that shown.

For brass or aluminum work a so-called "flat drill" is frequently used on account of the great amount of chip clearance obtained with this type. The cutting lip *M* is ahead of the center and has considerable rake. A flatted portion is milled on the shank *K* at *L*, so that the set-screws in the toolholder will bear at this point. Tools of this kind are not very expensive and their upkeep is not costly. They should be kept very sharp and the cutting edges should be stoned smooth to secure the best results.

Cutter-heads

Cutter-heads are not usually designed unless a large number of pieces is to be machined, as they are somewhat expensive and the cost is not warranted if small lots are to be manufactured. In turret lathe practice, when inside work is to be done on a machine having turret longitudinal feed only, a cutter-head may often be used to good advantage. A head designed for a condition of this kind is shown at *A* in Fig. 2. The inside of the rim is to be bored, the hub turned and the web faced. The body of the holder is made of cast iron and is dovetailed to fit the turret face, where it is secured by means of gib *K* and screws *J*. A series of holes is drilled in the face of the head for the tools *B*, *C*, *D*, etc., these being secured in place by screws *H*. The tools are so located in the face of the head that their cutting paths overlap each other slightly so that all of the surface is covered. Tool *B* bores the inside of the casting rim and faces a little of the web. Tool *C* faces part of the web and overlaps the cut produced by *B*. Tools *D*, *E*, *F* and *G* complete the remainder of the web facing and tool *G* also turns the hub. The action of this kind of tool is very satisfactory. Attention is called to the fact that the cutting faces of all the tools except *G* are ahead of the center so that they produce a scraping cut. Tool *G* has its cutting face on the center because it is used for turning and therefore should not be ahead of the center on account of its liability to "dig in."

The lower part of Fig. 2 shows another type of cutter-head that was designed for boring out and facing the inside of a cone pulley. Two heads were made for this work, one for roughing and one for finishing. The heads were identical except for the facing tools, which were "nicked" in the roughing head so that they would attack the scale better. The body of the head *M* is a steel casting cored out at *S* to reduce the weight and fastened down on the turret face by screws *Y* and *Z*. Additional stiffness is secured by permitting shoulder *U* to bear against the edge of the turret. In order to prevent chatter, the forward end is provided with a revolving toolsteel bushing *X* which is a running fit on a stem forced into the body of the tool. A hardened and ground thrust washer *W* is interposed between the bushing and the shoulder on the stem. The tools themselves are of flat high-speed steel, 5/8 inch thick, and are fastened in place by screws *R*. The screw holes are slotted to provide for adjustment. Tools *N* and *P*, although shown in the same plane as *O* and *Q*, are in reality set at right angles to them, so as to distribute the cut to better advantage. The facing tools *P* and *Q* are set slightly nearer the center than the boring tools *N* and *O* so that they do not cut until they reach the shoulder. Although this type of tool does not appear to be very economical as regards upkeep, it is really much better than it appears, as the tools are comparatively inexpensive. Both roughing and finishing tools are used, which is a decided advantage. There is also provision for considerable adjustment in the slotted holes.

Boring-bars

For small work it is obvious that the cutters in boring-bars cannot be of large size, as the size of the bar will not permit it, nor can much be done in the line of adjusting screws for the same reason. About all that can be done in a case of this kind is to make up a bar something like that shown at *A* in Fig. 10. This bar has a flatted portion at *B* so that it may be firmly held by set-screws in the tool-holder. Tool *C* is of round section, flatted on one side so that the pin *D*, one side of which is flat tapered, can be driven in to hold it in place. Tools of this kind are somewhat difficult to set for diameters, but in turret lathe work, when a machine having a cross-sliding turret is used, diameters may be easily regulated by this feature.

When the work is of a size large enough to permit it, a bar such as that shown at *E* will be found much better and more convenient than that at *A*. The tool *G* is of larger section and is provided with an adjusting screw at *H*. Two set-screws *J* bear against a flat on the tool and hold it firmly. It is now possible to buy high-speed steel of round section very close to size, so that no turning is required on the tool, and the cost of upkeep of a bar of this kind is therefore very small.

For work of still larger diameter the type of bar shown at *K* will be found of advantage. This bar is slotted at the forward end, slightly larger than the thickness of some easily procurable high-speed steel of rectangular section. In order to strengthen the end of the bar a filler block is fitted to the slot and is held in place by two screws *N*. The tool is held in any desired position by the two screws *O*. No adjustment is provided for the tool. The cost of upkeep is exceptionally low.

A very different type of bar is shown at *P*, this being provided with a pilot on the forward end which enters a bushing in the chuck. The bar is made of machine steel and is provided with hardened tool steel bushings *T* which are forced onto pilot *S*. This bar is designed both for boring the large hole and facing the shoulder *Y*, as well as boring the smaller hole which extends completely through the work. The tool *R* is set at an angle of 30 degrees and is held in place by screws *U*. Screw *V* is provided for fine adjustments. The tool *Q* is set into the bar at right angles to the center line in order to facilitate grinding. Backing-up screws and set-screws are provided at *X* and *W*. This bar is cheap as regards the cost of upkeep.

Counterbores and Kindred Tools

Fig. 11 shows at *A* a counterbore such as is regularly used for screw heads and work of a similar character. Counterbores of this type are made with three, four, five or six flutes, according to the work for which they are required, the most common being four flutes as shown at *B*. Pilots for this type of tool are frequently made removable so that special conditions can be readily met. Tools of this kind may be reground a number of times.

A useful tool for counterboring or cutting shoulders in larger work is shown at *E*. The body of this tool is made of machine steel and is tapered at *F* to some standard taper. Tool *H* is of high-speed steel and is held in position by screws *J*. The end of the holder is slotted at an angle and a filler block *G* is used to strengthen the end, being secured by a screw and dowel. Rectangular stock can be used in this holder and replacements are very easy. A holder of this kind may be used on the lathe, milling machine or turret lathe, as the occasion and conditions may demand.

A counterbore having a removable head and pilot bushing is illustrated at *K*. The stem *M* is of tool steel and is tapered at the rear end to a standard taper. Two keys are provided at *L* to drive the cutter-head, these keys being let in to an enlarged portion of the stem. The cutter-head *K* is shouldered at the rear end and cut out to receive the ends of the keys. The forward end of the stem is reduced in size and tapped out for screw *O* which holds the bushing *N* in place. In an arrangement of this sort a great number of combinations are possible, as heads and pilot bushings may be readily interchanged.

Another type of counterbore having interchangeable guides and heads is shown in the lower view. The construction of this tool is somewhat different from the one above. A holder *P* is slotted at *V* to act as a driver for the cutter-head. The pilot *Q* is reduced in size at *R* and fits hole *T* in the shank, where it is secured by the pointed screw *S*. An angular groove prevents it from turning. The cutter-head *U* is similar to that shown at *K*, and fits the stem *R* of the pilot. A tool of this type is manufactured by the Pratt & Whitney Co., Hartford, Conn., and may be bought in various sizes.

Hollow Mills

Hollow mills are generally used on bar stock for rapid removal of metal and are usually followed by a box-tool or a single-point turner of some sort. They are not intended for accurate work. Fig. 9 shows in the upper view an ordinary type of hollow mill such as is commonly used in screw machine work. This type of tool is well known. Angle *B* varies from 10 to 15 degrees; angle *C* from 3 to 7 degrees; and angle *D* from 8 to 15 degrees. The back clearance at *E* should be approximately 1/8 inch per foot, or a trifle more. The cutting edges should be on the center for brass, but a trifle ahead of the center for steel. Mills of this type are comparatively cheap. Re-grinding changes the size somewhat, but this may be offset to a certain extent by the use of a clamping ring which draws the cutting lips together. This is not shown in the illustration.

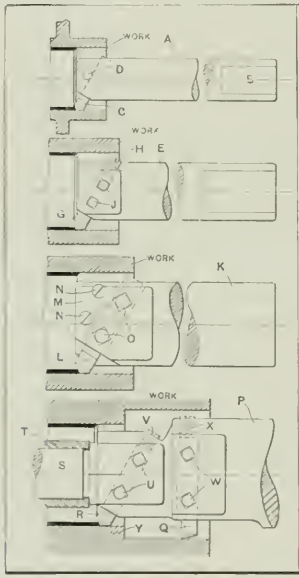

Fig. 10. Boring-bars of Different Types

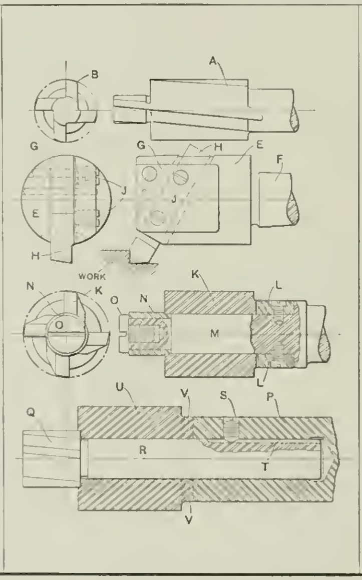

Fig. 11. Counterbores of Different Types

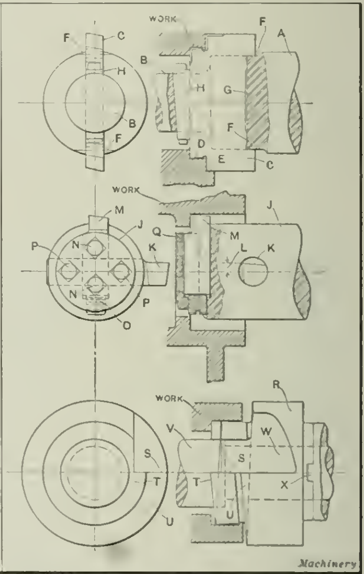

Fig. 12. Three Types of Shoulder Tools

Another form of hollow mill which possesses valuable features of adjustment is shown at *F*. This tool is made by the Geometric Tool Co., New Haven, Conn. It is not designed for heavy cutting, but is especially recommended for brass finishing and light cutting on other metals. It consists of three parts, a holder *F*, a plate *G*, and a cam which controls the cutters. The holder is slotted on the front end to receive the cutters *K*, plate *G* keeps these in place. The diameters are controlled by screw *H* which operates the cutters. An index is provided on the side by which readings to 0.010 inch may be obtained. A hardened plug is recommended for setting the cutters for various diameters.

Another type of adjustable hollow mill is shown at *M*. The body of this tool is made of machine steel and is slotted to receive the two cutters *N* and the back-rests *O*. Screws *P* bind both back-rests and cutters in place when set to the required diameter. The shank *M* fits the hole in the turret. This tool is not suited for heavy cutting, but is quite adaptable to various diameters, and the cutters may be replaced with ease.

The hollow mill shown in the lower part of Fig. 9 was designed for heavy reductions on bar stock in a horizontal turret lathe. The body *R* was made of cast iron and was fitted to the turret at its rear end and drawn up by the dovetailed gib *S*. There were three tools set 120 degrees apart and placed in the holder as shown at *T*. These tools were clamped by screws *U*, while adjustment was provided by backing-up screws *V*. This tool was followed by a single-point turning tool in order to hold the size within the required limits. An opening at the side of the tool was provided at *X* to allow the egress of chips. A plug gage was made to facilitate the setting of the tools and an angular gage for the end of the tools was also found necessary in order that all tools might remove an equal amount of stock. Under test this tool reduced two-inch bar stock to one inch diameter at a speed of 100 feet per minute and a feed of 0.040 inch per revolution.

Shoulder Tools

Great difficulty is sometimes experienced in turret lathe work in keeping shoulder distances uniform after the tools have once been ground. It is therefore advisable, whenever possible, to so design the tools that changes will not take place when they are re-ground. The desired result may sometimes be accomplished by the use of a grinding gage, but it is much better to so arrange the tool that no changes are possible. Several types of shoulder tools are shown in Fig. 12. The one at *A* is piloted with a stem *B* at the forward end in a chuck bushing. A double-ended cutter *C* of high-speed steel fits a slot in the bar and is located sideways on the two flats *F*. A wedge *H* holds the tool back against the rear end of the slot, and all tendency to rock is prevented by the relief at *G*. The faces of the two shoulders *D* and *E* are the important points on this piece of work, and a gage was found necessary in order to keep them uniform when grinding.

Another method of handling a somewhat similar condition is shown in the bar *J*. Two cutters of round section are inserted in the bar at right angles to each other as shown at *M* and *K*. The distance *L* is 3/16 inch, so that this tool would be ahead of the center and would therefore have a scraping action in facing the end of the hub. The tool *M* used for internal boring and for facing the shoulder is also slightly ahead of the center. The screws *N* hold the tool *M*, while those at *P* secure *K*. The heads of the two screws *N* project about one-half inch more beyond the end of the bar than the other two in order to facilitate the use of a wrench. Some difficulty is experienced in keeping the shoulder distances within the required limit.

A tool which is not affected by re-grinding as far as shoulder distances are concerned is shown at *R* in the lower portion of Fig. 12. In this particular instance, a pilot *V* was used and this extended back through the holder at *W* and acted as a clamp for the cutter-head, being drawn up against it by means of a nut and washer at the rear end of the holder, not shown in the illustration. The holder is provided with a driver at *X* which enters a slot at the rear of the tool proper. The tool *R* is of high-speed steel and is turned to the proper diameters and then given a slight back clearance of about 0.0015 inch to the inch to prevent rubbing. The two cutting faces *U* and *T* are faced with a flat tool on a right-hand spiral having a lead of ¼ inch to the foot. It will be seen that radial re-grinding may be easily accomplished at *S* without changing the shoulder distances. There is consequently no danger of variation.

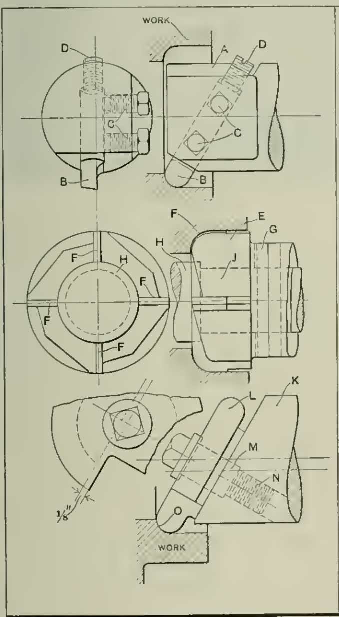

Fig. 13. Bottoming Tools

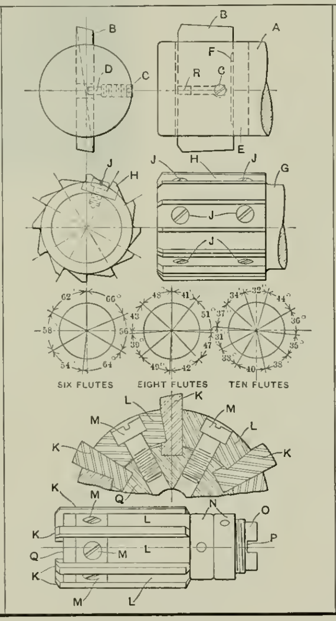

Fig. 14. Finishing Reamers

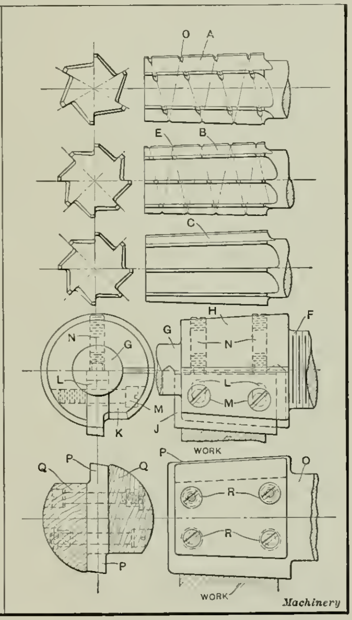

Fig. 15. Taper Reamers

Machinery

Bottoming Tools

In automobile construction, ball bearings are often used in the hubs, and the diameters and seats must be carefully machined. As it is not good practice to grind a reamer to a radius such as that shown in the upper portion of Fig. 13, it is necessary to provide some other tool for this work. A simple type is shown in the upper figure, this consisting of a bar *A* having a cutter of cylindrical section, formed at *B* to the proper radius. The cutter is held in place by two screws *C*, adjustment being provided by the backing-up screw *D*. The upkeep for a tool of this kind is expensive, especially if the work on which it is used is a steel casting. Sand spots and blow-holes in this class of material make frequent re-grinding necessary and considerable care must be used in re-setting in order to keep the work within the required limits of accuracy.

Another method of handling a piece of similar work is by means of a face mill having four cutting lips *F* formed to the radius of the seat. The mill *E* is relieved at the rear end and is driven by a flatted pin in the holder *G*. The pilot *H* enters a bushing in the chuck and is shouldered at *J* to assist in keeping the mill in position. The shank passes entirely through the holder and is secured at the rear end by a nut and washer. A tool of this type may be re-ground considerably without seriously changing the contour. A point worthy of note in the design of face mills which are hand-operated (as in turret lathe practice), is that the lips or cutting faces should be as few as is consistent with the work in question, especially if much surface is to be faced. Too many lips make it difficult to make the mill cut. The mill shown in the illustration was originally designed with eight cutting lips, but it was found that it was about all a man could do to force it to cut on account of the amount of surface to which the cutting edges were presented at once. Four of the lips were therefore ground away; this overcame the difficulty. The approximate diameter of this mill was 3½ inches; it was used on a horizontal turret lathe.

An arrangement for a bottoming tool that can be re-ground without changing its shape is shown in the lower illustration. A bar *K* is held in the turret and is beveled on the forward end to an angle of 30 degrees, and is counterbored and tapped off center, as shown at *M* and *N*, to receive a shouldered screw which holds the circular forming tool *L* in position. Attention is called to the fact that the center of this tool is ⅛ inch above the center of the work in order to provide the necessary clearance. It will be noted that the form *O* does not change its shape, because the tool is ground radially. The expense of making a tool of this kind is not excessive, nor is the cost of upkeep.

Straight Chucking Reamers

There are many varieties of adjustable reamers on the market, but very few can be adjusted to cut a certain size without the necessity of re-grinding. Re-grinding, however, is a small matter when compared with the cost of a new reamer. Probably the simplest type of reamer that will produce satisfactory work is that shown in the upper illustration of Fig. 14. The bar *A* fits the turret hole and is slotted at the forward end to receive the flat reamer cutter *B*. The back of this tool is relieved at *F* and bears against pin *E* which is of hardened steel, flattened on one side, and forced into the bar. The screw *C* has a teat *D* which fits loosely into a hole in the reamer cutter, so that a certain amount of "float" is permitted. A tapered cut in tool *B* runs into the hole which the teat screw enters, and a plug *R* may be forced down to open up the blade, thus permitting a number of re-grindings. A reamer of this sort, when used on a horizontal turret lathe, should be turned so that the blade stands vertical in order to minimize errors in the indexing of the turret. It should be lightly guided by the fingers in entering the hole.

The type of reamer shown at *G* is non-adjustable, except if re-ground. In this type of reamer shank *G* is held at the rear end in a floating holder. The forward end is milled out so that a number of blades as shown at *H* may be inserted in the slots and fastened by screws *J*. In milling a reamer of this kind, the blades are inserted and the cutting done on body and blade together. The blades are then taken out and hardened, after which they are assembled and ground in position, both cylindrically and along the faces of the flutes. When a reamer of this kind becomes worn, the blades may be removed and "papered up," and then re-ground. The cost of upkeep on this type of reamer is small.

Occasionally it is desirable to space flutes unequally in order to obviate chatter. It is contended by some that unequal spacing on one half of the reamer answers every purpose and that it only causes extra trouble to space every flute differently; in other words, in an even-fluted reamer the teeth may be opposite each other, thus facilitating calipering; this is, however, doubtful. Unequal spacing for six-, eight- and ten-flute reamers is given in the diagram, and other spacings may be readily determined.

The expansion type of reamer shown in the lower portion of Fig. 14 is made by the Pratt & Whitney Co., Hartford, Conn. A body *Q* fits a taper arbor and is driven by the slot *P* which engages with a pin in the arbor. The blades *K* fit the tapered slots shown in the sectional view. The clamps *L* are drawn down to lock the blades securely by means of the screws *M*. The blades may be set for various diameters within their capacity by means of the two check-nuts *N*. This type of reamer is exceptionally good for turret lathe work.

Taper Reamers

Taper reamers should always be made considerably longer than the hole which they are to ream in order to provide for long life. In rough-cored taper holes a starting tool or boring-bar should first be used in order to start a true hole, so that the roughing taper reamer may not be influenced by the irregularities of the core. The series of reamers *A*, *B* and *C* shown in Fig. 15 are used for roughing, rough-finishing and final finishing; *A* has six flutes and a series of notches as shown at *D* in order to break the chips and make cutting easier; reamer *B* has eight flutes and also a right-hand thread or groove *E*; the finishing reamer *C* also has eight flutes and may or may not have a groove like that at *E*. If the lead of this groove is not sufficiently great, a series of steps will appear in the finished work. If the taper is very shallow, it may be found necessary to mill the flutes left-hand in order to prevent "drawing-in" and chatter.

A taper scraping tool having a single blade capable of considerable adjustment is shown at *H*. A tool of this type is preferably piloted at *G* in a bushing in the chuck while the rear end is secured firmly in the turret hole. A slot is cut in the body in which the blade *J* is clamped by means of the two screws *M*. These screws pass through the slotted holes *L*, thereby permitting radial adjustment. Two backing-up adjusting screws *N* bear against the back of the blade. The body is cut away at *K* to provide for chip clearance. Shank *F* may or may not be threaded for a collar so as to provide a longitudinal stop. This reamer should be held in such a way that the blade will stand vertically when used in horizontal turret lathe work This tool has given excellent results.

A cheap taper reamer with which good work can be done is shown at *P* in the lower portion of Fig. 15. The blade *P* is flat and is formed to the desired taper. The portion *O* is permitted to float in a slotted holder driven by a pin. The two pieces *Q* are of maple or some other wood equally good, and are formed to the correct taper, so that they follow the blade and prevent chatter They are fastened in place by the four screws *R* which pass completely through the blade and enter bushings on the opposite side

TOOLPOST FOR HEAVY LATHE WORK

The halftone and line illustrations, Figs. 1 and 2, show a tool designed by Archer Thompson, efficiency engineer at the American Engineering Co.'s plant in Philadelphia, for heavy lathe work. The design of the toolpost provides a solid, rigid support for the cutting tool and enables smaller sections of tool steel to be used more efficiently than is possible with the ordinary type. It thus effects a saving of investment in tool steel and reduces the waste of steel in the shank of the tool to a minimum. With the ordinary toolpost, the length required of a new tool was 10 inches and the dimensions of the stock, ¾ by 1½ inch. With the Thompson style of tool support, it is possible to use tools only 4 inches long, made from stock 1 inch square.

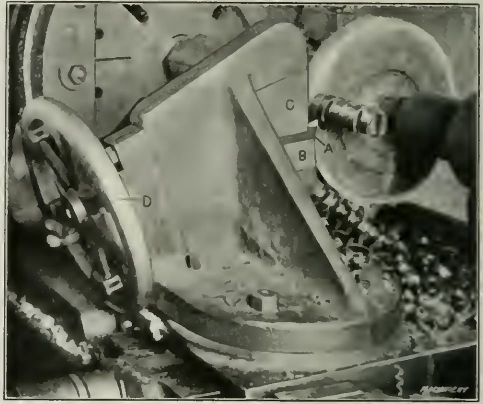

Fig. 1. Special Toolpost designed for Heavy Cutting

Referring to the illustrations for detailed construction, it will be seen that the tool *A* is held between the two sections *B* and *C*, both of which are channeled to receive the 1-inch square tool. The lower part *B* is integral with the base of the toolpost, but the upper part *C* is in the form of a wedge that can be drawn backward toward the operator by the handwheel *D*, this movement causing *C* to clamp the tool *A* firmly in place. In order to provide for tools that have been reground and which are consequently shorter than the standard length, an adjusting screw *E* is used to make up the required length.

The toolpost is secured to the carriage of the lathe by four bolts that may be seen in Fig. 1. This illustration also shows the heavy web provided in the casting to stiffen the toolpost laterally. Notwithstanding the strength and rigidity of the construction, the design is such that the tool and its support can be used effectively in narrow places such as when turning the crank-pins of crankshafts, etc. It is virtually equivalent in this respect to an overhanging tool, minus the overhang.

C. L. L.

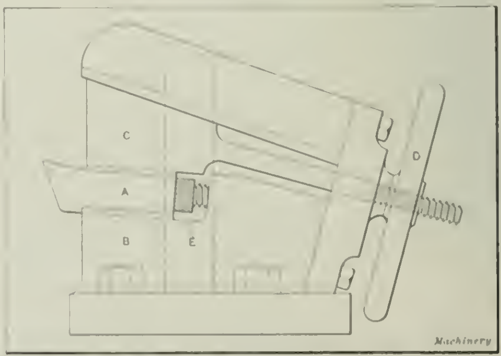

Fig. 2. Construction of Toolpost shown in Fig. 1

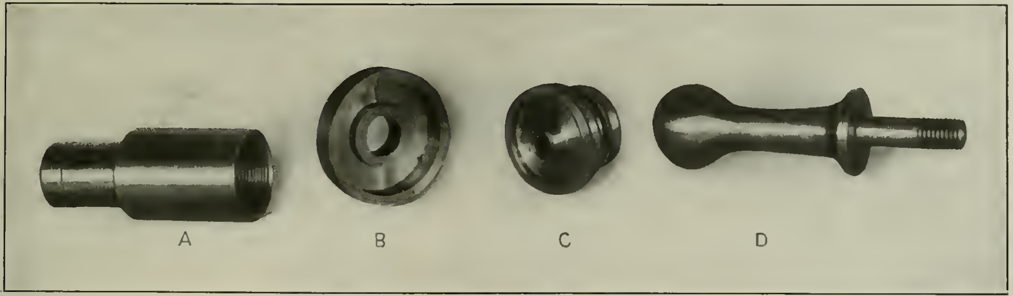

Fig. 1. Examples of Work produced on Model A Cleveland Automatic

EXAMPLES OF SCREW MACHINE SET-UPS*

ARRANGEMENT OF TOOLS AND OPERATIONS FOR PRODUCING VARIOUS PARTS ON THE CLEVELAND AUTOMATIC SCREW MACHINE

BY DOUGLAS T. HAMILTON†

ONE of the first points to consider in operating the Cleveland automatic screw machine is the best method of arranging the tools in the turret and on the cross-slide; it is also necessary to take into consideration any peculiarities in the shape of the work, and decide whether the job can best be handled by standard tools or turned out more quickly and efficiently by designing special tools. If large quantity production is to be provided for, it is sometimes advisable to design special tools, as is necessary in all classes of machinery. For small quantity and large variety, the standard tools are adaptable. These various points should be taken into consideration by the operator before starting to lay out a set of tools for producing any given piece of work. In the following article, four typical jobs are taken as examples, and the various points in connection with these are illustrated and described.

Example 1

We will take for our first example the special chrome-nickel steel sleeve shown at *A* in Figs. 1 and 3. The requirements for this part are comparatively simple, *viz.*, drilling, long forming, producing a body concentric with the bore, and recessing. It will be seen that there is nothing unusual about this job, so no special equipment is required. A 3¼-inch model A automatic screw machine with a No. 4 spindle drive is used. As shown in Fig. 2, the operations would then take the following order:

First, gage stock to length by a gage stop *A* in the first hole in the turret.

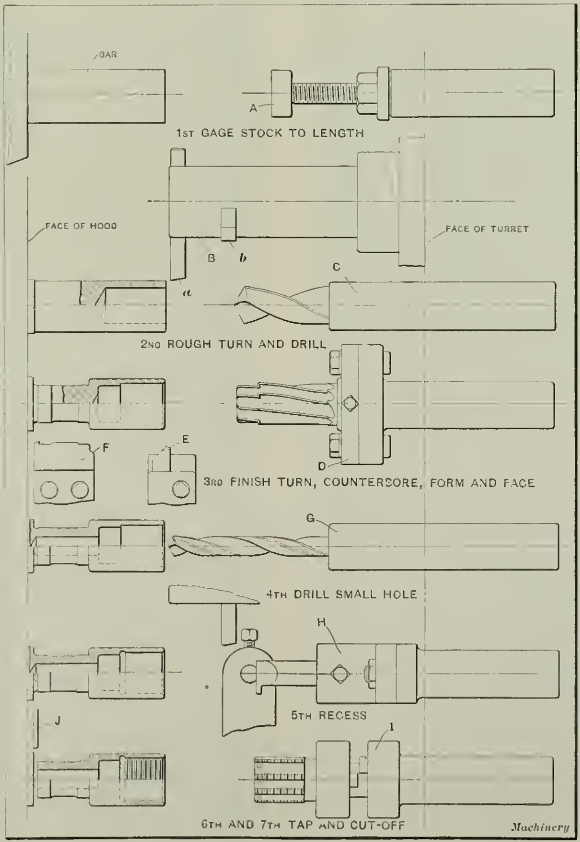

Fig. 2. Tool Set-up and Operations for making a Chrome-nickel Steel Sleeve on a Model A Cleveland Automatic

Second, index turret and rough-turn large diameter with cutter *a*, using an overhanging turning attachment *B*, and at the same time drill large hole full depth, using drill and split holder *C* in second hole in turret; time of operations, 3 minutes and 35 seconds.

Third, index turret and finish-turn large diameter with second cutter *b* held in turning attachment, and at the same time counterbore large hole, using counterbore and holder *D* held in third hole in turret. As no tools are in the way on the front side, forming tools *E* and *F* can be brought into operation to face the end and to form the rear diameters, using flat forming tools and toolpost and an open-side toolpost on the front of the cross-slide. The time for these operations is 4 minutes and 30 seconds.

Fourth, index turret and drill small hole, using drill and split holder *G* in the fourth hole in the turret. Time of operation is 2 minutes and 15 seconds.

Fifth, index turret, recess, using a recessing tool and holder *H* in the fifth hole in the turret. The operating cam for effecting a movement of the recessing tool is held on the front of the cross-slide. Time of operation is 1 minute, 25 seconds.

Sixth, index turret and bring tap-holder *I* and tap held in sixth hole, into operation. The time for threading this piece is 1 minute and 45 seconds.

Seventh, cut off, using cut-off blade *J* held in a universal cut-off toolpost on the rear of the cross-slide. Time for operation is 1 minute and 30 seconds. Total time for the entire operations enumerated, including the idle motion of the machine, is 15 minutes.

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* For previous articles on Cleveland automatic screw machine practice, see "Operating Automatic Screw Machines," October, 1914, and articles there referred to.

† Associate Editor of MACHINERY.

When the tools have been set in their proper relation to each other, and the feed-regulating cams have been so adjusted as to give the proper feeds for the various tools, the position of the various cams is noted and recorded on a chart, a copy of which is shown in Fig. 4. All the tools are recorded on this chart, so that when an operator comes to set the same piece up again he can refer immediately to the tools that were used and can set them in the positions in which they were found to give the best results. This makes the second setting-up very simple.

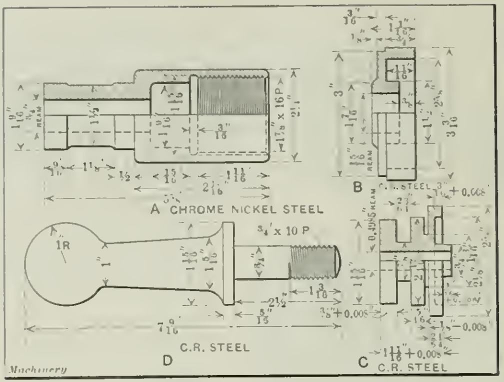


Fig. 3. Parts shown in Fig. 1, dimensioned

Example 2

Another comparatively simple piece of work to produce on the Cleveland automatic is shown at *B* in Figs. 1 and 3. This job can be handled best as shown in Fig. 9 on a 3¼-inch model A machine, using the No. 1 drive:

First, feed stock to stop *A*, which is held in first hole in turret.

Second, index turret and drill hole full depth, using drill holder *B* in the second hole in the turret. Time for operation, 50 seconds.

Third, index turret and finish-turn outside diameter with overhanging turning attachment *D*, carrying two cutting tools—tool *a* for roughing and tool *b* for finish-turning. At the same time counterbore hole, using a counterbore held in holder *E* in the third hole in the turret, and form and face with tools *F* and *G* which are held on the front part of the cross-slide, using a post with flat cutters and spacing blocks to set them the correct distance apart. Time for the operation, 3 minutes and 55 seconds.

Fourth, index turret and finish-turn with second cutter *b* in overhanging turning attachment *D*, and ream hole, using a reamer and floating holder *H* carried in the fourth hole in the turret. The time for these two operations is 18 seconds.

Fifth, index turret and cut off with a universal cut-off tool blade *I* and post held on the rear of the cross-slide. Time, 32 seconds. The total time, including the idle motions for chucking, advancing and withdrawing the turret and indexing, is 5 minutes and 35 seconds.

The arrangement of the forming and cutting-off tools is shown in Fig. 6. All the data obtained from the setting-up of this job is recorded on the operation sheet shown in Fig. 5, as well as any particular features necessary to turn this job out more effectively. All the tools and attachments are

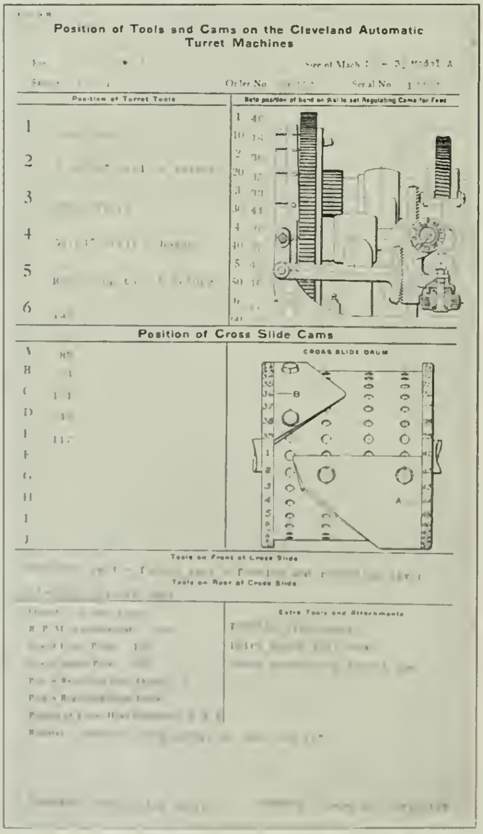

Position of Tools and Cams on the Cleveland Automatic Turret Machines
Position of Turret Tools
Note position of hand on dial to set Regulating Cams for Feed
1
2
3
4
5
6
Position of Cross Slide Cams
CROSS SLIDE DRUM
A
B
C
D
E
F
G
H
I
J
Tools on Front of Cross Slide
Tools on Rear of Cross Slide
Extra Tools and Attachments
R. P. M.

Fig. 4. Chart indicating Position of Tools and Cams on the Cleveland Automatic for making the Part shown at A in Fig. 1

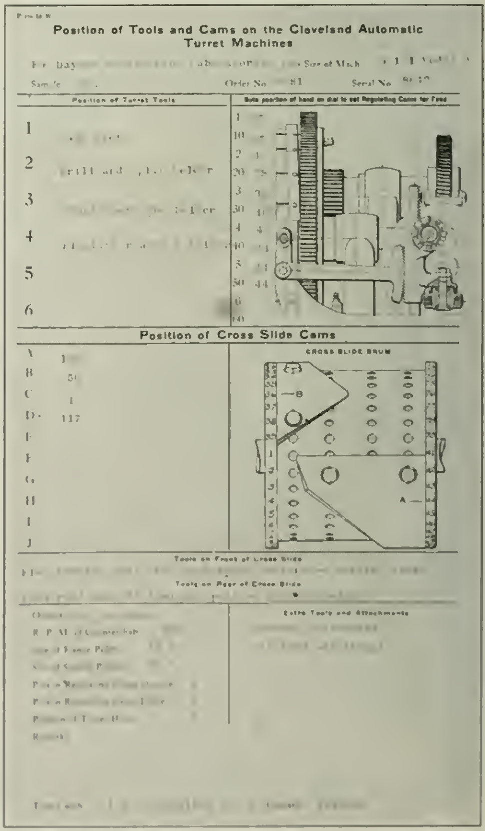

Position of Tools and Cams on the Cleveland Automatic Turret Machines
Position of Turret Tools
Note position of hand on dial to set Regulating Cams for Feed
1
2
3
4
5
6
Position of Cross Slide Cams
CROSS SLIDE DRUM
A
B
C
D
E
F
G
H
I
J
Tools on Front of Cross Slide
Tools on Rear of Cross Slide
Extra Tools and Attachments
R. P. M.

Fig. 5. Diagram showing Position of Tools and Cams on the Cleveland Automatic for making the Clutch Case shown at B in Fig. 1

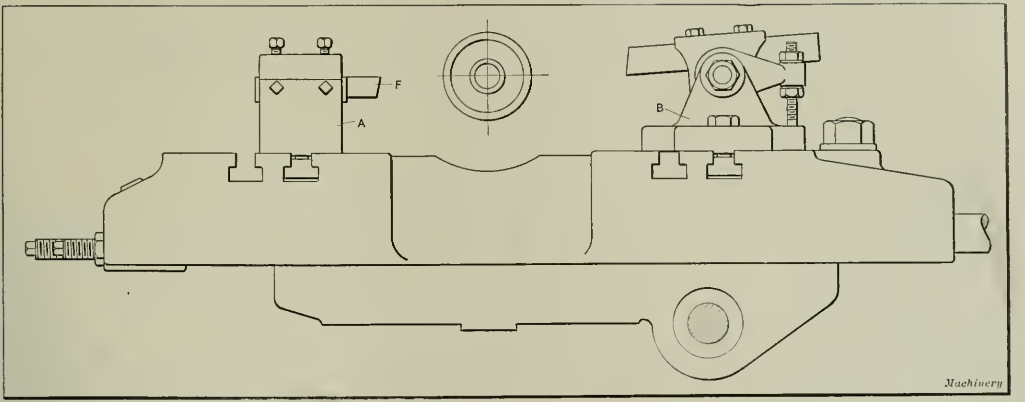


Fig. 6. Diagram showing Arrangement of Cross-slide Tools for forming and cutting off Piece shown at B in Fig. 1

noted under the various headings on the sheet, as well as the size of the pulleys, number of pins in the regulating drum, and other points regarding the proper setting-up of the machine.

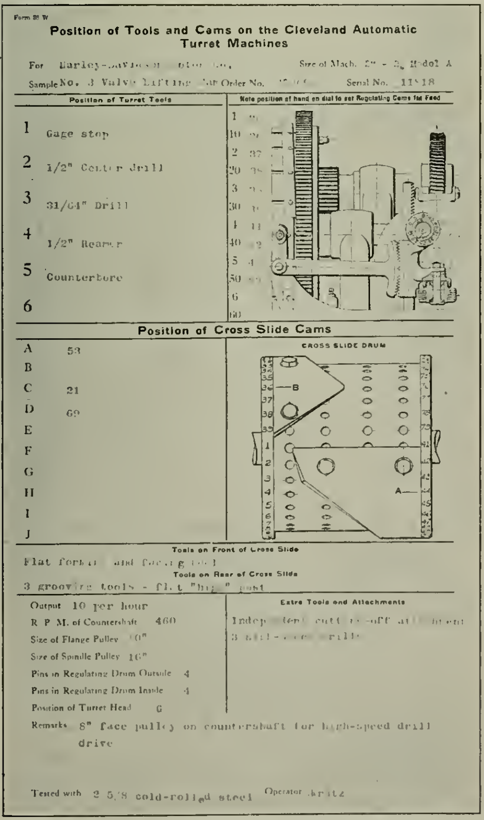
Example 3

Referring to the twin gear blank shown at *C* in Figs. 1 and 3, it will be noted that the greatest amount of work on this piece is to be done from the cross-slide; also that the drilling depth is considerable, so that the best way to lay out this job would be to use two drills, one going in part way and the other the remainder of the distance. Referring to Fig. 10, which shows the set-up for this job, the operations take the following order on a 3¼-inch model A machine with a No. 1 drive.

First, gage stock to length by stop *A* held in the first hole in the turret.

Second, index turret and turn part way with tool *a* in overhanging turning attachment *B* carrying two turning tools, and drill part way, using high-speed drill held in holder *C* in second hole in turret. Time for the two operations, 40 seconds.

Third, index turret and finish-turn, using second cutter *b* in overhanging turning attachment *B*, and drill full depth, using a high-speed drill-holder *D* held in the third hole in the



Form 58 W

Position of Tools and Cams on the Cleveland Automatic Turret Machines

For Harley-Davidson Motor Co. Size of Mach. 2" - 3¼ Model A

Sample No. 3 Valve Lifting Car Order No. [illegible] Serial No. 11818

Position of Turret Tools

1 Gage stop

2 1/2" Center Drill

3 31/64" Drill

4 1/2" Reamer

5 Counterbore

6

Note position of hand on dial to set Regulating Cams for Feed

Position of Cross Slide Cams

A 53

B

C 21

D 69

E

F

G

H

I

J

Tools on Front of Cross Slide

Flat forming and facing tool

Tools on Rear of Cross Slide

3 grooving tools - flat "high" post

Output 10 per hour

R. P. M. of Countershaft 460

Size of Flange Pulley 10"

Size of Spindle Pulley 16"

Pins in Regulating Drum Outside 4

Pins in Regulating Drum Inside 4

Position of Turret Head G

Extra Tools and Attachments

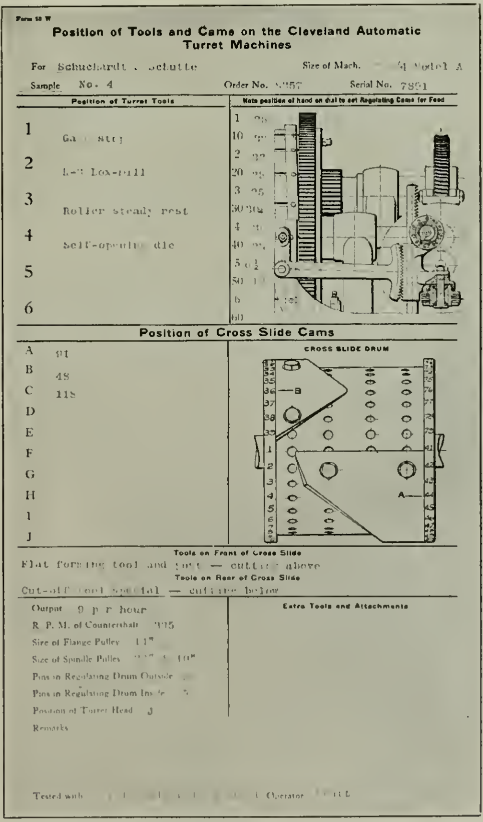
Independent cutting-off attachment

3 high-speed drills

Remarks 8" face pulley on countershaft for high-speed drill drive

Tested with 2 5/8 cold-rolled steel Operator [illegible]

Fig. 7. Diagram showing Position of Tools and Cams on the Cleveland Automatic for producing the Part shown at C in Fig. 1



Form 58 W

Position of Tools and Cams on the Cleveland Automatic Turret Machines

For Schuchardt & Schutte Size of Mach. [illegible] Model A

Sample No. 4 Order No. [illegible] Serial No. 7891

Position of Turret Tools

1 Gage stop

2 [illegible] Box-mill

3 Roller steady rest

4 Self-opening die

5

6

Note position of hand on dial to set Regulating Cams for Feed

Position of Cross Slide Cams

A 91

B 48

C 118

D

E

F

G

H

I

J

CROSS SLIDE DRUM
B
A

Tools on Front of Cross Slide

Flat forming tool and [illegible] — cutting above

Tools on Rear of Cross Slide

Cut-off tool special — cutting below

Output 9 per hour

R. P. M. of Countershaft [illegible]

Size of Flange Pulley 11"

Size of Spindle Pulley [illegible] 10"

Pins in Regulating Drum Outside [illegible]

Pins in Regulating Drum Inside [illegible]

Position of Turret Head J

Extra Tools and Attachments

Remarks

Tested with [illegible] Operator [illegible]

Fig. 8. Diagram showing Position of Tools and Cams on the Cleveland Automatic for producing Part D in Fig. 1

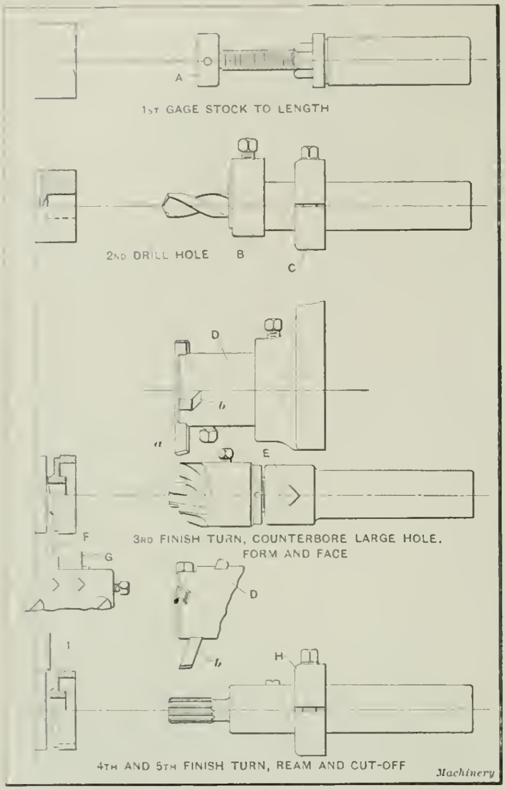

A
1st GAGE STOCK TO LENGTH
2nd DRILL HOLE
B
C
D
a
b
E
F
3rd FINISH TURN, COUNTERBORE LARGE HOLE, FORM AND FACE
G
D
b
I
H
4th AND 5th FINISH TURN, REAM AND CUT-OFF
Machinery

Fig. 9. Tool Set-up for making a Clutch Case on a Model A $3\frac{1}{4}$-inch Cleveland Automatic

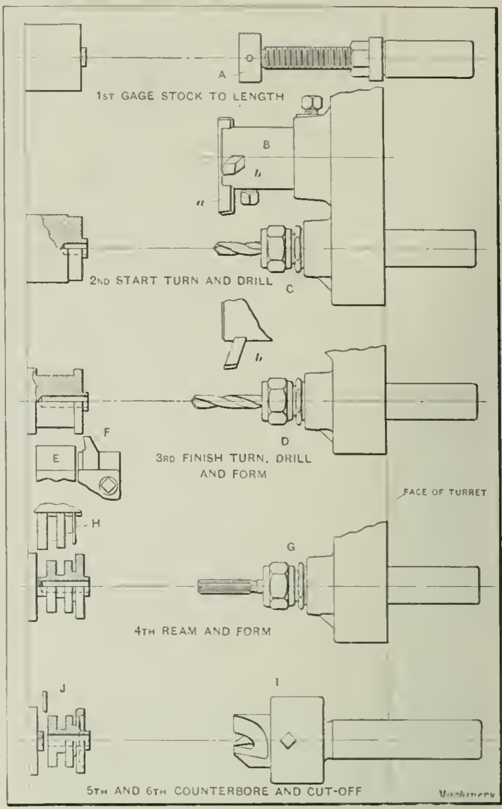


Fig. 10. Tooling Set-up for producing the Twin Gear Blank shown at C in Fig. 1

turret. At the same time advance tools *E* and *F* held on the front of the cross-slide and start forming the rear diameters. Also take cut on front face, using flat forming tool *F* and open-side toolpost on front of cross-slide. Time for operations, 1 minute and 55 seconds.

Fourth, index turret and ream hole, using a reamer held in a high-speed drill-holder *G* in the fourth hole in the turret. The use of two drills on a hole of this depth avoids the necessity of using a boring tool, and the reamer in this case can be held in a rigid instead of a floating holder. At the same time that the reaming operation is being accomplished, three cutting blades *H*, held on the rear of the cross-slide and separated by flat spacing blocks, are brought into action. The grooving blade nearest the chuck is made considerably wider than the requirements of the work demand and is used for roughing the front end of the next piece. Time for operations, 3 minutes, 40 seconds.

Fifth, index turret, and counterbore with tool held in holder *I* in fifth hole of turret. Time for operation, 1 minute.

Sixth, cut off with blade *J*, using independent cut-off attachment shown in Fig. 11, and index turret twice. Time for operation, 35 seconds. Total time, 7 minutes and 50 seconds.

This is an example where there was considerable forming to be done from the cross-slide, which could not be handled efficiently with only one set of tools, that is, using only one end of the cross-slide for forming tools. Consequently, both ends of the cross-slide, as shown in Fig. 11, are utilized and the work is then cut off by the independent cut-off attachment shown. The operation of this attachment was described in a previous article and therefore needs little mention here. A special cam disk *A* is held on the rear shaft carrying a cam *B*. This is adjustably mounted in the T-slot groove cut in the side of the disk and can be set in any desired position. This cam comes in contact with a

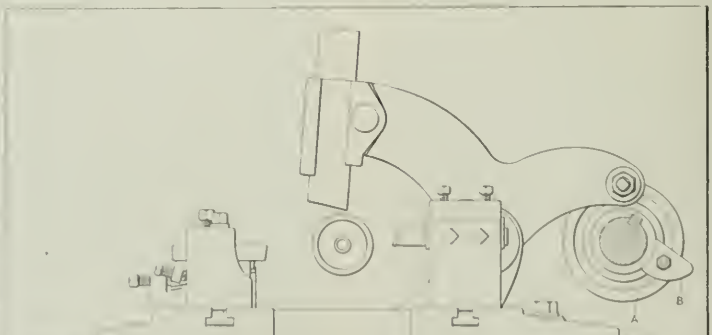


Fig. 11. Arrangement of Cross-slide Tools for the Forming and Cutting-off Operations on the Part shown at C in Fig. 1

roll carried in the rear end of the fulcrumed arm of the attachment, raising it up and consequently depressing the front end and advancing the cutting-off tool toward the center of the work.

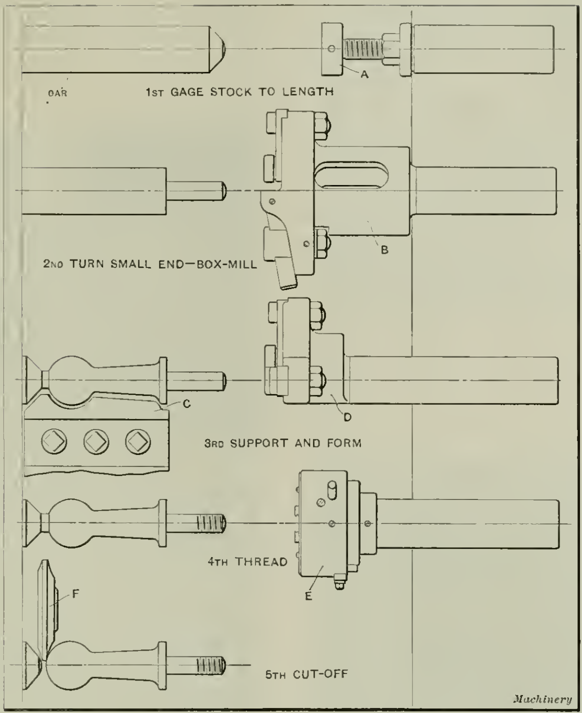


Fig. 12. Tool Set-up for producing the Stanchion Bolt shown at D in Fig. 1

Referring to the set-up chart shown in Fig. 7, it will be seen that all the tools, positions of the cams, etc., have been recorded on this sheet. It will also be noted that an 8-inch pulley is used on the countershaft for driving the high-speed drill. This is a special attachment held in the turret which was described in a previous article. Notation is also made of the independent cutting-off tool attachment, and also three high-speed drill holders. The information given concerning setting the cutting-off tool "high" should be noted, because in this case the work is not reversed, no threading operation taking place, so that the tools on the rear of the slide, instead of being set "low" are set "high" and cut with the stock rotating in the forward direction.

Example 4

The stanchion bolt *D*, Figs. 1 and 3, brings up a point in the operation of the Cleveland automatic that is worthy of special attention; that is, the handling of long forming operations, especially on steel parts. This can be done much more efficiently by means of a long flat forming tool than by a circular forming tool. There are two reasons for this: First, the flat forming tool gives much better side clearance than the circular tool; second, the flat forming tool can be held much more rigidly and heavier cuts can be taken with it. It is also much cheaper to make. The only other point of interest about this job is the use of a self-opening die-holder. The use of this type of die cuts down the time necessary for threading, as the die does not need to be backed off but is opened as soon as the thread is completed, and the turret can be drawn back on the fast speed.

Referring to Fig. 12, it will be seen that the operations are handled in the following order, a 2¾-inch model A No. 1 spindle drive machine being used:

First, gage stock to length with gage stop *A* held in first hole in turret.

Second, index turret and turn down stem with No. K-3 box-tool *B* held in second hole in turret. Time for this operation, 1 minute and 30 seconds.

Third, index turret and form irregular shape, using flat forming tool *C* held on front of cross-slide, and supporting work at same time with a roller steadyrest *D* held in third hole in turret, running on the stem of the work. Time for this operation is 3 minutes and 20 seconds.

Fourth, index turret and thread, using a self-opening die-head *E* in fifth hole in turret. Time for operation is 35 seconds.

Fifth, cut off, using circular cut-off tool *F* held on rear of cross-slide. Time, 45 seconds.

Total time, including all the idle movements, 6 minutes and 15 seconds.

The arrangement of the tools held on the cross-slide is clearly indicated in Fig. 13. Referring to this illustration, it will be seen that the flat forming tool *C* is mounted on a wedge *A* for vertical adjustment. The forming tool is held down by the cap-screws and the wedge is adjusted by a set-screw *D*. Another set-screw *E* backs up the forming tool, supporting it much more rigidly. The cut-off tool is held on the rear forming slide and is turned upside down so that the spindle need not be reversed, the cutting off being done with the stock running in the forward direction.

The tool set-up shown in Fig. 8 gives all the particulars regarding this job that would be needed by the operator when setting it up for a second time. While these examples that have been chosen are comparatively simple as regards tooling equipment they nevertheless illustrate points in the operation of the Cleveland automatic screw machine that are worthy of note.

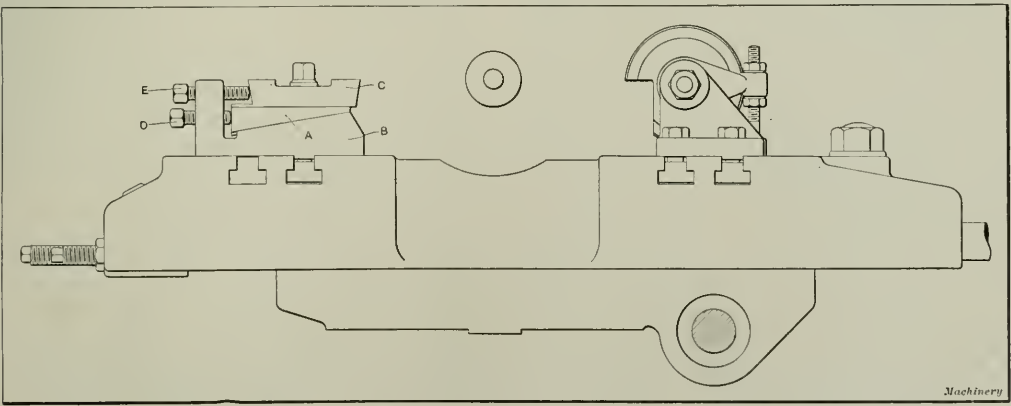


Fig. 13. Arrangement of Cross-slide Forming and Cutting-off Tools used in connection with the Tooling Set-up shown in Fig. 12

RING WHEELS AND SOLID WHEELS FOR DISK GRINDING

NOTES ON ECONOMICAL METHODS OF MACHINING PARTS WITH DISK GRINDERS

BY A. J. MATHISON*

With the advent of the modern disk grinding machine and the greater efficiency of the artificial abrasives such as carborundum and alundum as compared with emery, the use of ring and disk wheels is supplanting the shaper and milling machine for many classes of work, and is reducing the cost of production from 50 to 90 per cent. The abrasive cloth disks have proved the economy of disk grinding as far as the time required for finishing a piece of work by grinding, as compared to milling or shaping, is concerned; but their wider application for finishing work on the disk grinder has been retarded because of the high cost of the abrasive cloth disks, due to the cloth, glue, emery and labor that enter into their manufacture. The experience of the past two years has proved conclusively that the solid ring and disk wheels can successfully take the place of cloth disks for all classes of work except, perhaps, the use of the finer grained disks from No. 46 up; and each year will see the fine grained solid wheels doing more of this work, until the general use of cloth disks will not be considered practical.

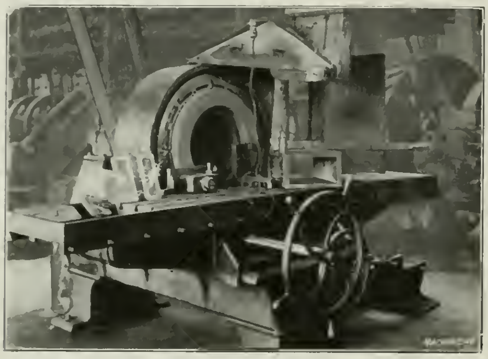


Fig. 1. Work for which Ring Wheel with a 3- or 4-inch Face is well suited

The ring wheel must not be confused with a wide faced solid wheel, because a ring wheel is one that has a working face of from 1 to 4 inches, and all work ground on these wheels must be securely fastened in a jig or fixture when passed across the face of the wheel, whereas "floating" or applying the work free-hand to the face of the wheel is the method employed when a wide-faced wheel or disk is used. The wider faced ring wheels with a working face of from 3 to 4 inches or more are well adapted for much work that is now being ground on the so-called "edge" or surface grinders which are usually supplied with a wheel having a 2-inch working face. Such a piece of work is shown in Fig. 1.

The larger sizes of single-head disk grinding machines fitted with 18- or 20-inch ring wheels mounted in "Perfection" chucks and having a geared lever feed table are preferable to the 24-inch edge grinder for handling small or medium sizes of work. The disk grinding machines are well designed and the table traverse on machines equipped with the swinging lever table is easily operated. The ways of the table are dust-proof and have no lost motion, so that good work can be obtained. When used dry, the ways of edge grinders wear out because they are not dust-proof. It is hard work to operate the table by hand if the ways are fitted close, and with the lost motion which exists when the table runs loose on the ways, satisfactory results cannot reasonably be expected. In the writer's opinion, only automatic edge grinders equipped with water attachments which prevent the dust collecting on the ways, and with power traverse and close adjustment of the ways should be used.

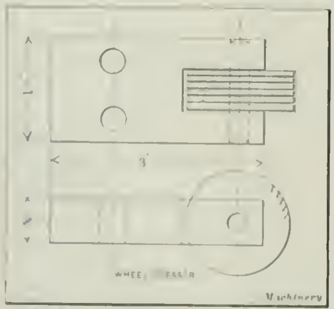


Fig. 2. Method of mounting the Huntington Wheel Dresser

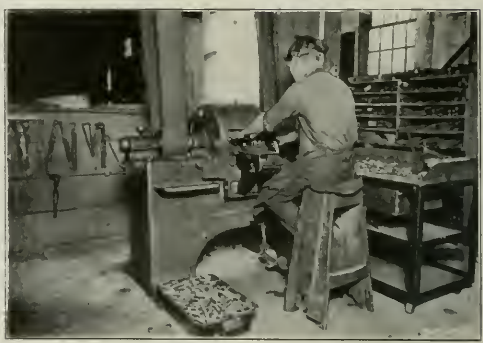


Fig. 3. Grinding Parallel Surfaces on a Double-head Machine equipped with Sliding Table Attachment

Where a wide-faced ring wheel is to be used on a 24-inch edge grinder, the ring wheel should be 24 inches in diameter by 6 inches wide, with a face width of 3½ inches, which makes the diameter of the hole 17 inches. A 16-grain, grade O alundum wheel is recommended for general use on cast iron, malleable iron, steel or brass. When a 2-inch rim wheel is to be used for general work, a 16-grain, grade P alundum wheel is used, this wheel being a trifle harder than the one just referred to. When only cast iron or brass is to be ground, a 20-grain, grade M or N carborundum wheel will give satisfactory results. The wheels should be driven at such a speed that a peripheral speed of 6000 feet per minute is secured. As considerable power is required when grinding heavy work, good wide driving belts should be used, which give the best results when running nearly horizontal. For truing up a ring wheel, a Huntington cutter, set in a piece of ⅝ by 1½ by 3 inch machine steel and mounted on an angle-plate which can be clamped to the table, will give very satisfactory results. Such an equipment is shown in Fig. 2. The cutter is on a line with the center of the wheel and extends ½ inch beyond the inside edge of

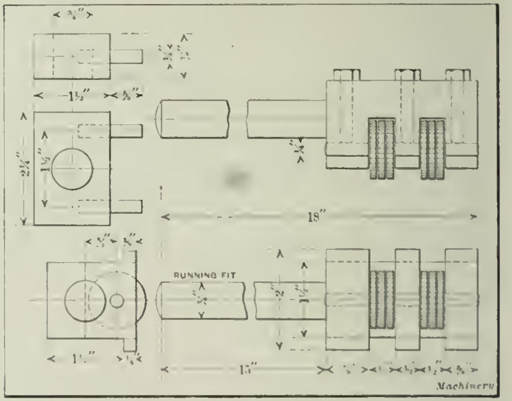


Fig. 4. Dresser for Use on Double Spindle Grinder equipped with a 1½-inch Table

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the table. In truing a wheel with this tool, the operator feeds the cutter up to the wheel and, using the handwheel for the table traverse, passes the cutter back and forth across the wheel until the latter runs true. This wheel dressing tool should be kept on the table at all times when the nature of the work will permit so doing. If the truing tool is set ½ inch over the edge of the table and the jigs are so designed that the work extends ¾ inch over the table, the truing tool does not interfere with the use of the machine and is ready for service at an instant's notice. The wheel truing tool will be seen in Fig. 1 between the magnetic chuck used to hold the hand hole plates and the box jig seen at the right-hand end of the table. For removing glaze from the wheel, a Huntington dresser may be applied free-hand if necessary. Experience has shown that oil or tallow applied with a cloth helps to keep the wheels from glazing when grinding large malleable iron or steel parts.

Fig. 3 shows two 16-inch ring wheels with 2-inch working faces, mounted in "Perfection" ring wheel chucks on a Gardner double-head grinder. This machine has a lateral movement of one or both heads by simply engaging the rack on one end of the machine. The grinder shown in this illustration is also equipped with the Gardner sliding table attachment which has the top of the table planed off so that special fixtures are fastened to it. This combination of a double-head machine with the sliding table attachment has enlarged the field of ring wheel grinding on double-head machines, because it is now possible to grind two parallel sides on this machine and obtain absolute accuracy. For keeping the dust out of the ways on the sliding table attachment, the top and sides are covered with a piece of 16-gage iron and the front is protected by a piece of rawhide with a weight at the bottom. This has proved quite an effective means of keeping dust out of the ways. It is absolutely necessary to keep the ways clean so that the table runs the full length of its traverse without lost motion, which it will not do if the ways get worn at the front end.

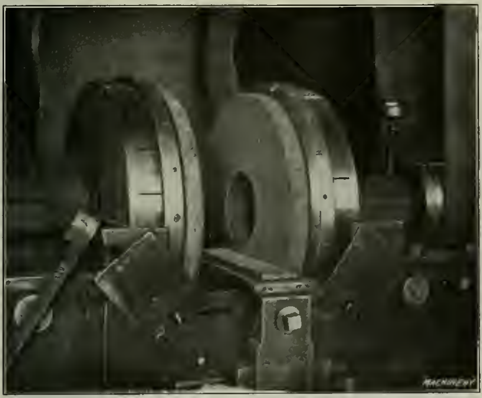


Fig. 5. Type of Dresser used Free-hand for removing Glaze from Wheel

The grinder shown in this illustration is working on malleable iron pump links and the sliding table or spring attachment is being used. One end is securely fastened between two clamps and held in place by an eccentric lever; and with the two ring wheels held in a positive position by means of the foot lever, the disk is forced between the wheels and ground to exactly the required size. When the opposite end is ground, the table is adjusted to the right position, after which the operation is conducted in the regular way. This work was formerly milled and required four minutes to finish each piece; it was found that it could be finished by grinding with equally satisfactory results and that it only required one minute per piece by this method. The wheels used for this purpose are 16 inches in diameter by 5 inches wide; the working face is 2 inches in width and the hole in the wheel 12 inches in diameter. The wheel is 24-grain, grade P or Q alundum, and runs at a peripheral speed of 5500 to 6000 feet per minute.

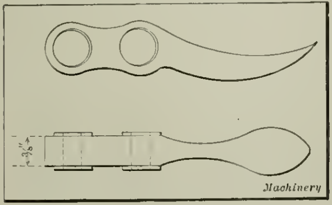


Fig. 6. An Example of Work conveniently held by Hand

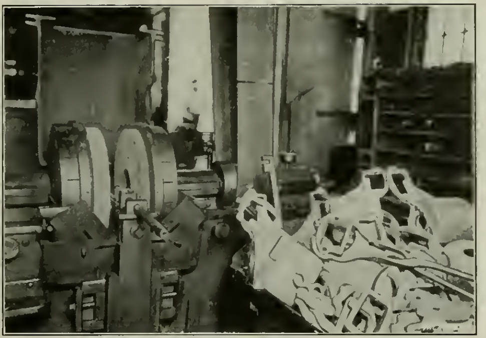


Fig. 7. A Case where holding the Work by Hand increases Operating Efficiency

The trimmer shown in Fig. 4 is used for truing the wheels of single- and double-head grinders where wide-faced, solid wheels are used, and the successful application of solid wheels on disk grinders is largely due to the perfection of this double cutter dresser. To grind a piece of work true by "floating" it up to a disk or applying it free-hand, it is essential for the wheel to have a perfect face, and this can only be secured by the use of an efficient dresser such as the one shown in this illustration. The clamping of an ordinary Huntington dresser on a geared lever feed table of a single-head machine, and rocking it across the face of a wide faced wheel, was tried but did not prove satisfactory, as it was noticed that when the cutters were in a vertical position, they cut faster than when rocked to an angle of 10 or 15 degrees. This resulted in the wheel being lower where the cutters passed over the wheel in a vertical position than at the outside and inside edges where the cutters were inclined at an angle of about 15 degrees. The single cutter emery dresser can be used for dressing a ring wheel with a two- or three-inch rim, because all work done on a narrow ring wheel is rigidly clamped in a jig or fixture and is not dependent upon whether the face of the wheel is even or has a groove 0.003 inch or more in depth at the center. The only requirement is that the wheel shaft shall not run out of truth. The shaft for the double cutter dresser should run in hardened bushings and the bushings should be kept from turning inside the cutter-head by means of ¼-inch set-screws put in back of the head. Unless this is done, the bushing will turn and the hole become worn, resulting in lost motion which must be avoided if the wheel is to be dressed quickly and accurately.

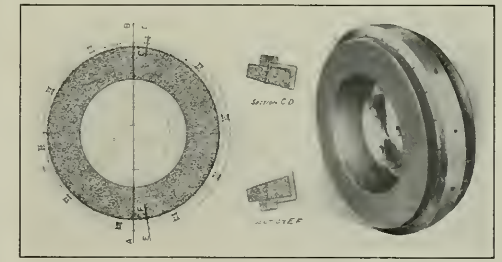


Fig. 8. The Gardner "Perfection" Ring Wheel Chuck

For truing ring wheels on a double-head machine, when the work is being ground in a fixture and a table from ½ to 3 inches in width is used between the wheels, the double cutter dresser shown in Fig. 4 can be used, although this tool was really designed for truing wider faced wheels. As usually employed, a 1½-inch table is used for a rest and the guide block is set 4 inches outside of the rim of the wheels, on the center line of the table, and with the handle passing through the guide block. The cutters are passed back and forth across the face of the wheels, at the same time adjusting the depth of cut by regulating the back stop screw, until the wheels run true. These wheels have run without truing for several hours, and an occasional use of a dresser applied free-hand to remove the scale or glaze was the only attention required. For this purpose, a Huntington cutter set in a ⅝ by 1½ by 14 inch machine steel handle, with the handle shaped as shown in Fig. 5 in order to reduce the weight, will be found very satisfactory. A dresser of this type is also used for truing wheels when the spring attachment or sliding table is used, by clamping it onto the table and proceeding the same as when using a double cutter dresser.

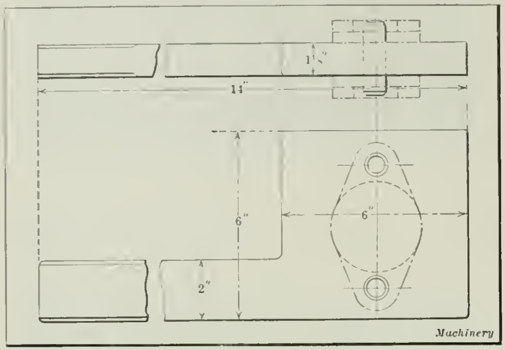


Fig. 9. Method employed for grinding Two Flanges at a Time

For grinding cast iron or brass, a 24-grain grade G+ or H carborundum wheel may be used with satisfactory results. Ring wheels should be rather harder than solid wheels for the same class of work, because when the wheels are locked and the work forced between them, the edges soon wear round, and where close limits are required the adjustment of the wheels to take up wear is not necessary at such frequent intervals. The work-table used on a double-head machine may be made in different widths so that small work such as malleable iron castings of the form shown in Fig. 6, which are to be ground on two sides to a width of ⅜ inch, can be held by hand, thus saving time that would otherwise be required to secure the work in a fixture and remove it when finished. It is sometimes more convenient to hold the work by hand, a case in point being the reservoir shown in Fig. 7, which may be conveniently handled, the operator using both hands for the purpose. For finishing work that must be held to close limits, it is best to use the machine with the left-hand head locked, having all of the movement in the right-hand head, as there is likely to be some lost movement in each head and the error due to lost movement is reduced 50 per cent by holding one of the heads stationary. The work may easily be ground within a limit of 0.003 inch when this precaution is taken.

Fig 8 shows a ring wheel mounted in a "Perfection" ring wheel chuck. There are many designs of these chucks to be had, but some of them are of such a weight that they are very inconvenient to handle. The chuck shown in the illustration is recessed at the back to reduce its weight as far as is consistent with safety. The operation of this chuck is simple and it acts quickly Fig. 7 shows two 16-inch carborundum ring wheels with 5½-inch working faces mounted in "Perfection" chucks which are set up on a Gardner double-head machine A table 1½ inch in width with a guide block set four inches outside of the wheels is mounted preparatory to dressing the wheels. The valve end of the auxiliary reservoirs shown on the work bench is ground on this machine, the grinding time being three minutes. These parts were formerly finished on the shaper, by which method fifty minutes was required to finish them The valve casing, held in the iron tongs of the work-holder, is also finished by grinding. This piece was finished on the shaper before the use of the disk grinder was adopted, and a corresponding saving of time through the change has been effected. These pieces are 5½ by 4 inches in size and are ground to a width of ½ inch; a reduction of 1/32 inch in thickness is made during the finishing operation and the work is held to a limit of 0.002 inch as regards the parallelism of the sides. The clearance of the wheels from the inside of the valve end to the body of the reservoir is only ¾ inch and when the wheels are worn down to within ½ inch of the face of the chuck, the retaining rings on the chuck will not allow the valve end to be finished next to the body. To overcome this difficulty, the chuck bodies were beveled back to within 1/16 inch of the hollow set-screws; this beveling of the rings has also made it more convenient to handle many other classes of work on the sliding table. Solid wheels used on double-head grinders stand up and wear evenly for a long time, and when it is necessary to true them up the truing can be done in about ten minutes, the method of procedure being the same as that described for ring wheels on a double-head machine. Solid wheels of this kind have been used for two days by a skillful operator without needing to be trued up with the table dresser, the occasional use of a single cutter dresser to remove the glaze being all that was required.

Fig. 5 shows a table 3 inches in width with a 2-inch guide on the top which fits in a groove in the bottom of the work-holder. This equipment is used on work finished on four or six sides, which must be kept parallel and square with each other. Such work is finished more economically in this way than on a single-head machine, grinding one side at a time. For a plant having a limited amount of work for which a single-head machine would ordinarily be used, a double-head disk grinder can be used just as economically. Connecting-rod caps and pipe flanges as large as the one shown in Fig. 9, and work of a similar kind, can be ground two at a time by using steel pins which fit through the holes at the ends of the flanges and secure the work together while it is being ground The large flanges shown in Fig. 10 can be finished on the 16-inch wheels two at a time, the rate of production being fifty per hour These machines are now equipped with a foot lever which makes it easier for the operator to handle the work, owing to the fact that both of his hands are available for this purpose. For adjusting the ½- to 3-inch stationary table or the sliding table attachment used on these machines to the right or left, two pieces of steel ⅝ by 2 by 4½

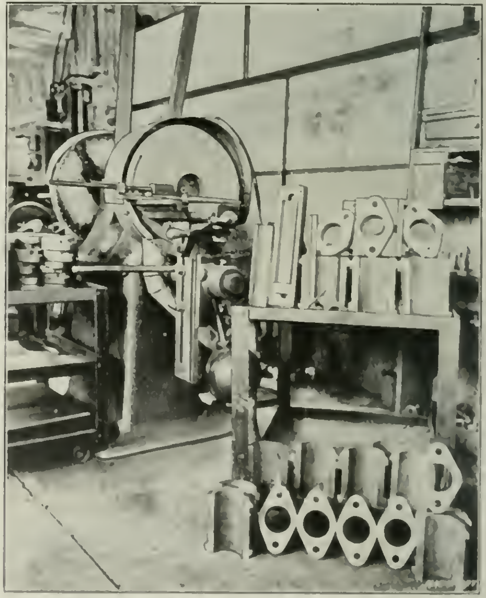


Fig. 10. Besly Machine equipped for grinding Various Sizes of Brasses

inches in size are drilled in the center to receive a ½- by 3-inch cap-screw. The slide is then drilled and tapped on each side for the ½-inch cap-screw which is slipped into the hole in the ⅝-inch plates and screwed into the slide. By loosening one of these screws and tightening the other, the lateral adjustment of the table can be made in a few moments. This will be clearly understood by referring to Fig. 7. This method will be found more satisfactory than loosening the set-screws holding the gib on the top way of the slide and then tapping the table into the required position with a lead hammer. This is especially the case when lining up a job which is ground to within 0.002 inch in positive relation to an intermediate point.

For grinding cast iron and brass on these machines, 24-grain grade M carborundum wheels are found satisfactory. For steel or malleable iron, the same grain and grade of wheels are used as were recommended for grinding this material on a single-head machine equipped with 18-inch wheels. For rough-grinding work preparatory to polishing, the double-disk machine is found far more economical than an ordinary floor grinding machine on which the work is applied to the periphery of the wheel. This is especially true in the case of grinding hexagon cast brass or cast-iron nuts of all sizes, the heads of bolts, wrenches, etc. For small brass nuts which are to be polished, a 60-grain, grade N carborundum wheel can be used, and such work can then be roughed out on a No. 120 or 150 emery wheel.

Fig. 10 shows an 18-inch, solid carborundum wheel mounted in a "Perfection" ring wheel chuck and set up on a Besly grinder. The wheel is 24-grain, grade J bond GB, and is used for grinding cast-iron and brass parts. The short bearing brasses are set with the edge projecting ¼ inch over the inside of the table; they are held in a V-block and floated up to the wheel. The short, heavy brasses are 7 inches long by 5⅝ inches wide and are finished at the rate of 130 per hour. These pieces were formerly finished on the shaper, by which method the machining time was four minutes each. The long, narrow brasses are held in a special V-block fastened to an angle-plate. These brasses are 12½ by 2⅜ inches wide and are finished at the rate of 100 per hour. On the shaper, it required five minutes to finish each brass. The cast-iron pipe flanges are laid in a wooden block which is cut out to conform to the shape of the work. The block is fastened in a knuckle joint fixture, and the work is then floated up to the wheel, the method of procedure being illustrated in Fig. 11. The extreme length and width of this flange is 7⅝ by 4½ inches and the pieces are ground at the rate of 75 per hour. They were formerly machined in the lathe, by which method four minutes was required to machine each piece. These pieces are merely cleaned up on the surface, *i. e.*, they are not held to close dimensions, and disk grinding should be employed for all jobs of this kind that can be finished by grinding.

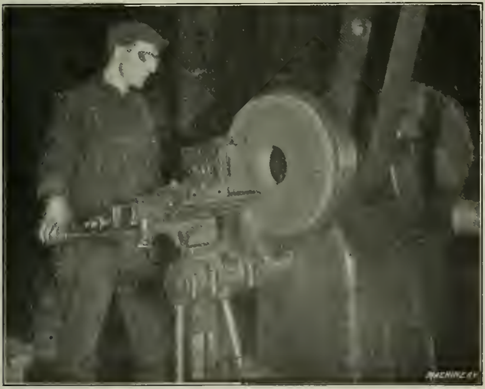


Fig. 11. Method of grinding Cast-iron Pipe Flanges shown in Fig. 10

For grinding steel or malleable iron parts with a surface of 2 square inches or more to be finished, a 16-grain, grade N alundum wheel should be used. For smaller areas which must be ground to within a limit of 0.003 inch or less, a 20-grain grade P wheel is suitable. The following figures show the saving effected through the use of solid wheels in place of the abrasive disks formerly employed on a certain grinding operation. The disks were 20 inches in diameter and 12 grain, such disks costing 75 cents apiece. Two and one-half disks were used up each day, which makes the cost during a period of one hundred working days $187.50. A solid wheel 18 inches in diameter by 3½ inches face width will last for one hundred days and costs $18. It will be evident from these figures that a saving of $168.50 has been effected through changing to the use of solid wheels. This represents the saving in the cost of abrasive for only one end of the machine, and an additional saving corresponding to an increase of from 10 to 20 per cent in efficiency was also effected. Furthermore, many jobs which the high cost of abrasive cloth disks made it impractical to finish on the disk grinder can now be handled in this way with a saving of from 50 to 90 per cent as compared with the cost of machining on the shaper or miller.

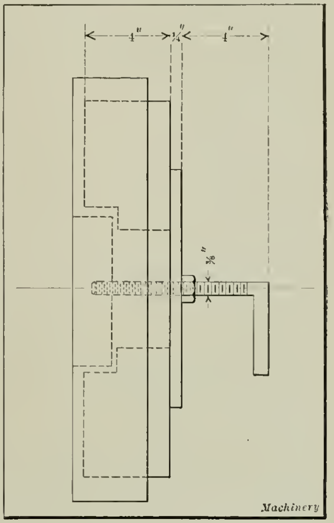


Fig. 12. Fixture for Use in Connection with Worn Wheels held in a Chuck, for holding the Wheel until Set-screws are tightened

In fitting a disk wheel into a chuck used on a single-head machine, difficulty was experienced in keeping the wheel against the back of the chuck, and when setting the wheel out after it had become worn down to the face of the chuck to be sure that the wheel rested against the "backing plugs" which are used in connection with worn down wheels. For holding wheels in place while fitting them in the chuck, the fixture shown in Fig. 12 should be used. Where wheels of different shapes or of different grains and grades have to be used, so that it is necessary to change wheels one or more times a day, wooden rings 18 inches in diameter by ½, 1 or 1½ inch wide can be used instead of the backing plugs. Their use saves time as compared with the use of the backing plugs. In this connection, it is important to note that the chuck should never be removed from the spindle of the machine while fitting a new wheel in place or setting one out that is being used. The reason is that the removal of the chuck wears out the pilot on the arbor that locates the chuck, and such wear, combined with the weight of the chuck and the wheel, and the high speed at which the wheel is driven, sets up vibration in the machine that makes good work impossible.

If trouble is experienced in getting a large disk to run true and in balance, the operator should investigate the condition of the countershaft and the lacing of the belt. If the countershaft is loose and the pulleys are out of balance, or if the lacing of the belt is bad, vibration will be set up in the machine and this is bound to show itself on the work. In the event of the wheels being too small so that they cannot be held in the chuck, they may be shimmed up with paper or cardboard; conversely, if the wheels are too large, they may be rubbed down with a piece of a worn out wheel. When wheels have been worn down to a thickness of 1 inch, which marks the limit of safety for use in a ring wheel chuck, they can be used up on a heavy grinding stand where work is applied to the periphery of the wheel, by using a flange collar and flange with ⅛-inch rubber washers on each side of the wheel. Fig. 13 illustrates the safety collars used for this purpose.

When ordering chucks for solid disk wheels with a face width of 4 inches or more, straight backs should be specified. When the chucks are recessed in the back, the wheels have to be recessed to clear the hub of the chuck, the amount of clearance necessary for different sized wheels being given in the table. The recessed back is designed to reduce the overhang to a minimum, which may be a point worth considering on a light machine, but with the modern disk grinding machines, the straight-back chuck is preferable. A 16 by 3½ by 5 inch solid disk and an 18 by 3½ by 5 inch solid disk have been used for the past two years on one end of a Besly No. 14 single-head machine and the up-keep of the machine has not been any greater than it was when equipped with 20-inch iron disks. When an 18-inch solid disk recessed 1¼ inch deep on one side to accommodate the hub of a recessed back chuck is worn down to a thickness of 1¾ inch, there is only ¼ inch wall for a distance of 2½ inches out from the hole. It is not safe to run a wheel under these conditions, as a serious injury to the operator might easily result in the event of the wheel breaking. In the interest of safety, such wheels should be discarded and used up on other classes of work; they may be used for grinding small pieces or employed as ring wheels. When the wheels are first placed in a recessing chuck, backing studs 1 inch in length or a wooden ring 1 inch wide must be used to set the wheel out so that the bottom of the recess clears the hub of the chuck. Referring to the table, the diameter *A* should be held close and the wheels should be without lead bushings in the hole *C*. If it is necessary to balance them, lead should be placed on the back in the recess at *D*.

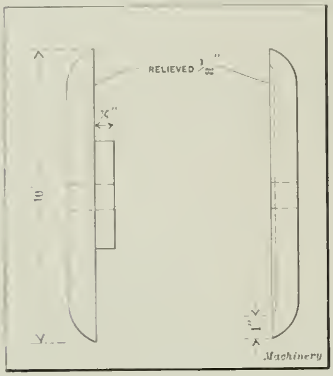
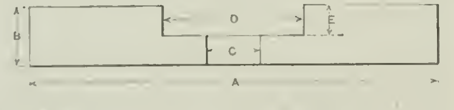


Fig. 13. Flanges for using up Worn Wheels on a Grinding Stand

DIMENSIONS IN INCHES FOR WHEELS HELD IN RECESSED CHUCKS



Size of Chuck	A	B	C	D	E
14	14	3½	1½	5¾	¾
16	16	3½	5	7	1
18	18	3½	5	10	1¼

Machinery

To secure a fine finish on small brass nuts or similar work, a carborundum wheel of 36 to 60 grain, grade M, will be found satisfactory. For securing a finer finish on steel, a 36 to 46 grain, alundum wheel of grade O or P can be used. Such wheels are not recommended for fast cutting; they are only suitable for those classes of work where a No. 46 grain cloth disk would give satisfactory results. Much might be said in favor of the use of solid disks for special jobs and also of the class of work holders which are most suitable in different cases, the position of the work when applied to the wheel, and how the work is most easily brought to the required condition, but lack of space precludes the possibility of presenting detailed information on these points.

THE RIGHT WAY OF OBTAINING FOREIGN TRADE

Many columns in our newspapers and trade journals have been filled with suggestions relating to the methods of obtaining South American trade. In nearly all of these a sound conception of the fundamental laws of commerce and trade between nations has been conspicuous by its absence. People who have not the slightest conception of political economy in its application to foreign trade rush into print with suggestions extremely one-sided in their nature. It is, therefore, refreshing to find a business man who suggests that there is a right and wrong end at which to begin the expansion of the South American trade. M. W. Mix, president of the Dodge Mfg. Co., Mishawaka, Ind., urges that buyers, rather than salesmen, should be sent to open our trade relations with South American countries. There is a plain reason for this proposal. The Latin-American countries have lost not only the markets in which they used to buy, but also the markets in which they used to sell their products. Before a credit system with this country can be established, enabling the South American republics to buy, they will require a market for the goods that they have to sell to replace the market which they had in certain European countries.

Latin-America's present need is not for salesmen asking her to buy, it is for buyers of what she has to sell. If in this country users are found for South American products—if markets are opened here for goods to replace the markets of Europe—then credit will be established here on which South America can buy goods from the United States. The problem is not merely one of rushing salesmen and samples to people ready to buy and able to pay; it is one of organizing broader trade relations and effecting an exchange of commodities.

It was aptly stated by the *Chicago Herald* that in the end all trade is barter; it is an exchange of surplus products. Many people think of trade in terms of money only and have no conception of the trade relations between nations as they actually exist. If the United States buys from South America then South America can buy from the United States. We must buy as well as sell, and in this particular case it is practically necessary for the United States to buy first in order to establish a credit for the South Americans.

A similar situation relating to the trade possibilities in Sweden for goods from the United States is voiced by our consul at Gothenburg. He intimates that there is considerable demand for American goods on the part of Swedish importers at present, but that it is impossible for them to buy on account of the fact that there is no credit established for them in the United States. To buy as he says, they must have "dollars in New York," and to establish such credit it is necessary that Sweden shall sell something to merchants in this country. Even in times of peace, gold shipments take care of but a small percentage of the trade between nations. In these troublesome times large gold shipments are out of the question, and practically all trade between nations must take the nature of an exchange of exports and imports—not directly, of course, but indirectly through our credit and banking system.

* * *

The safest way to store pig iron, says the *Travelers Standard*, is to stow it in bins, or pile it up in neat stacks. This is more costly, however, than throwing it down promiscuously in piles, and hence the safer methods are often neglected. Electro-magnetic cranes are coming into wide use for handling pig iron, and although they are very convenient, they have serious drawbacks when regarded from the safety standpoint, and their hazards should be clearly understood and carefully avoided. When the electro-magnet is used no one should be permitted to stand, walk, or work near the path followed by the magnet, because any interruption of the electric service, from the opening of a switch, the blowing of a fuse, the short-circuiting of the magnet coil, or any other cause, will instantly let the whole load drop. Sometimes, too, a pig is just barely held by the magnet, so that the least jar will break its contact and allow it to fall.

LETTERS ON PRACTICAL SUBJECTS

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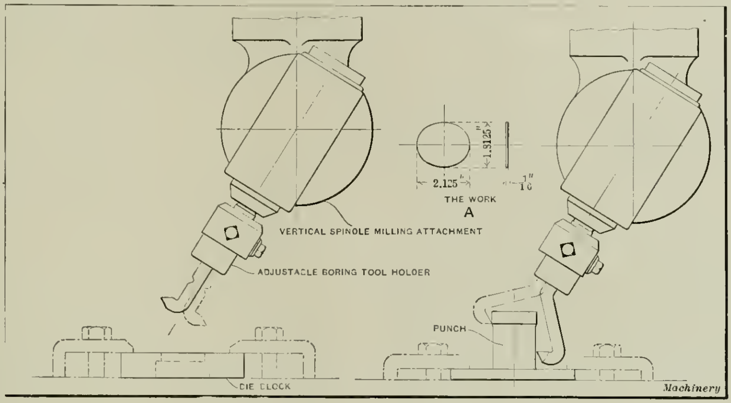
ELLIPTICAL BORING AND TURNING

The writer once had occasion to make a blanking die for the part shown at *A*. The shape of this part is an ellipse, with a major axis of 2⅛ inches and a minor axis of 1 13/16 inch. The elliptical hole was bored in the die block by setting the vertical milling attachment at an angle with the table. The hole was first bored round, leaving stock for finishing, and was recessed on the under side, as it is impossible to bore a deep hole by this method.


VERTICAL SPINDLE MILLING ATTACHMENT
ADJUSTABLE BORING TOOL HOLDER
2.125"
1.8125"
1/16"
THE WORK
A
PUNCH
DIE BLOCK
Machinery

Method of machining an Elliptical Punch and Die

The proper angle at which to set the vertical spindle was obtained by dividing the minor axis of the ellipse by the major axis, which gave the cosine of the angle, in this case 31 degrees, 28 minutes. With the spindle swung to this angle it was only necessary to feed the table of the miller up in the usual manner, the tool following a perfect ellipse. The punch was turned in the same way, using a forged tool in the vertical attachment. It is necessary to have the tools ground to a sharp V-point, as any curve on the point would present different cutting edges on opposite sides of the work, with the result that it would not generate a perfect ellipse.

Detroit, Mich. R. A. BLACK

A PROBLEM IN GEARING

In presenting this article my object is principally to show how easily even the best machine designer may make serious blunders, overlook simple principles when they appear in a slightly unfamiliar form, and design a wholly inoperative mechanism. In this case not only was the designer a first-class mechanic, but so was the machinist; yet the mechanism described here was actually completed and ready for trial before the mistake was discovered. In order to perform a certain function in an automatic machine, a device was constructed embodying the scheme of gearing shown in Figs. 1 and 2.

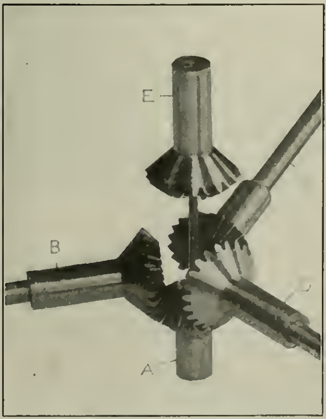


Fig. 1. Arrangement of Gearing that was found to be Inoperative

The miter gear *A* has 22 teeth and its axis is in a vertical line. The miter gears *B*, *C* and *D* are exactly like gear *A* and mesh with it. The axes of these gears, of course, lie in the same plane (horizontal) and they were at first spaced equidistant around the gear *A*, as shown in Fig. 2. At a certain period in the cycle of operations, another gear *E*, Fig. 1, which is exactly like each of the other four gears, and whose axis is in the same line as that of gear *A*, is supposed to move into mesh with gears *B*, *C*, *D* and, of course, rotate in the opposite direction to gear *A*.

When the device was tried the gear *A* meshed with and drove the gears *B*, *C*, *D*, but when gear *E* was tried it did not mesh properly with gears *B*, *C*, *D* while they were in mesh with gear *A*, but ran all right with them when gear *A* was removed. The designer was positive that the lay-out was correct and that the trouble was due to inaccurate workmanship. In his opinion the trouble might be caused by the axes of gears *B*, *C*, *D* not radiating from the apex of gear *A*, not being in the same plane, or not being spaced exactly 120 degrees apart; but most likely the fault was in the cutting of the gear teeth which were probably cut skew-wise so that while the gears *B*, *C*, *D* might run with gear *A* alone, they could not possibly run with gear *A* and *E* at the same time, as then the errors would be multiplied.

The machinist was just as positive in his assertion that the workmanship was accurate. He had a suspicion, however, that the cause of the trouble was that the gears *B*, *C*, *D* were not correctly spaced in the design. He thought that they should be spaced a whole number of teeth apart around gear *A*, instead of being 120 degrees or 7 1/3 teeth apart. How to prove this was the question. As the machine would not run, it was up to him to show why, which he did by laying out a diagram in which the gears *A* and *E* are supposed to be of infinitely large diameter so that they can be represented by racks *A* and *E*, Fig. 3. The gears *B*, *C*, *D* are represented by pinions *B*, *C*, *D*. The pinions *B* and *C* are shown a whole number of teeth (six) apart. It was readily seen that the center distance between pinions *B* and *C* could not be altered by one-third of a tooth distance. The least possible change in center distance that can be made is one-half tooth, as shown at *D*, where tooth *X* has been moved one full tooth in rack *E* and tooth *Y* has been allowed to remain in the same space in rack *A*. The number of teeth (twenty-two) in the gears could

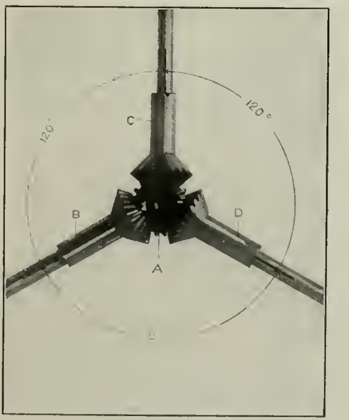


Fig. 2. Plan View showing Original Spacing of Pinions B, C and D

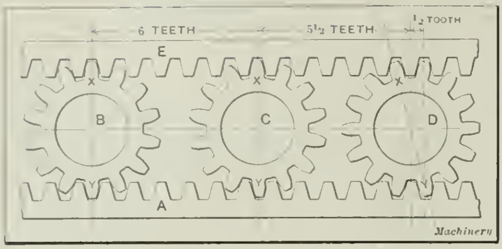


Fig. 3. Diagram showing Error in Original Spacing

not be changed, so the device was reconstructed with the correct spacing, and then it ran all right.

Brooklyn, N. Y. **Samuel Gahan**

THREAD MEASURING TOOL

A thread measuring tool was devised in order to eliminate the "personal equation" in measuring thread plug-gages and in comparing them with standards, as it had been found that in using thread micrometers, whether equipped with conical or ball points, measurements made by different men—or even by the same man at different times—showed variations of from 0.0001 inch to 0.0003 inch. This tool was designed to dispense with the element of "touch," using, instead, the indicator principle. It is based on two fundamental facts of trigonometry: that the axis of a cylinder held in an angular groove lies in the plane that bisects the angle, and that if the angle of the groove is 60 degrees, this axis will be at a distance from the vertex of the angle equal to the cylinder's diameter.

The body of the tool is a block *B*, Figs. 1 and 2, with a 60-degree groove, a straightedge *E*, and the slot shown in Fig. 2. *E* is so placed that if either attachment *C* or *L* is in contact with it, the axis of the attachment passes through the vertex of the 60-degree angle. To bring its axis into coincidence with that of a piece held in the V, it is necessary only to insert between the attachment and the straightedge a size block of thickness equal to the diameter of the work. Fig. 2 shows the method of determining the proper location of *E*.

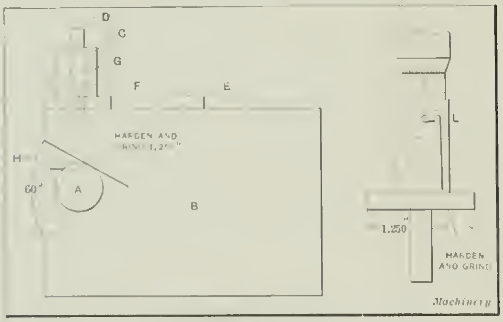


Fig. 1. Tool for accurately measuring or comparing Thread Diameters

On the top of *B* is mounted, surface gage fashion, an indicator reading in ten-thousandths. Part *C* carries a rod *D*, which extends down through the slot in block *B* and rests upon the wire *H* laid between the threads of the work. To prevent the dropping of the wire, *D* is strongly magnetized, and to prevent the magnetism from interfering with the free movement of *D* in *C*, the former is surrounded by a brass bushing *G*. A brass grub-screw keeps *D* from falling out. Attachment *L* (see enlarged view, Fig. 1) carries a micrometer head, reading to ten-thousandths. This is fast in a bushing that is free to move upward from the shoulder on which it rests, but is held from turning by a loosely fitting screw. A piece of steel, let into the bushing, bears upon a pin in the short arm of the pointer shown. A very light spring tends to force the pointer to the left, but is prevented by the weight of the micrometer head. This attachment is so adjusted that if a 0.500-inch test bar is held in the 60-degree groove and the micrometer is turned down to make contact with the test bar and is then turned enough farther to bring the pointer to the zero mark, the micrometer will read 0.250 inch.

The wires *H* are of drill rod, hardened and ground to exact sizes, an assortment being provided to suit the different pitches of thread to be handled. A wire having a diameter equal to three-quarters or seven-eighths of the pitch works satisfactorily, but to facilitate calculations, it is well to keep to an even number of thousandths—0.120 inch, for instance, being preferable to 0.125 inch.

Now if our object is to compare a piece of threaded work with a standard, we first clamp the standard in the V, put a size block equal in thickness to the diameter of the standard between *F* and *E*, let *D* rest upon a wire laid on the standard, bring the indicator to the top of *D* and take a reading. Repeating this with the work, using, of course, the same wire, we know within 0.0001 inch how it compares with the standard.

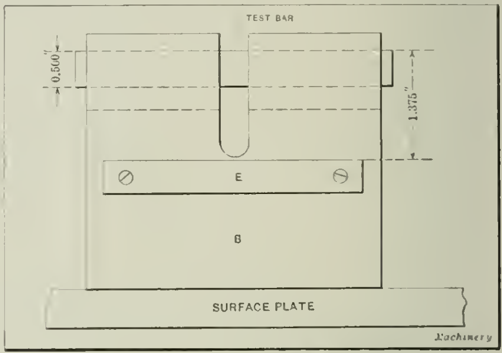


Fig. 2. Another View of Thread Measuring Tool

If, however, we wish, not a mere comparison with an existing standard, but an actual measurement, we swing the indicator aside, and substitute attachment *L* for *C*. Subtracting from one-half the diameter of the work 0.866 × pitch, for a V-thread, or 0.7578 × pitch for U. S. standard form of thread, and adding 1½ times the diameter of the wire, gives the reading of the micrometer attachment *L*, if the size of the work is correct.

For example, if a V-thread is 1 inch diameter and has 8 threads per inch, and we use a 0.100-inch wire, the micrometer reading = 0.500 inch + 0.150 inch — 0.10825 inch = 0.54175 inch.

For a 1-inch diameter, U. S. standard thread, of ⅛ inch pitch, the reading = 0.500 inch + 0.150 inch — 0.094725 inch = 0.55527 inch.

New London, N. H. **Guy H. Gardner**

INDEXING WORK HELD IN A VISE

It is often required to machine pieces of the form shown in Fig. 1, which have a flat milled on both sides as shown at *A*, or a groove on both sides as illustrated at *B*. To handle this work in the usual manner requires an expensive set of indexing centers which are in general demand in the shop, and the following outlines a method by which work of this kind may be handled equally well in a vise equipped with a dog for indexing the work, as illustrated in Fig. 2. The use of a vise attachment of this

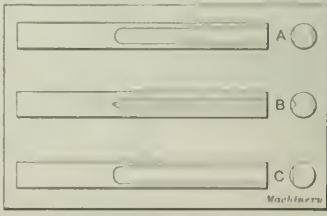


Fig. 1. Type of Work to be milled

kind does away with the necessity of tying up an expensive dividing head for handling the work, and it also enables such work to be handled satisfactorily in small shops in which a dividing head is not included in the equipment.

To mill these flats or grooves on the opposite sides of a piece of work, a pair of auxiliary jaws *A* and *B* are provided for the vise. Referring to Fig. 2 it will be seen that the jaw *A* is slotted at *X* to receive the tail of the dog *C* which is secured to the end of the work in the usual way. A detail of the dog is also shown in Fig. 2 where the provision of the set-screw *D* and shoe *E* for securing the dog to the work is clearly shown. It will be seen that the dog has two tails. In starting to mill the piece of work, the dog is secured in place on the work and set up in the vise with one of the tails entering the slot *X*. The first cut is then taken, which leaves the work as shown at *C* in Fig. 1. After completing the first cut, the work is taken out of the vise and turned over so that it may be replaced with the other tail of the dog in the slot *X*. The vise is then tightened up and the second cut taken, which completes the milling operation.

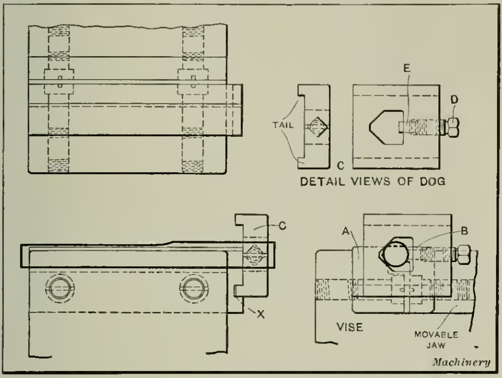


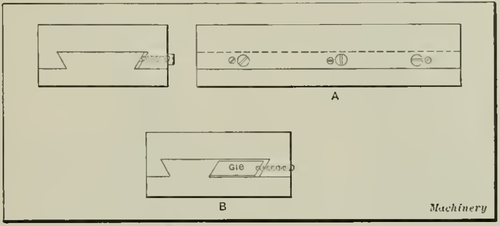
Fig. 2. Method of using Auxiliary Vise Jaws with Dog for indexing

F. Server

ADJUSTING GIBS

The vertical slide of the tool-block in our school shaper was constantly getting out of adjustment, being either so tight in some positions that it could scarcely be moved, or so loose as to be quite useless for its purpose. This state of things was no doubt partly owing to its being constantly used by boys who are fond of adjusting things, usually in the wrong place, but probably more often to the way the gib was set up. This gib, as shown in the accompanying illustration, is a steel strip ¾ inch wide by 3/16 inch thick, and is set up by three screws which seat in depressions about 1/16 inch deep. The screws are an easy fit in the block and require very little to move them either way with the results above mentioned.

The remedy I applied, which has proved quite effective, was to drill holes close to each screw, as shown at *A*, and insert screws that are threaded into the gib and have clearance in the block. These screws hold the gib tightly against the points of the set-up screws and prevent any accidental change of adjustment. I have since applied this method to similar gibs in various other slides with equally good results. The above-mentioned gib is unusually thin and flexible, too much so, in my opinion, for satisfactory work. At the same time it is easily seen that the thinner the gib and the more closely it fits its recess, requiring the least possible overhang of the set-up screws, the better. This may be shown by giving the gib an exaggerated thickness as at *B*. Any vertical pressure applied upward will have a far greater toggle joint bursting effect on the slide than in the case where the thin gib is used.

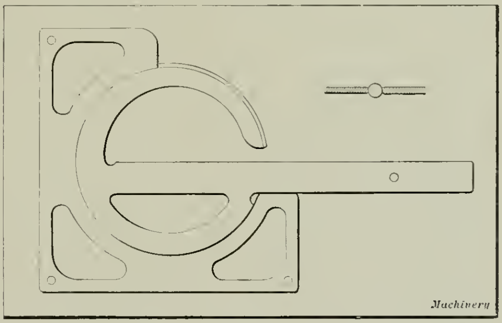


Improved Method of securing an Adjusting Gib

Christchurch, New Zealand. John Peddie

PROTRACTOR BALL BEARINGS

In a drafting-room where I was once employed, several of the draftsmen owned Brown & Sharpe protractors. After experimenting with one of these instruments, we made the change shown in the accompanying illustration and found that it added materially to the efficiency of the tools. This change consisted of inserting regular ⅛-inch steel balls in the protractor in order to lift it from the surface of the paper. Fitted in this way, the protractor slides much easier and does not soil the paper; it is also easier to pick up, as the balls lift the instrument sufficiently to enable one to get hold of it.

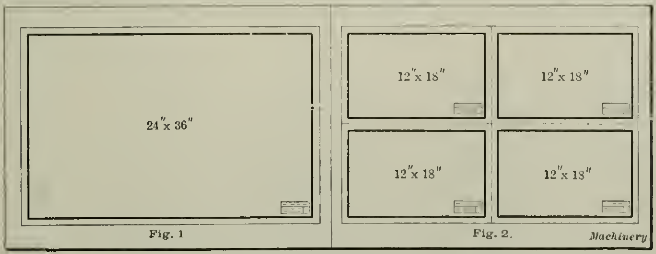


Method of holding a Protractor out of contact with Drawing Paper

St. Louis, Mo. F. E. Pettersson

COVER SHEETS FOR TRACINGS

Sometimes it is desirable to make several small drawings or a number of details on one large sheet of tracing cloth, so that the blueprints may either be used as one large sheet



Figs. 1 and 2. Cover Sheets for printing Various Forms of Borders on Blueprints

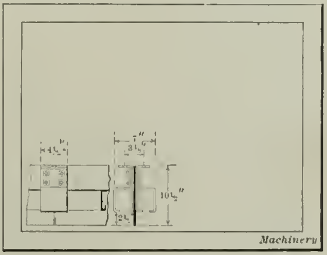


Fig. 3. Cover Sheet for printing Border and Detail on Blueprint

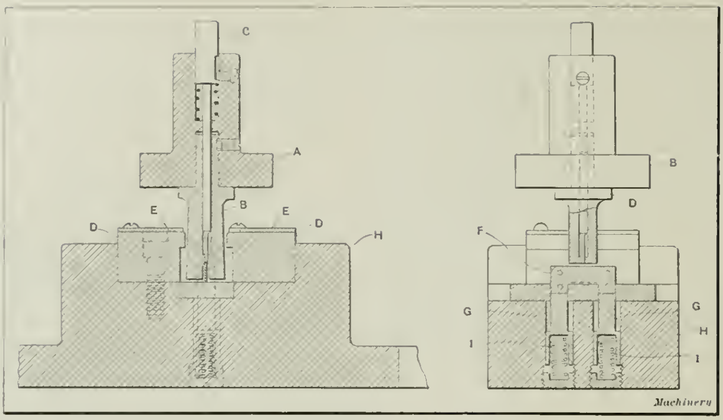


Fig. 1. Cross-sectional Views of Staple Bending Die

or cut up into several smaller ones. For large prints, a single border line around the outside of the entire sheet is preferable to having separate border lines around each detail. This is particularly true when the blueprint is used for advertising or show purposes; but if the single border line is drawn around the outside of the large tracing and the blueprint is cut up into smaller sheets, these small sheets will only have border lines on one or two sides, and this detracts from their appearance.

Such cases could be handled by making two tracings, but a much cheaper method, and one which is perfectly satisfactory, is to omit the border line from the tracing entirely and then prepare separate sheets of thin tracing paper of the same size as the original tracing, drawing the different border lines on these sheets. These sheets—which have been aptly called "cover sheets"—are fastened over the tracing with small wire paper clips to hold them in place when printing. A slightly longer exposure is required, but if a thin, transparent tracing paper is used the additional time is not excessive. Fig. 1 shows the cover sheet for a standard 24 by 36 inch drawing. The blueprints from this tracing are used largely in installation work and so arranged that they can be cut into four sheets 12 by 18 inches in size, which are bound with other prints of the same size for distribution among architects and engineers. When printing these small sheets, the cover sheet shown in Fig. 2 is used, the dotted lines in this illustration marking the trimming lines. Each of the small blueprints is given a title and drawing number.

Another use for the cover sheet is found in cases where some special name or address is desired on the blueprint, as, for instance, the name of a jobber or the address of some particular branch office. This additional lettering can be done on the cover sheet and the sheet fastened to the tracing for printing. In this way, the standard drawing is not interfered with, yet the blueprint has the appearance of having been prepared from a tracing made especially for the job. The patchwork effect resulting from other methods commonly used is avoided in this way. Still another use for cover sheets is found in cases where a special drawing is required for each job, but where some of the details on each sheet are standard. These standard details can be drawn on cover sheets and only the special parts need then be drawn on the regular tracing for each job. This saves a large amount of time without sacrificing the completeness of the drawing, the same cover being used for all of the jobs. An illustration of such a cover sheet is shown in Fig. 3. A fourth use of cover sheets consists of their application in blotting out certain figures or words on a tracing, which it is desired to eliminate from the blueprint. To accomplish this a neatly inked-in place is drawn on the cover sheet in the proper place to cover the words or figures that it is required to eliminate. To make a neat job it must be understood that the cover sheet must be the full size of the tracing; otherwise a difference in the color of the blueprint at different places will be noticeable, due to the difference in the thickness of the tracings through which the light must penetrate. The cost of these cover sheets is usually very small, and the time required to produce them almost negligible.

Aurora, Ill. E. J. G. Phillips

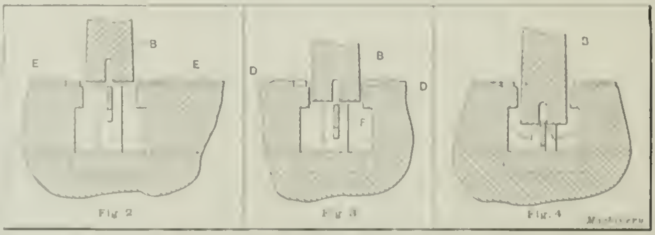
STAPLE BENDING DIE

We had an order for a large number of staples that were to be made of 0.025-inch sheet steel, and to provide for handling this work the punch and die which forms the subject of this article was designed. The way in which this tool operates will be best understood by first referring to the cross-sectional views shown in Fig. 1. The cast-iron punch-holder *A* carries the tool-steel punch *B*, which has ejector bar *C* running through its center. The outside bending dies *D* are provided with nests *E* for locating the blank in the required position preparatory to bending. The staples are bent over the inside former *F*, which is riveted to the tool-steel pins *G*, the pins *G* being a sliding fit in the die shoe *H*.

Figs. 2, 3 and 4 illustrate steps in the downward stroke of the punch *B*. In Fig. 2 the blank is shown in position in the nest *E* ready for the punch to descend upon it. Fig. 3 shows the punch after it has carried the blank down between the side bending dies *D* and brought it into contact with the inside former *F*. In Fig. 4 the punch has descended a little further, with the result that the blank is partially bent over the former. At the conclusion of the downward stroke, the two sides of the staple will be bent into close contact with the former. This is the position shown in Fig. 1.

On the upward stroke of the punch the inside former *F* rises with the punch until it is flush with the top surface of the die, this movement being actuated by the springs *I* that act against the lower side of the pins *G* on which the former *F* is mounted. The staple is held in the punch *B* until the punch has almost reached the top of its stroke. At this point a knock-out bar on the punch press strikes the ejector bar *C* and ejects the staple from the punch. The press is inclined so that the work drops clear of the die and leaves the latter ready for the next operation.

Harrison, N. J. A. J. O'Malley



Figs. 2 to 4 Successive Stages in bending a Staple

KNOCK-OUT FOR A PUNCH PRESS

The accompanying illustration, showing a mechanically operated knockout for the punch press, will require little explanation to make the design of this equipment clear to any mechanic. This mechanism was designed by F. Green, tool-room foreman of the Bausch & Lomb Optical Co., Rochester, N. Y., and has been in successful operation in the punch press department of that company's factory for the last three years. It operates more satisfactorily than a rubber bumper—especially for brass forging dies and small re-draw dies, and is less expensive.

Fig. 1 shows the attachment in place on a punch press. Referring to this illustration, *A* is a collar which is bored out to fit over the projecting end of the crankshaft to which it is fastened by means of two bolts shown at *L* in Fig. 4. Adjustment of the length of the stroke is provided by means of a T-slot in which the crank-pin *K* is secured, and the knockout can be timed to suit the requirements of the work on which the press is engaged by loosening bolts *L*, Fig. 4, and turning collar *A* to the right or left with relation to the crankshaft. The hubs *B* at each end of the connecting-rod *C* are alike, except that one hub is threaded right hand and the other left. The connecting-rod *C* has a flat on it which can be engaged by a wrench, and by turning the rod, a very fine adjustment of the knockout is secured. Further adjustment may be made by using different sizes of washers *J* and knockout pins *I*.

In Fig. 3, it will be seen that the collars *E* support bearings in which the shaft *F* turns. These collars have four short legs cast on them, it being possible to file the legs to compensate for irregularities in the frame of the punch press on which the attachment is to be applied. The collars are fastened to the bed of the press by four half-inch cap-screws. The crank *D* is keyed to the shaft *F* and the same method is used in securing the cam *G* in place. The bracket *H* has four short legs cast on it so that it may be fitted to the rough bed casting and fastened by two cap-screws. The hole in this bracket is bored large enough so that the knockout pin *I* is a sliding fit in it.

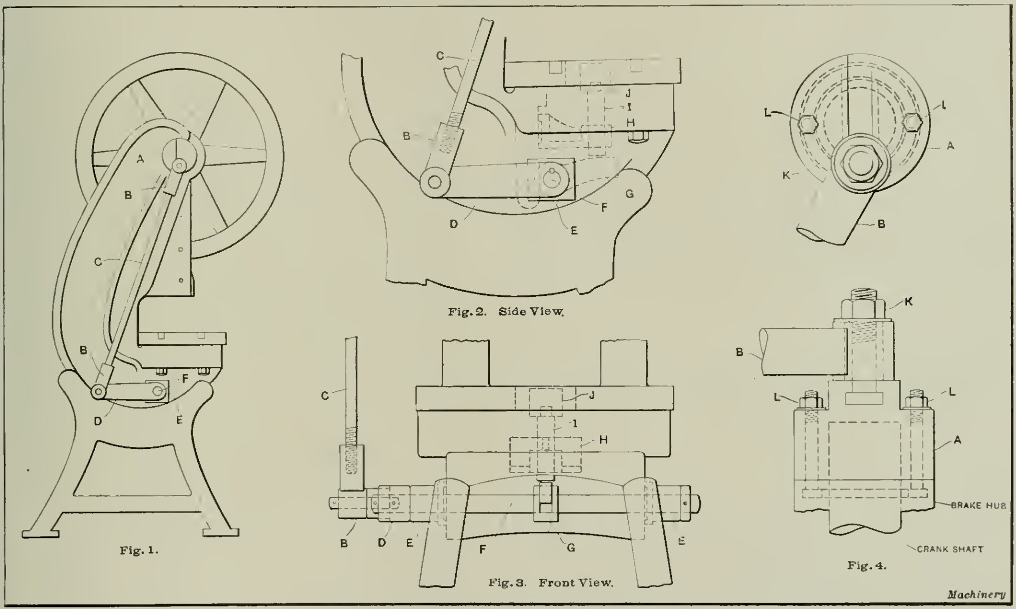


Fig. 1.

Fig. 2. Side View.

Fig. 3. Front View.

Fig. 4.

Figs. 1 to 4. Power Press equipped with a Mechanical Knockout and Views showing Details of Design

The method of operation of this attachment is as follows: When the ram of the press is in the upper position, the collar *A* is set with the slot vertical. The hub *B* is next fastened to the lower end of the slot by means of the stud shown at *K* in Fig. 4. On the downward stroke of the ram, the collar *A* makes one-half revolution, thus raising the connecting-rod *C* and crank *D*. The cam *G* turns and lowers the knockout pin *I* and collar *J*. Then when the ram commences its up stroke, the crankshaft completes the revolution, pushing down the connecting-rod *C* and the crank *D*, and raising the pin *I* and collar *J* through the action of the cam *G*. In this way, the work is ejected from the die. In some cases corrugations are milled on the inside of collar *A* and the brake hub to prevent the collar from slipping.

Rochester, N. Y. CARL M. WEBER

A SANITARY SHOP SINK

There are many shops where no particular attention is given to the provision of sanitary equipment for the use of employes in washing up after their day's work. Often half a dozen men may be seen washing in a single bowl, and little discussion is necessary to emphasize the dangers of such a practice. The importance of the provision of proper equipment for this purpose is becoming generally realized, and there are now many shops where soap and towels, and strictly sanitary equipment are provided. The apparatus which forms the subject of this article is used in the machine shops of the Leedy Mfg. Co., Indianapolis, Ind., and was installed by the company's superintendent, Mr. Charles B. Wanamaker. A constant stream of warm running water is provided, which is ample for the purpose without requiring an unnecessary amount of water to be used.

The unit accommodates twelve men at a time and is made of thin boards supported on legs 2 by 3 inches in size. The boards *A* and *B* and the trough *C* are covered with zinc. The boards *A* and *B* were provided for supporting individual wash basins which were originally used. It was found more convenient, however, for the men to wash directly under the small jets of water. These jets *D* are made of ⅛-inch pipes tapped into the main supply pipe. As the stands for the basins are no longer required, it is intended to make the next unit by substituting curved sheet metal guards in place of the stands *A* and *B*. These guards will absolutely prevent water from being splashed onto the floor or on the workmen's clothing, and would provide better drainage back into the trough.

The hot water is obtained by allowing steam and cold water to enter opposite ends of the mixing pipe *E*. By properly adjusting the water and steam valves, a steady flow of water of any required temperature may be obtained. Fig. 2 shows a cross-sectional view of the water heating arrangement, from which the construction will be better understood. Referring to this illustration, it will be seen that the steam enters into the larger pipe which is the heater, while the water is admitted through a smaller perforated pipe. It

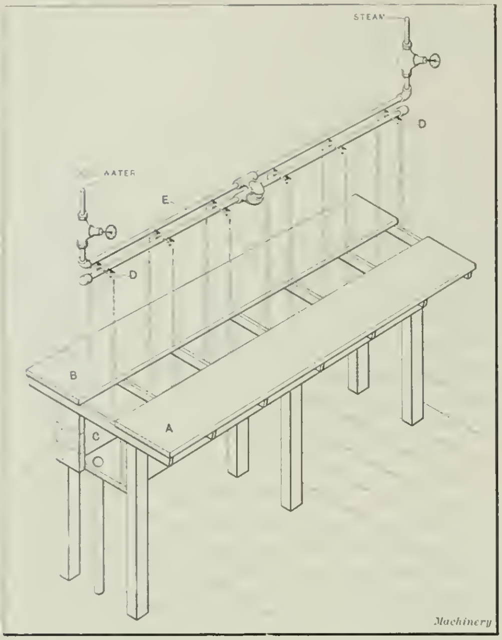


Fig. 1. Sanitary Shop Sink for Use of Employes

will be evident that the steam cannot be discharged into a pocket of cold water and result in the disagreeable condition known as "water hammer" which is one of the annoying features of many steam installations. The chief advantage of this wash-up equipment is that each man is bound to use a fresh supply of water so that infection is a practical impossibility.

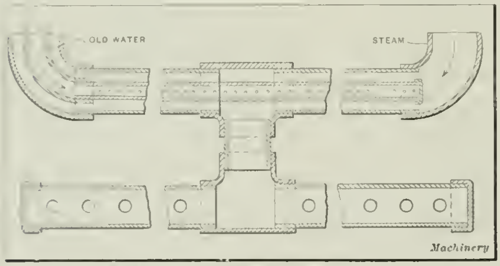


Fig. 2. Noiseless Water Heater for Use in connection with Sanitary Sink

Indianapolis, Ind. JAMES F. HOBART

AUTOMATIC STOP FOR BLANKING DIES

This stop is intended for use on small blanking dies in which the stock is fed through in a long strip. The usual form of stop employed for this purpose is shown in Fig. 1 and reference to this illustration will show that it consists of a pin with one side beveled, the pin being held in contact with the work by means of a spring. To operate this stop, it is necessary to push the stock ahead and then draw it back so that the edge of the hole from which a piece was blanked in the preceding operation, comes into contact with the stop pin. It will be evident from this that a double movement is required, i. e., to first push the stock ahead more than the required distance and then pull it back into contact with the stop. The advantage of the mechanism shown in Fig. 2, which forms the subject of the present article, is that the operator is only required to push the stock ahead until it engages the stop, thus doing away with the double movement.

Referring to Fig. 2, it will be seen that this improved stop mechanism consists of a trigger *A* which is pivoted on the pin *B*. The trigger works in a tapered slot in the stripper plate which allows it a sidewise movement of about 1/32 inch. A helical spring *C* pulls the point of the trigger down and tends to hold it on the side of the slot nearest to the advancing stock. A trip screw *D* is screwed into the upper member of the sub-press die directly over the trigger, and is so adjusted that it will cause the point of the trigger to be raised as soon as the punch has started operating on the stock. The method by which this mechanism operates is as follows: When the stock is pushed forward against the trigger, the latter is moved over to the far side of the tapered slot and the stop locates the stock in the required position for punching. As soon as the punch engages the stock, the trip screw *D* strikes the trigger and raises this point out of contact with the stock. As soon as the point of the trigger is out of the hole in the stock, the spring *C* pulls it to the opposite side of the tapered slot so that when the punch rises and the trigger is allowed to drop, the stop comes down on top of the stock instead of in the hole produced by the blanking operation. Consequently, the stock can be pushed forward until the stop drops into the next hole and the movement of the stock is then continued to the position for the next punching operation. The point of the trigger is beveled at the back to provide for withdrawing the stock if necessary. The sliding stop *E* is placed in the stripper plate to locate the end of the stock in the proper position for the first operation with progressive blanking dies.

Detroit, Mich. R. A. BLACK

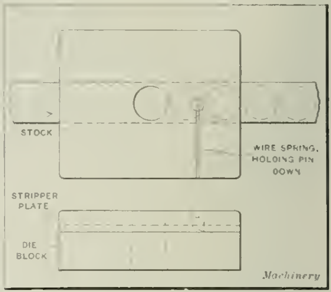


Fig. 1. Stop Mechanism requiring Double Movement to locate Stock

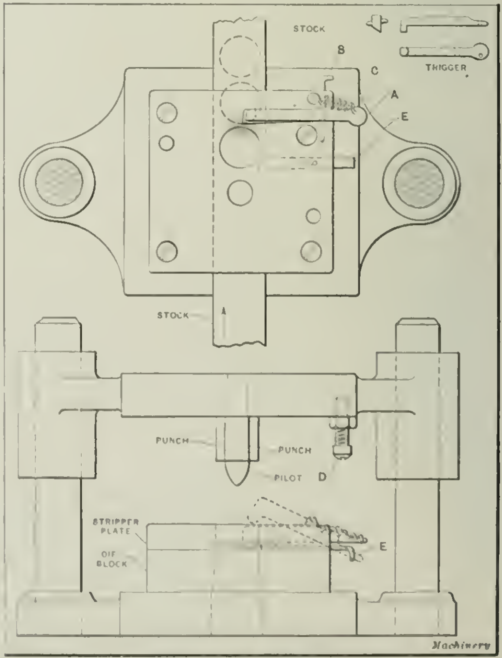


Fig. 2. Improved Form of Stop Mechanism for Use on Progressive Blanking Dies

A VISE DRILLING JIG

The accompanying illustration Fig. 1 shows a quick way for drilling and milling an elongated hole in a piece of work where the limit of accuracy required is not less than ± 0.003 inch. The writer having several hundred shafts *A*, Fig. 2, to machine, realized that after the drilling operation, to elongate the hole *a* with an end mill in a milling machine and produce the work cheaply and quickly would result in considerable tool breakage, besides handling the work twice. So the following method was employed with success.

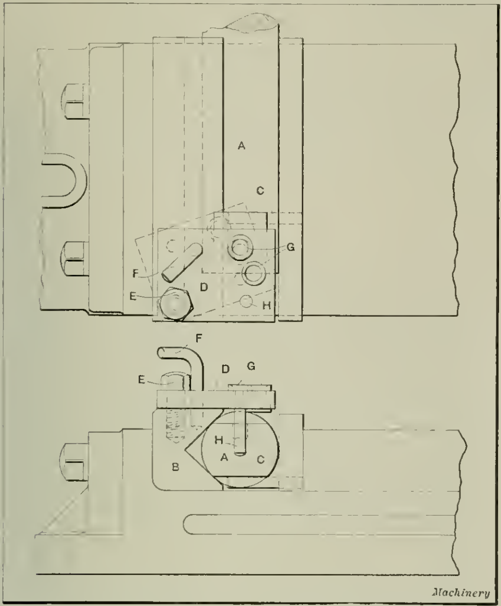


Fig. 1. Vise Drill Jig with Swiveling Leaf for forming an Oblong Hole

A flanged milling machine vise was fitted with a special jaw having a V groove cut lengthwise, as shown at *B*, Fig. 1. Pin *C* was put into a soft jaw on the movable slide of the vise and located so the milled surface of shaft *A* would rest on the upper surface of the pin and hold the shaft level for drilling. Bushing plate *D* was next put on and held in place by a cap-screw *E*. Bushing plate *D* was then laid out and drilled and reamed in position for the locating pin *F* and the drill and counterbore bushings *G*. The stop-pin *H* was located in the bushing plate *D* to insure getting the right location of the drilled hole from the end of the shaft *A*.

After the hole was drilled the locating pin *F* was pulled out and the plate *D* swung around from the first position, as shown by the dotted lines, to the second position, and pin *F* was inserted in another hole. Each hole for pin *F* was pin *F* was inserted in another hole. Each hole for pin *F* was located so as to bring the bushing plate *D* into the proper positions for drilling and counterboring. The special counterbore or mill *K*, Fig. 2, was then used through the bushing *G* to elongate the hole to the proper size and depth. This counterbore was made from drill rod of the same diameter as the width of the elongated slot in the shaft. Four teeth were cut in the end and it was then hardened and tempered. This made a cheap and efficient tool.

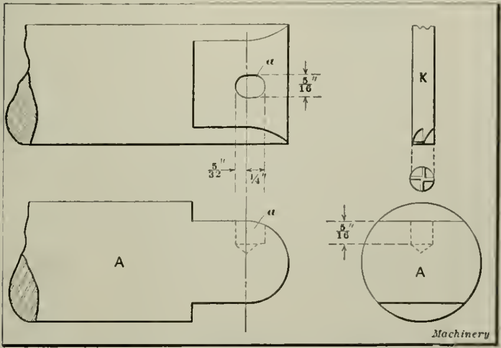


Fig. 2. Work for which Jig shown in Fig. 1 was designed

After the shaft *A* was properly drilled and counterbored, it was removed from the vise, and the bushing plate *D* swung back into the drilling position; this also brings the stop-pin *H* into position for locating the next shaft. Another shaft is now put into the vise against the stop-pin and the previous operations are repeated.

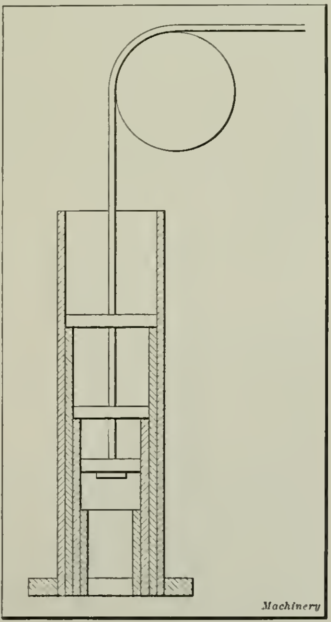
This device has been used with new bushing plates to suit many different kinds of work. For drilling and tapping, when a tapping chuck is used or on a drill press that has a reversible spindle, it will be found to be a very handy tool. After the tap hole is drilled in the work, pin *F* is pulled out and bushing plate *D* can be swung out of the way.

Providence, R. I. Edwin C. Fuller

A VARIABLE COUNTERWEIGHT

In designing a certain automatic machine the problem arose of producing a counterweight which would decrease in magnitude as the weight approached the floor. The desired result was obtained by means of a simple device which is illustrated diagrammatically in the accompanying illustration. It will be seen that it consists of a scale pan which holds a series of weights. These weights are circular disks which are all of a standard thickness, but of different diameters; they are placed on the scale pan so that the weight of smallest diameter is at the bottom and the largest weight at the top. The weights are hung in a guide which is made up of pieces of pipe with internal diameters corresponding to the outside diameters of the weights that are used. These pieces of pipe are cut in varying lengths and set up with the longest pipe—which is also of largest diameter—on the outside, and running down to the smallest pipe which is of the smallest diameter, on the inside.

When this counterweight is in operation, the scale pan is so hung that its center coincides with the center line of the guide. When the counterweight descends far enough to reach the end of the first section of pipe in the guide, the largest counterweight is lifted from the pan. Subsequent weights are lifted as each length of pipe is reached, the operation continuing until all of the weights have been removed. If it is desired to decrease the load on the scale pan by equal increments, the weights may be made of varying thicknesses so that all will be of equal magnitude.



Arrangement of a Variable Counterweight

Owego, N. Y. Sidney K. Eastwood

SHOP AND DRAFTING-ROOM KINKS

INGENIOUS MEANS AND SHORT CUTS FOR SAVING LABOR AND MATERIALS

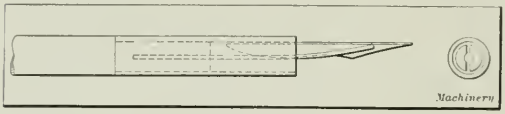
IMPROVED FILE CLEANING METHOD

In MACHINERY for June the writer noticed an article entitled "Method of Cleaning Files." In the method described copper was employed as the cleaning element. The writer has found, from experience, that copper is fairly good for this purpose, but that sheet-fiber is much better. Another improvement is to cut the fiber into a disk about 6 inches in diameter and mount it on an ordinary emery wheel stand. When the file to be cleaned is held against this revolving disk or fiber it will be cleaned much quicker and better than would be possible by hand, or by the copper method. Fiber ¼ inch thick is best suited for this purpose.

East Orange, N. J. G. N. GARRISON

AN IMPROVED PEN POINT

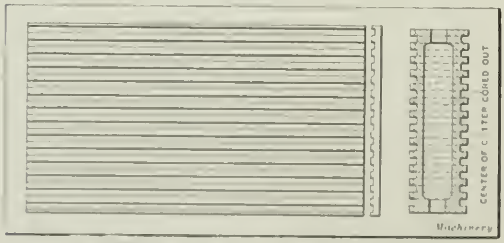
Those who have facilities for making blueprint copies of drawings frequently find it convenient to use the same method for producing duplicates of bills of material and many similar documents. Some use the typewriter for making the original copy and get fairly good results in this way, but the best blueprints are only obtainable where India ink is employed. To improve a pen point for this purpose, a small round wire may be inserted in the wooden center of the pen holder with the end extending out just far enough to reach the under side of the pen at about ¼ inch from the point. With such a pen, India ink will flow freely and evenly. The arrangement is clearly shown in the illustration. A piece of German silver wire is best for this purpose, although a satisfactory substitute may be obtained by straightening out an ordinary paper clip and cutting off a piece of the required length. It is not claimed that this is a new idea, but the writer believes there are many who have not heard of it and that it may prove valuable to readers of MACHINERY. R. J. D.



An Improved Pen Point

A BRASS MILLING CUTTER FOR HARD RUBBER

We have quantities of hard rubber plates ⅝ inch thick by 14 inches wide by 24 inches long, that have fourteen grooves ½ inch wide by 1/16 inch deep to be milled in them. These grooves are cut lengthwise on one side of the plate, as shown in the accompanying illustration. The cost of making a gang mill and keeping it sharp was rather high, and after experimenting we found that a cutter made of hard brass stands up well. Such a cutter does not last as long as a steel cutter would, but when it gets a little dull it can be sharpened with a file without the necessity of grinding. The formula for the brass from which this cutter was made is as follows:



Brass Milling Cutter and Hard Rubber Piece to be milled

Copper	78 per cent	Lead	5 per cent
Tin	12 per cent	Zinc	5 per cent

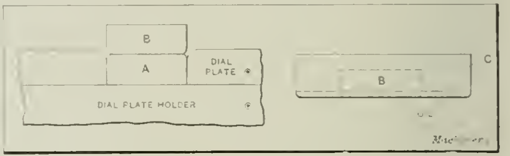
Add a stick of phosphorus and stir the metal well before pulling the pot from the furnace.

Swissvale, Pa. WILLIAM MUASCH

A DIAL PRESS KINK

The following describes a little kink that the operators in our dial press department make use of, and although it is not exactly new it will doubtless prove useful to those who are not familiar with it. In handling shells in a dial press, it sometimes happens that the operator puts one in the dial the wrong way, *i. e.*, bottom side up, as shown at *A*. This shell can be removed in less time than it takes to tell about it, by placing the oiled bottom of a second shell *B* on top of the shell *A*. The application of a slight pressure causes the shells to stick together and it is then an easy matter to lift out the shell *A*. This method is far better than one which the writer has often seen used where a "picker" is jammed into the bottom of the shell *A* to remove it. This obviously destroys the shell for further use. By way of conclusion, it may be mentioned that the shell *B* is kept in a larger shell *C* which contains just enough oil to keep the bottom of the shell *B* covered at all times. This shell is kept within reach of the operator so that it is always ready for immediate use.

MIDDLE WEST

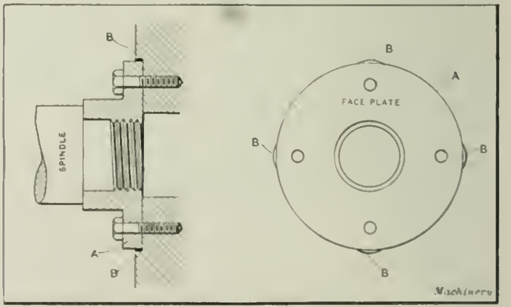


Easy Way of extracting an Inverted Shell from a Dial Feed Plate

TRUING UP A LATHE CHUCK

A lathe chuck that runs out of true may be brought back into condition to produce accurate results by the following method: After the threaded chuck faceplate has been thoroughly cleaned, a light cut is taken over the circumferential surface of faceplate *A*. Three or four spots of solder *B* are then applied at equal distances apart around *A*, after which these spots are turned off to fit accurately into the recessed portion of the chuck, while the faceplate is screwed onto the lathe spindle. These solder spots *B* are merely relied upon to locate the chuck in the required position, after which the screws are tightened to hold it in place.

Wollaston, Mass. GEORGE L. COLBURN



Method of truing up a Lathe Chuck with Solder

• • •

The oxy-hydrogen blow-pipe was invented early in the last century by an American, Robert Hare, at the age of twenty.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

TO PREVENT GUMMING OF MACHINES BY MIXTURE OF STARCH AND OIL

H. W. D.—Where I am employed, there are a number of automatic wrapping machines which give much trouble by becoming stuck. Considerable starch is used on the product wrapped, and this falls on the working parts of the machine, absorbs the oil and forms a hard and gummy coating. The machines are so constructed that it is impossible to shield the working parts. We are using machine oil as a lubricant, but have tried gasoline, and machine oil mixed with kerosene, and found that they made the machines stick worse. When the machines become stuck, we use soda water to loosen them and then apply machine oil.

A.—Perhaps deflocculated graphite in one of the several forms available could be used successfully. Suggestions from the readers are invited.

ECCENTRIC-OVAL GEARING FOR QUICK-RETURN MOTION

G. H. B.—I was recently called upon to design a set of gears of the form illustrated in Fig. 2, and was unable to carry the work through methodically. Finally, I arrived at as accurate a solution of the problem as was possible by a purely cut-and-try method. The gearing in question was for the drive of a slotting machine and was required to give a ratio between the quick-return speed and the cutting speed of about 1.8 to 1. During the cutting stroke, the 15-tooth pinion is in mesh with the half spur gear *A*, and must be so designed that as soon as a cutting stroke is finished, the 22-tooth eccentric pinion comes into mesh with the elliptic segment gear *B*. The number of teeth in the elliptic segment gear is the same as in the pinion which meshes with it, *i. e.*, 22 teeth. My chief difficulty lay in determining the required shape for the elliptic segment gear *B*. Any information in regard to the solution of this problem would be greatly appreciated.

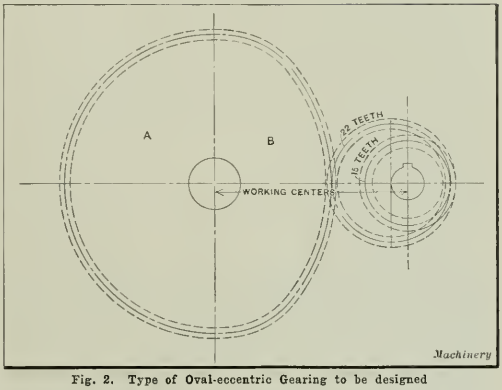


Fig. 2. Type of Oval-eccentric Gearing to be designed

Answered by Frank B Smith

On all shapers, slotters and other machines of like nature, it is desirable to have a slow, strong, even stroke on the forward movement of the tool with a quick return to the starting position after finishing the cut. To accomplish this many inventors have spent much time and energy in producing various devices, most of which have more or less merit. But in nearly all of them there is one radical fault, which is that while a slow advance with a quick return is given to the tool, the cutting stroke is not made at a uniform speed but begins with a gradually retarded motion, and then, in the last half of the stroke, the speed begins to accelerate again. This change, while hardly noticeable to the casual observer, puts an uneven strain on the cutting tool, causing it to spring more at one point than another, which results in a cut of varying depth and chips of unequal thickness. This fault, while of no great importance where the cut is short, makes a material difference on cuts of greater length when very close work is desired. It was to overcome this defect and to produce a machine with an absolutely uniform motion during the entire cutting stroke, that the novel combination of oval-eccentric and spur gearing shown in Fig. 1 was designed.

The oval gear shown in Fig. 1 makes but one-half a revolution to each complete revolution of its eccentric driving pinion. Therefore, we may cut away half of the oval gear, as shown in Fig. 3, and mount it on the same shaft with half of a regular spur gear made like that shown in Fig. 4, the pitch diameter of which is equal to the major axis of the oval gear. And then on the shaft with the eccentric driving pinion, we will place an ordinary concentric pinion, the pitch diameter of which is equal to one-fourth that of the half spur gear, mounting this pinion so that it will engage the half spur gear when the eccentric pinion has swung the oval gear into the position shown in Fig. 1. At this point, the eccentric pinion ceases to drive the oval gear, owing to half of it being removed, as already mentioned and shown in Fig. 3. The concentric pinion now engages the teeth of the half spur gear, picks up the load and continues to drive it through the next half revolution of the oval gear shaft, or until the teeth of the working half of the oval gear are again engaged by the eccentric pinion. Owing to the difference in diameters of the half spur gear and its pinion, the latter must make two revolutions before the eccentric pinion

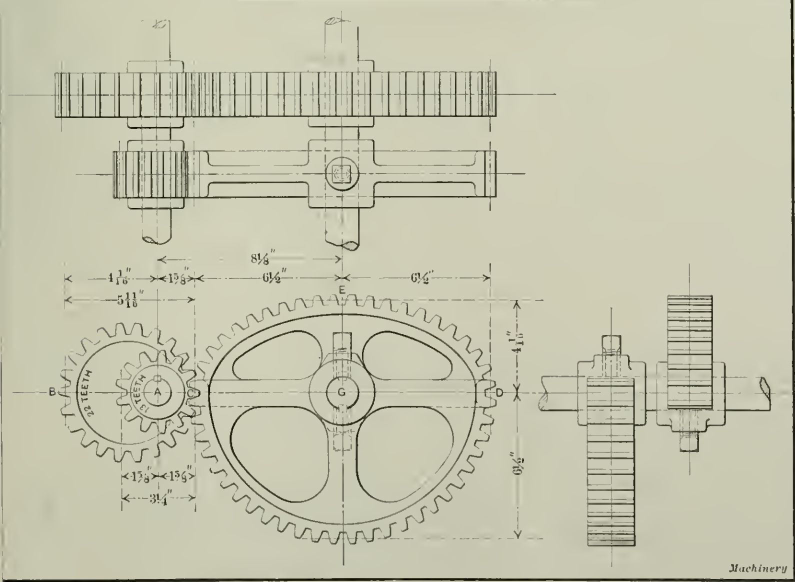
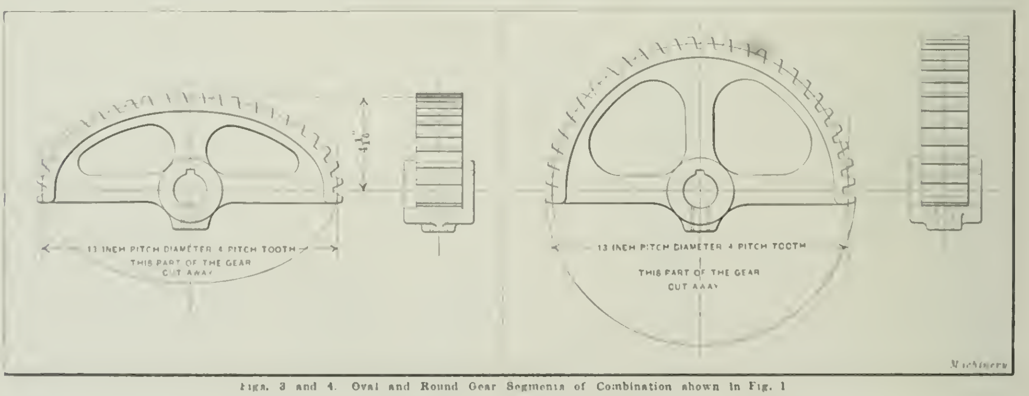


Fig. 1. Quick-return Gearing with Ratio of 2 to 1

can again engage the teeth of its oval mate. It will be noticed that when the eccentric pinion picks up the load it does so at the same speed at which the concentric pinion left it, due to the fact that the short segment of the axis is equal to the radius of the concentric pinion. Now as the eccentric pinion begins to swing the oval gear around, the gear will gain speed until it reaches a point where the long segment of the axis of the eccentric pinion is opposite the minor axis of the oval gear, when it has reached the maximum speed. After that, the speed of the oval gear will gradually decrease until it again reaches that of the concentric pinion, whereupon it will be once more picked up by the concentric pinion and the same cycle will be repeated.

It will be observed, if the foregoing has been carefully followed, that for each three revolutions of the pinion shaft the oval gear shaft makes but one, and that while it takes two revolutions of the concentric pinion to cause the oval gear shaft to make one-half a revolution, the eccentric pinion will drive the oval gear the remaining half revolution while making one turn. It will also be seen that the concentric pinion drives the half spur gear on the oval gear shaft at a slow and uniform speed, during which time the tool should make the cut. After this the eccentric pinion starts to drive, the oval gear rotating slowly at first but gaining headway, reaching the maximum and then falling back to the original slow speed. During this time the tool-head is returned with a quick motion to the starting position ready for the next cutting stroke. The ratio of the quick return to the cutting speed must not be too great or else a jerky motion will ensue that will cause an excessive vibration in the machine. It has been found by experiment that a ratio of 2 to 1 is about the best speed at which the tool can be run, and fortunately, by the combination just described, we obtain this proportion with a smooth easy change from fast to slow, approaching as nearly as possible the ideal motion.

To thoroughly understand the principles involved in the laying out of these gears it may be well to take a specific case and follow it through the several operations required to develop it, from the drawing on paper to the finished pattern ready for casting. As the main feature of this combination of gearing is the oval-eccentric pair, on the proper construction of which depends the success of the quick return, we will give it our special attention, examining the points that determine its size and shape. It may be well, however, before attempting to do any drawing, to state briefly a few cardinal points that are absolutely without change in all gears of this form. First, the long segment (*AB* in Fig. 1) of the eccentric pinion in all oval-eccentric pairs is equal to one-half the distance between the centers of the shafts. Second, the short segment (*AC* in Fig. 1) of the eccentric pinion is equal to one-half the diameter of the concentric pinion running on the shaft with it. Third, the true diameter (*BC* in Fig. 1) of the eccentric pinion equals the sum of its long and short segments (or *AB* + *AC* in Fig. 1). Fourth, the major axis (*CD* in Figs. 1 and 5) of the oval gear is equal in all cases to twice the distance between the shaft centers, less twice the short segment (*AC* in Fig. 1) of the eccentric pinion. Fifth, the minor axis (*EF* in Fig. 5) of the oval gear equals in all cases the distance between the centers of the shafts. Sixth, the oval gear, if complete (as shown in Fig. 5) should have twice the number of teeth that there are in its eccentric driving pinion, and the number of the teeth in both the oval gear and eccentric pinion should be even. Seventh, the shaft hole (*G* in Figs. 1 and 5) of the oval gear is always placed at the intersection of the major and minor axes, or in other words, in the exact center of the oval gear.


13 INCH PITCH DIAMETER 4 PITCH TOOTH
THIS PART OF THE GEAR CUT AWAY
13 INCH PITCH DIAMETER 4 PITCH TOOTH
THIS PART OF THE GEAR CUT AWAY
Machinery

Figs. 3 and 4. Oval and Round Gear Segments of Combination shown in Fig. 1

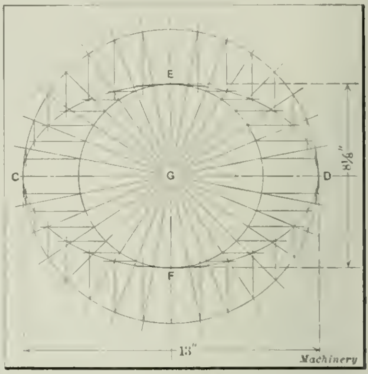


Fig. 5. Diagram showing Method of laying out Oval Gear Segment

With the foregoing rules in mind, let us consider the proper pitch for the gear teeth. These should be of a size to stand up well under the work and show little loss from wear. As 4 diametral pitch answers these requirements and is a good rugged tooth, we will accept it without question for use in this case. Now as the half spur gear makes but one-half a revolution to each two revolutions of its concentric driving pinion, it naturally follows that it must have twice the number of teeth in half its circumference as are contained in the entire periphery of the concentric pinion that drives it. In other words, if the gear were a complete circle, it would have four times the number of teeth in its pitch line that are contained in that of the concentric driving pinion. If, therefore, we assume this circle to contain 52 teeth, then the pinion should have one-fourth that number, or 13 teeth. If we use a 4-pitch tooth, the pitch diameter of the larger gear would be equal to 52/4 or 13 inches, while that of the pinion would be 13/4 or 3¼ inches. As the distance between the centers of the shafts is equal to one-half the sum of the pitch diameters of the intermeshing gears running on them, it would, in this case, equal $\frac{13 + 3\frac{1}{4}}{2}$ or 8⅛ inches.

Now let us consider the eccentric pinion. We know its long segment to be equal to one-half the distance between the centers of the shafts, also that the short segment is equal to one-half the diameter of the concentric pinion running on the same shaft with it. Therefore, the long segment will equal $\frac{8\frac{1}{4}}{2}$ or 4 1/16 inches, while the short segment will equal

$\frac{3\frac{1}{4}}{2}$ or $1\frac{5}{8}$ inch. Now as the true pitch diameter of the eccentric pinion is equal to the sum of its long and short segments, it will, in this case, equal 4 1/16 + 1 5/8 or 5 11/16 inches. This pitch diameter multiplied by the pitch of the tooth gives 4 × 5 11/16 or 22 3/4 as the number of teeth in the pitch circle. This, of course, is impossible, and as it is necessary that the number of teeth in the eccentric pinion be even, we will ignore the extra ¾ tooth and use but 22 teeth. This will necessitate spacing them slightly farther apart, but as the error per tooth is only 0.026 inch, it will not be noticeable on a four-pitch tooth in a gear of this size.

The oval gear should next receive our attention. We know the major axis is the same as that of the half spur gear, which we have found to be 13 inches. Its minor axis is equal to the distance between the shaft centers or 8⅛ inches. Having these figures to work with, we may proceed to construct the oval pitch line of the gear as shown in Fig. 5. First draw the major and minor axes *CD* and *EF*, respectively. Then with *G* as a center and a radius equal to *GD*, draw a circle as shown; and again, with *G* as a center and a radius equal to *GE*, draw another circle concentric with the first. Now draw a series of equidistant radial lines converging to a common point in the center at *G*, and from the points where they cut the smaller circle, draw horizontal lines parallel to the major axis and extending outward from the circle. Then from the points where the radial lines cut the larger circle, draw vertical lines parallel to the minor axis and intersecting the previously drawn horizontal lines at points between the two circles. The points just found lie in the periphery of the oval and by connecting them with suitable curves, the oval pitch line may be laid out. Great care should be taken in obtaining these points to have them absolutely correct and the curves connecting them smooth and even. Otherwise, difficulty will be experienced in finishing the gears so they will run freely.

After having obtained the pitch line, lay off the tops and bottoms of the teeth parallel to it and draw in the teeth. If the dividers are used for spacing the teeth, it is advisable to set them at one-fourth the circular pitch, in order that the curve of the pitch line may be more closely followed, the position of the tooth being located by marking every fourth step. When the circular pitch of a given tooth is not known, it may be readily found by dividing 3.1416 by the diametral pitch, and if this be again divided by 4, it will give the proper setting for the dividers. After completing the drawings of the gear, they should be placed in the patternmaker's hands and he should proceed as follows, to make the pattern. First, having prepared a suitable wooden blank, he must make an accurate reproduction of the draftsman's drawing on it, showing the teeth and all other essential parts of the gear. Then with great care, the form of each tooth should be worked out, cutting away the wood until the teeth are all properly shaped. When this has been satisfactorily accomplished, the wooden pattern may be waxed and iron patterns cast from it. In a shop where there is regular gear-cutting machinery, the patternmaker can save himself a lot of unnecessary labor by having a rack of proper size and pitch cut out of a straight piece of clear grained hard wood. From this rack he may remove the teeth and fasten them onto the oval gear blank, one by one, with wire brads and glue. In this case, the gear blank should be shaped to the root diameter of the gear instead of the outside diameter, as in the former case.

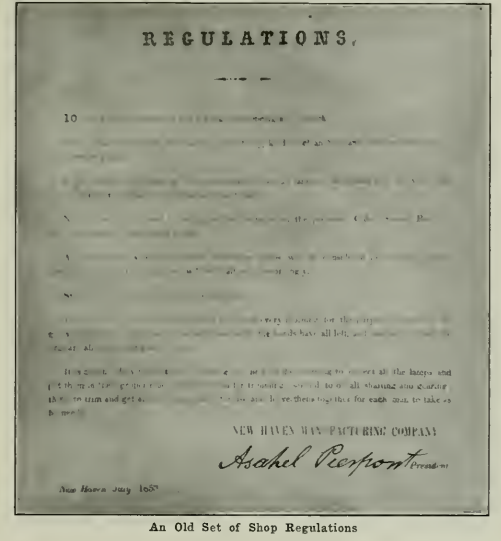
The eccentric pinion running with this oval gear is nothing more than an ordinary circular pinion with the shaft hole set off center, and it may be formed in a manner similar to the oval gear, the teeth being fastened to the blank by the method just suggested for those of the oval gear. This will often save a lot of trouble when the pitch circle is of such a size as not to divide easily into an even number of teeth. It is essential, in laying out the oval gear, that both ends of the major axis should bisect a space as shown in Figs. 1 and 3, owing to the fact that in a normally formed oval-eccentric gear pair, the eccentric driving pinion makes two complete revolutions to each one of the oval gear and so corresponding points on the opposite side of the oval should be constructed in like manner; otherwise, the eccentric pinion, which should have a tooth at the end of both the long and short segment of its axes, as shown in Fig. 1, will not mesh properly with it.

* * *

SHOP REGULATIONS OF 1853

Hanging on the wall of the office of the New Haven Mfg. Co., New Haven, Conn., is a set of regulations that was printed, framed and hung in the shop during its early days. This concern was started in 1851 by Asahel Pierpont who, coming from Springfield, Mass., with several associates, interested New Haven capital and started the company. Like many other shops, this concern started on a small scale but after two years its growth had been so rapid that posted regulations for the guidance of the workmen were deemed necessary. Accordingly, this set of regulations was hung in a conspicuous location in the shop. In general, it will be seen that the requirements of sixty years ago were not materially different from those of today, especially as regards the use of intoxicating liquors, or as regulations 4 and 5 put it, "The bringing into the shop of cider, strong beer, etc., is prohibited," and "Dram drinkers and frequenters of tippling shops" are looked on with disfavor. The regulation for the control of the kerosene lamps was given specifically, as these no doubt were a source of trouble and a fire risk.

C. L. L.



REGULATIONS.

NEW HAVEN MANUFACTURING COMPANY

Asahel Pierpont President

An Old Set of Shop Regulations

* * *

GERMAN DEFINITIONS OF MACHINE TOOLS

The German definition of machine tools, according to the information published by the British Board of Trade, is as follows: 1. Machines which remove a certain portion of the material during the processes of working, whether in metal or wood. Such machines are lathes, planers, slotting machines, mortising machines, boring machines, milling machines, molding machines for wood, shapers, filing machines, grinding machines, and saws. 2. Machines which cut the material, whether metal or wood. Such machines are shearing machines, punching machines, file-cutting machines, wood-planing machines, and chopping and splitting machines. 3. Machines which alter the form of the material without removing a part thereof. These machines include bending machines, straightening machines, nail-making machines, polishing machines, and wood-working pressing machines. It is evident that with this very broad definition of the expression "machine tool," which differs considerably from the meaning of the same term in this country, a comparison of the trade in machine tools of Germany and of the United States is difficult to make, as here we do not include woodworking machinery under the head of machine tools.

TRAINING FOR FOUNDRY LEADERS AT WENTWORTH INSTITUTE*

The progress, growth and ultimate development of the foundry industry must depend upon two principal factors. First: the supply of intelligent workers to fill places in the rank and file. Second: the ability, foresight and capacity for leadership of those who are controlling American foundries and foundry operations. The leader in the modern foundry has a variety of responsibilities. His work includes getting business, managing men, the up-keep of complicated mechanical equipment, the development of improved methods of foundry practice, the improvement of the quality of the product and the reduction of production costs. In order to fill his position efficiently, the foundry leader must possess ability which will enable him to do any of the work incident to the operation of his shop, with his own hands. He must be able to know what is a fair day's work and be in a position to instruct his men in any of the work handled in the foundry, or new work which is likely to come in from time to time. His knowledge of the details of foundry practice must be sufficiently intimate to enable him to order each job handled by the most efficient method—which means that the most efficient equipment for this particular job must be used—and the work must be handled in a way which will enable the quality of the product to be at least as good, if not better, than that turned out in competing foundries. In addition, the foundry leader must have sufficient engineering training to enable him to exercise supervision over the generation of steam, the transmission of power, the use of suitable methods of ventilation and the application of electricity and compressed air.

General View of Wentworth Institute Foundry

Speaking generally, manufacturers appreciate the importance of scientific methods of management and recognize the advantages to be derived from their adoption. But although they understand the value of scientific control of foundry operations, there are a large percentage of foundries where antiquated methods are still in use. Such foundries are forced to continue operating in this way because of their inability to get men with the training and capacity for leadership which is required for operation in accordance with the best accepted standards of the trade. Apprenticeship systems, as carried on in the average foundries, do not produce men with the proper training for successful management of a plant in accordance with the standards outlined in the preceding paragraphs. It will also be evident that practical experience is no longer sufficient to meet existing conditions in the trade and that "rule-of-thumb" methods will not solve the kind of problems which the modern foundryman has to deal with.

Realizing this situation, the Wentworth Institute, Boston, Mass., is now offering a two-year course designed to train men to fill managerial positions. This course is intended to train young men to fill advanced positions in the foundry industry—the positions which require a combination of skill, intelligence and technical knowledge. The intention is to give a broader practical training and a more thorough comprehension of the scientific principles that underlie modern foundry practice than can be obtained through practical experience in commercial shops. First: this course includes a variety of foundry work, and by exercising a careful supervision over individual students to avoid having them do the same work an unnecessary number of times, the equivalent of four or five years' experience gained by following the usual course of apprenticeship, can be secured in two years at the institute. Second: the kind of information that the apprentice is unable to obtain is secured at the institute by text book study, practical talks and lectures. Third: the foundry leader of today must have ability to express his ideas graphically and to read blueprints and drawings. To meet this requirement, the curriculum at the Wentworth Institute includes a course in drafting and design.

Fourth: as rapid and accurate computations of a great many kinds must be made in the foundry, a systematic course of instruction in making estimates of costs and quantities of material, and various other calculations involving the use of formulas of a more or less complicated character, is given. Fifth: the general principles of engineering and applied science which the progressive foundryman should have a knowledge of, are taught; and a special laboratory equipped with the necessary equipment is provided in order that the students may obtain practical knowledge of this part of their profession. Sixth: special emphasis is laid upon instruction in foundry chemistry, and in chemical and metallurgical engineering. This part of the course includes a particularly thorough training in the principles of combustion and the effects of temperature. Two laboratories are devoted especially to this part of the work. Seventh: as it is believed that the capacity for leadership can be developed, the students at the institute are given the opportunity to act as foremen, directing work of an increasingly difficult and complex character as their capacity for duties of this nature increases.

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* Abstract of a paper read before the annual convention of the American [illegible] Association in Chicago, October 5-11, 1914.

* * *

ELECTRIC CONDUCTORS

It is well known that the resistance of metal conductors to the flow of electricity diminishes with a decrease in the temperature. In the case of very pure platinum, for instance, the resistance at the lowest temperatures obtained with hydrogen—between 423 and 434 degrees F. below zero—is only 1/100 of the resistance at ordinary temperatures. In the case of very pure gold, the resistance at this temperature is only 1/300 of the resistance at ordinary temperatures. In 1908, Prof. Onnes succeeded in liquefying helium, and in this way was able to reach temperatures around 455 degrees F. below zero. He concluded that at these low temperatures the resistance to electric currents in metals would be almost negligible, and from experiments undertaken he has arrived at the conclusion that with absolutely pure platinum, as well as with other metals, the resistance is so small that it is non-measurable. A coil was made from fine lead wire having a diameter of 0.0006 inch, the length of which was one centimeter (0.4 inch approximately), containing 1000 turns per centimeter. At the liquefying point of helium, a current of 0.8 ampere would be transmitted through this wire without encountering any measurable resistance. Hence, it follows that an electric current can be induced in a conductor at extremely low temperatures and continue to flow without electromotive force acting in the circuit. In fact, Prof. Onnes has calculated that in the lead coil mentioned it would take more than a day for the current to die out at the extremely low temperature under consideration.

* * *

It is stated in the *Scientific American* that if oxygen is added to the air-blast for a blast furnace, so that it is present to an extent of 23 per cent in the air instead of the normal 21 per cent, there is a saving of from 110 to 130 pounds in the amount of coke required to smelt a ton of iron, and the iron produced is said to be of a higher quality.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

BAUSH MULTIPLE SPINDLE DRILL

To meet the requirements of the Ford Motor Co. in drilling flywheels, the Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass., has recently built two multiple spindle drilling machines, one of which is illustrated in Fig. 1. These machines are made in three different sizes, and are adapted for a variety of multiple drilling, reaming, counterboring and similar operations. It will be evident that the design has been worked out in such a way that holes can be drilled on the closest possible centers. This is due to the fact that holes which are located too close together to be machined by drills held in the same head, may be handled by successive heads on the machine. The multiple head feature also makes it possible for heavy and light drills to be grouped together so that both may be operated at suitable speeds and feeds.

It has already been mentioned that these machines were built for drilling flywheels in the plant of the Ford Motor Co., but it must not be thought that this is a single-purpose machine, for after reading the description it will be evident that there are a great many classes of work that could be handled on it in a very advantageous manner. There are eighty-one drilling operations on the Ford flywheel, and using this machine it has been possible to perform all of the drilling operations on a wheel in fifty-four seconds. Two of these machines which are now in use are drilling 1000 flywheels in eight hours with an actual rate of production of 510 wheels for each machine in 450 minutes. The operations illustrated in Figs. 2, 3 and 4 consist of first drilling sixteen holes in the inner circle through about $1\frac{1}{8}$ inch of metal, and sixteen holes on the outer circle half way through the same thickness of metal: second, counterboring the sixteen holes in the inner circle and drilling the holes in the outer circle through the remaining metal, a smaller sized drill being used for this purpose; third, milling or counterboring three half round faces in the hub of the wheel; fourth, drilling nine holes near the center of the wheel; fifth, reaming five holes. Each of the tools employed for these operations is operated at the proper speed and feed, and each cluster is provided with a jig which is used at that station and no other.

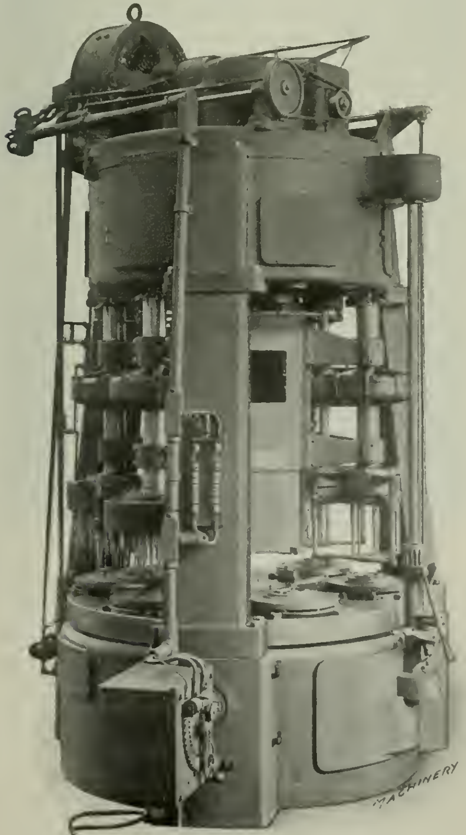


Fig. 1. Baush Multiple Spindle Machine for drilling Ford Flywheels

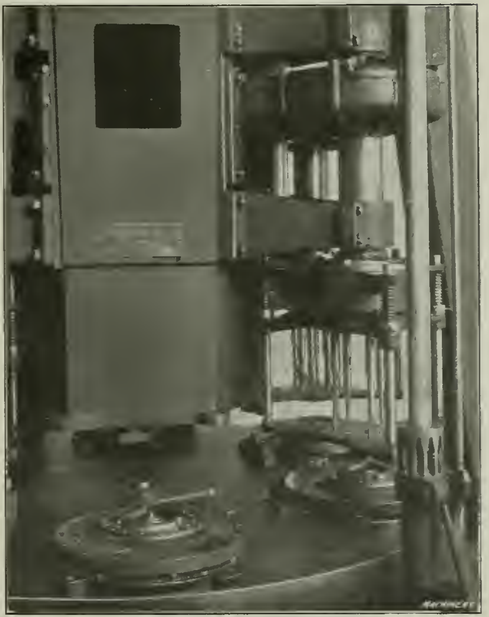


Fig. 2. Loading Station where Work is set up on Machine

In operating the machines, each flywheel is placed on a supporting block and secured by means of an expanding center. The "loading station" of the machine is illustrated in Fig. 2, and the wrench used for expanding the center on which the flywheel is held is also shown in this illustration. The counterbore in the wheel, which is the important part, is used to locate the work under each jig, this result being obtained by a tapered leader which enters the counterbore as the jig at each station on the machine comes down to the working position. In addition to this counterbore, there is a flat dowel in the supporting block which registers between two jaws on the extreme outside portion of the jig, thus securing the wheel against rotation.

The feed is accomplished by means of a barrel cam which is of the correct form to give a quick approach, and the desired rate of feed and return. By employing different cams, suitable rates of feed can be obtained for the tools in different heads. The table is rotated by a mechanism which also lifts it, allowing the weight to be carried on a center pintle while it is in motion, and the provision of ball bearings in this connection makes it possible for the table to be moved very easily. A hardened steel locking bolt is

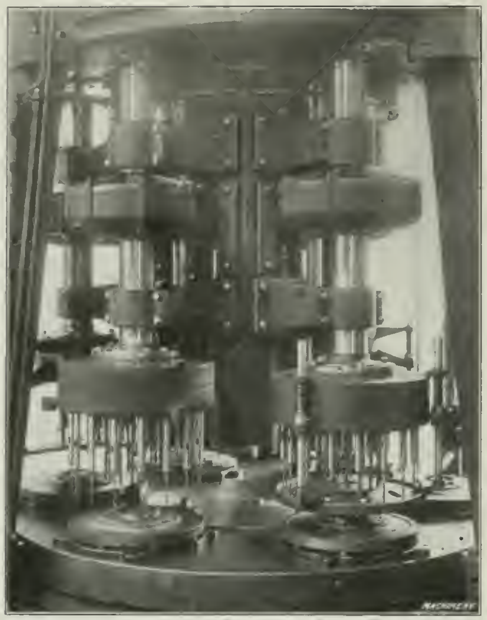


Fig. 3. View showing Different Sizes of Drills grouped in Separate Heads

provided, which is actuated by a cam and comes into play just before the table is lowered to its working position, where the bolt locks the table in place. When in the working position, the table rests on a circular rail which is slightly smaller than its outside diameter, this rail being carried up inside the flange at the periphery of the table to protect the bearing from chips. One central oiling system is provided which delivers lubricant to all bearings, the pump taking the oil from a tank in the base and circulating it through a system of return piping.

Each head is counterweighted, and different standard spindle clusters may be furnished to meet the requirements of different classes of work. These clusters may be readily removed to enable different ones to be substituted. The regular adjustable drill head of the well-known Baush type can also be used to adapt the machine for more or less general classes of multiple drilling. At the loading station shown in Fig. 2 it will be noted that the operator has a switch and starter which control the motor located at his left hand, and a small lever which governs the feed mechanism at his right hand. The last named lever enables him to instantly stop all of the feeding motions, including the indexing of the table, thus placing the machine under absolute control. The drive is from a 25-horsepower Westinghouse motor mounted on the head, power being transmitted through gearing. The machine is of very massive construction, which will be readily appreciated when it is known that the weight is 20,000 pounds.

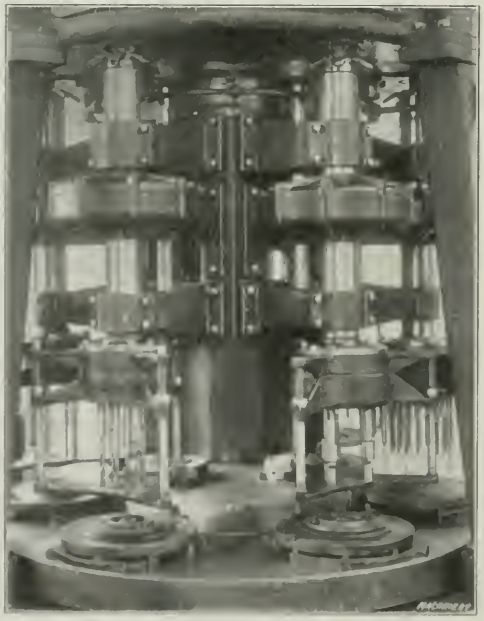


Fig. 4. The Application of Drills and Reamers

O. K. ALTERNATE ANGLE MILLING CUTTER

The O. K. Tool Holder Co., Shelton, Conn., is now manufacturing what is known as an "alternate angle," inserted-tooth milling cutter. The body of this tool is made of chrome-nickel steel and the inserted teeth are forged to the required shape by hydraulic pressure, and held in place by suitable clamping wedges. It will be seen that the teeth are inclined in opposite directions, their angle of inclination with the axis about which they rotate being 20 degrees, and the rake 15 degrees from the radial line. The inserted teeth are provided with shanks which fit into sockets in the body of the cutter, and the wedges which hold the teeth in place are tightened by means of socket head screws. When the screw in each wedge is driven in, the wedge is pulled down and its inclined side bears against the tooth and holds it firmly in place.

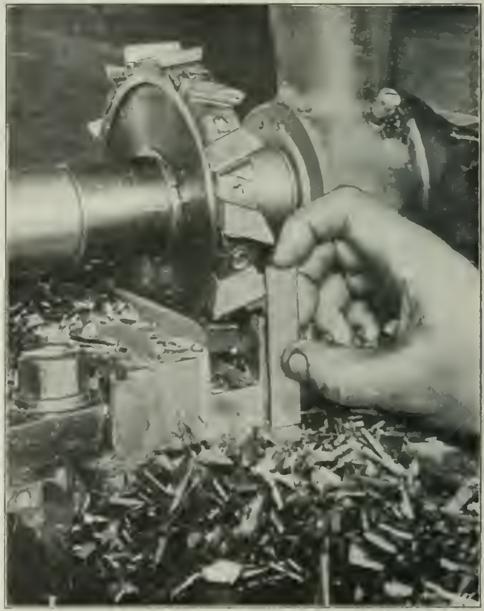


Fig. 1. 6 by 1 Inch O. K. Alternate Angle Cutter in Operation

Fig. 2 shows six of these cutters assembled for a slabbing operation. The cutters are held together by means of bolts which pass through four holes in each cutter, the bolts being of suitable length for the number of cutters which it is required to use. In Fig. 1 a cutter 6 inches in diameter by 1 inch face width is shown milling a 30 point carbon open hearth steel forging. The cutter is run at a surface speed of 190 feet per minute and the work is fed to the cutter at the rate of 4½ inches. It will be seen from the scale held beside the work that the depth of cut is 1¼ inch, and the chips

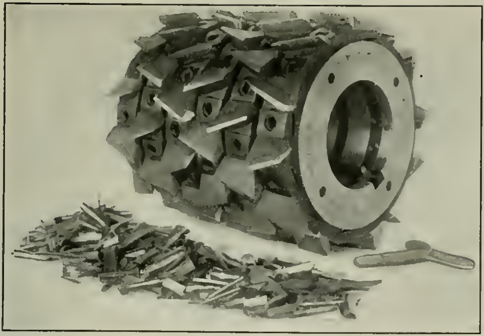


Fig. 2. Six O. K. Alternate Angle Milling Cutters assembled for a Slabbing Operation

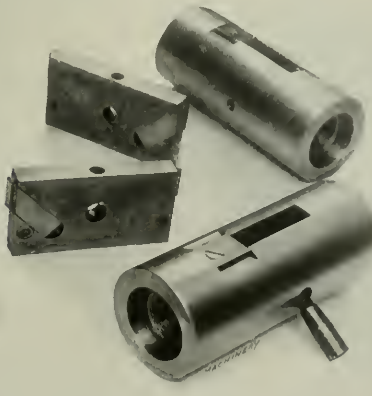
shown in the illustration give some idea of the way in which metal is being removed. Another test made with a cutter 4 inches in diameter by 1 inch face width consisted of driving the cutter at a surface speed of 200 feet per minute, the depth of cut being ½ inch; and under these conditions it was possible to feed the work to the cutter at a rate of 15½ inches per minute. In another test conducted with a 4 by 1 inch cutter, the surface speed of 200 feet per minute was employed with a depth of cut of ⅛ inch; and under these conditions the work was fed to the cutter at a rate of 40 inches per minute. In all of these tests the same material was used.

To give an idea of the capacity of these tools when used in multiple for slabbing operations, the following test may be cited. Four cutters 4 inches in diameter by 1 inch face width were run at a surface speed of 200 feet per minute, with a depth of cut of ⅛ inch. Used in this way it was found possible to feed the work to the cutters at the rate of 12½ inches per minute. A simple test which shows the ease with which these cutters remove metal consists of operating the feed by hand. If this is done, it will be seen that very little force is required to overcome the resistance offered by the work to the passage of the cutters over it.

KELLY BORING OR REAMING HEAD

The XX Type C boring or reaming head which is illustrated herewith is the latest product of the Kelly Reamer Co., Cleveland, Ohio. This head is adapted for use on the engine lathe, turret lathe or vertical boring machine and is made in diameters ranging from 2½ to 6 inches. Kelly boring or finishing reamers from 3 to 12 inches in diameter may be used in different sizes of these heads. It will be seen from the illustration that the head has a threaded socket at each end and pieces of shafting may be screwed into both ends of the head to form a lathe boring-bar of any desired length. When the head is to be used on a turret lathe, only one piece of shafting is screwed into it; and by using a tapered shank in one end of the head, it is converted into a serviceable vertical boring or reaming tool. An important advantage of this construction is that it is only necessary to ship the head to the purchaser, so that the transportation charges on heavy bars are saved.

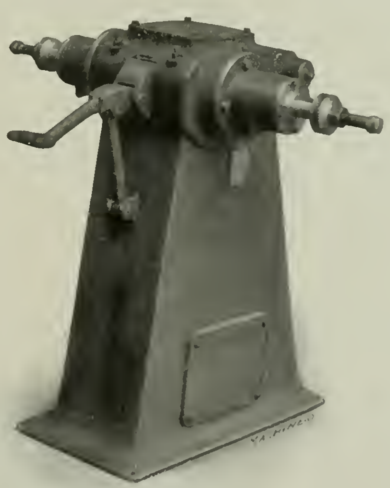
These heads are made with 0.0005 inch side float and 0.00025 inch end float, which experience has shown to be suitable for properly carrying out the floating reamer principle, giving the rigidity of a solid tool and the accuracy and finish to the work obtained with a floating reamer. The roughing and finishing reamers are interchangeable in the slot in the head, and are held in place by the taper locking bolt at the center. This bolt is tightened for the boring operation and loosened slightly to give the reamer the necessary "float" for finishing. Used in this way, a cylinder may be bored to within 0.005 to 0.006 inch of the required size, after which the floating reamer removes the feed marks, insuring the required accuracy and finish. The illustration presented in this connection is a reproduction of what is styled a "mirror" photograph. This is nothing more nor less than a photograph of the head taken in front of a mirror, so that a direct view of one side and a reflected view of the opposite side are obtained. The use of these mirror photographs in mechanical work makes it possible to secure two views of an object with the expense of making only one negative. It will be seen that the reamer and taper locking bolt are shown removed from the head, thus giving a good idea of their form.



Engraving made from "Mirror Photograph" of Kelly Boring Head

NEW BRITAIN BUFFING LATHE

The New Britain Machine Co., 64 Bigelow St., New Britain, Conn., has recently added to its line the ball bearing buffing lathe which is illustrated herewith. The spindle of the machine is driven from below with the belt completely enclosed in the base, so that the danger of accidents resulting from the operator being caught by the high-speed belt is entirely eliminated. This also makes a very compact construction, which results in a material saving of floor space; and the air currents set up by an exposed belt, causing dust and lint to be suspended in the atmosphere of the buffing room, are done away with so that the exhaust system on each machine is able to work at maximum efficiency. As a result, the unhealthful condition produced by having the operators inhaling dusty air is avoided.



New Britain Buffing Lathe with Head in Operating Position

In order to start the machine, it is merely necessary to pull the handle up to the position shown in the illustration. The entire head is hinged at the back, and when the handle is pulled up to the position shown, a toggle joint raises the head sufficiently to bring the belt into contact with the lower

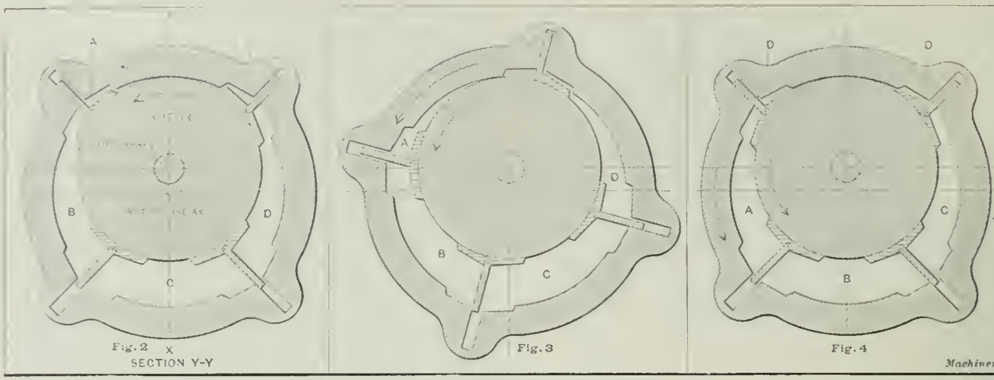


Fig. 2 Fig. 3 Fig. 4

Figs. 2 to 4. Diagrams showing Successive Positions of Air Pocket during ¼ Revolution of Rotor and Rotor Case

or driving pulley. This simple method does away with the necessity for clutches, idler pulleys, loose pulleys, etc., and makes the shifting of belts unnecessary. The belt is adjusted to the proper working tension and is only under this tension while the machine is in actual operation. When the machine is stopped, the tension in the belt is relaxed, and in this way the length of life of the belt is materially increased. The head is of massive construction to avoid vibration, but the toggle action of the handle employed to lift the head and bring the belt into contact with the driving pulley, is such that very little exertion is required to start the machine.

The spindle is made of special carbon steel and is mounted in four self-aligning ball bearings. These bearings are continually oiled and the pressure is distributed over one hundred balls so that smooth running of the spindle is insured at all times. The spindle and pulley may be removed and the lathe taken apart without requiring the belt to be cut; and access to the belt is had through the hand holes on top of the machine and in the side of the base. Single- or double-end shafts are furnished according to the requirements of the shop in which the machine is to be used. As the machine may be started promptly and stopped instantly by means of a brake, there is little time lost in changing buffs, and as a result, it is economical to use double-end spindles with two operators working at each buffing lathe.

WERNICKE-HATCHER ROTARY AIR COMPRESSOR

What represents a radical departure from standard practice in the design of air compressors has been made by the Wernicke-Hatcher Pump Co., Grand Rapids, Mich., in the construction of a new air compressor which has recently been placed on the market. This is of the rotary type and is said to possess several noteworthy advantages over the reciprocating form of equipment. No vibration is introduced at the points of reversal, so that wear resulting from this cause is eliminated; a uniform supply of air is delivered to the receiver; and as the rotor case is rotating at high speed and constantly exposed to fresh air, while the radiating surface remains constant, the possibility of the compressor overheating is done away with, without employing a water cooling system.

The principle upon which this equipment operates may best be explained in connection with Figs. 2, 3 and 4, which are simplified diagrams in which details are omitted and proportions amplified to make the idea as clear as possible. It will be seen that there is a rotor which revolves inside of a rotating case. This rotor has shoes secured to it at equal intervals, and vanes are secured to these shoes which work in grooves in the rotor case. In this way the vanes divide the space between the rotor and the rotor case into pockets. The diagrams show four pockets, but there are eight pockets in the regular compressor. The rotor and the rotor case run at the same number of revolutions per minute, but it will be seen that these two members are carried by shafts that are eccentric to each other. The result is that each pocket between the rotor and the rotor case varies in size according to the position of the rotor and case.

As any given revolution takes place, each pocket gradually increases in volume and draws air into it through the intake valve. When the pocket has reached its maximum volume, the intake valve closes and the continued rotation of the rotor and case results in a contraction of the volume of the pocket. This means that the air in the pocket is compressed, and as the compression continues the outlet valve opens, admitting the compressed air to the receiver. This principle will be readily understood by referring to Figs. 2, 3 and 4, which show the change in volume of the pockets resulting from a rotation of one-fourth revolution. In Fig. 2, the pocket *A* is in its position of minimum volume; in Fig. 3, one-eighth revolution has been completed and the pocket *A* has opened slightly; while Fig. 4 represents a rotation of one-fourth revolution from the position in Fig. 2, or one-eighth revolution from the position in Fig. 3, which has resulted in a further expansion of the volume of the pocket *A*. While this takes place air is being drawn into the pocket, this action being continued until the pocket *A* reaches the condition shown by the pocket *B* in Fig. 4. At this point the intake valve will close and further rotation results in the compression of the air in the receiver.

Fig. 5 shows a cross-sectional view along the line *XX* from

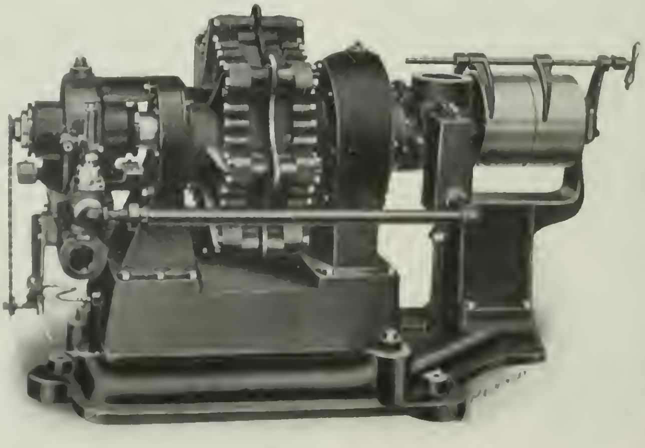


Fig. 1. Wernicke-Hatcher Rotary Type of Air Compressor

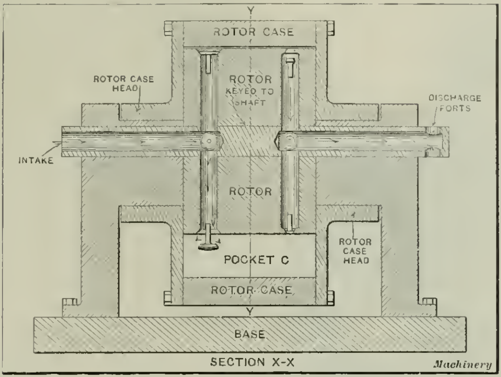


Fig. 5. Longitudinal Cross-sectional View through Rotor and Rotor Case

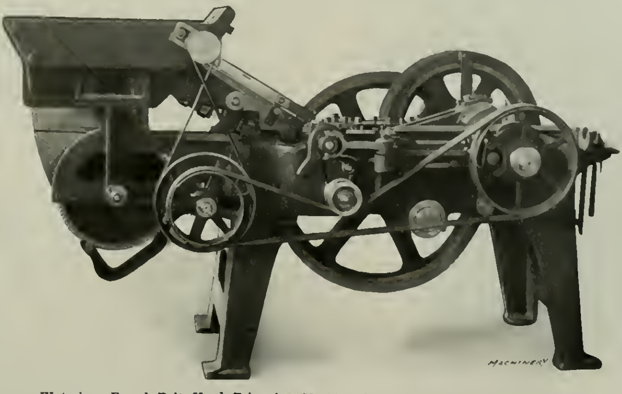
which it will be seen that the intake and discharge ducts are located inside the shaft on which the rotor revolves. Referring now to the general view of the machine shown in Fig. 1, it must be understood that this illustration is located in the reverse position to the cross-sectional view shown in Fig. 5, *i. e.*, the discharge ports are located at the left-hand end of the machine in this illustration, while they are shown at the right-hand end in the cross-sectional view. It will be seen that pulleys are provided for transmitting motion to the gearing which drives the rotor and the rotor case, but individual motor drive may also be employed. At the left-hand end of the machine there is a chain driven pump which draws oil from a reservoir in the base and delivers it to all members which are supplied by a forced system of automatic lubrication. This rotary air compressor is adapted for use in plants where air at a pressure up to 100 pounds per square inch is used.

The machine is 46 inches long by 28 inches wide by 35 inches high. The capacity is approximately 75 cubic feet of air per minute at a pressure of 100 pounds per square inch, when the machine is running at 400 revolutions per minute. Under continuous operation at this speed, the discharge temperature will not exceed 275 degrees F. when the intake temperature is not above 60 degrees F. The weight of the machine without the sub-base is 1400 pounds.

WATERBURY-FARREL BOLT HEAD TRIMMING MACHINE

To meet the demand for automatic machines for trimming the heads of bolts, the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn., has recently brought out a line of machines for handling this class of work. These are built in sizes capable of trimming the heads of bolts up to and including ⅝ inch in diameter, and up to a maximum length of 6 inches. These machines are primarily adapted for trimming cold-headed blanks with either a square or hexagon form of head. They may, however, be successfully employed for trimming the flash from hot forged bolt heads, and in such cases the diameter of the bolts which can be handled is somewhat larger than in the case of cold-headed blanks. Care must be taken, however, that the heads are concentric with the shanks.

In operating a machine of this type, the blanks to be trimmed are placed in the hopper, from which they slide down an inclined chute suspended by their heads. At the bottom of this chute, the bolts are carried one at a time to a position in line with and between the trimming punch and die, where they are held in a horizontal position. An interesting form of transfer mechanism is used for this purpose which picks up one blank from the bottom of the column of blanks in the chute, revolves it into a horizontal position, and then carries it over to the punch and die. The hollow punch then advances onto the shank or body of the blank until it reaches the under side of the head, when further motion of the punch forces the bolt head into the die, thus causing it to be trimmed to the required shape. The bolt remains with the head held in the die and the shank projecting out until the slide has returned almost to its starting position, at which time the bolt is pushed out of the die by a positive knock-out which is operated by the slide.



Waterbury-Farrel Bolt Head Trimming Machine for Bolts up to ½ by 6 Inches

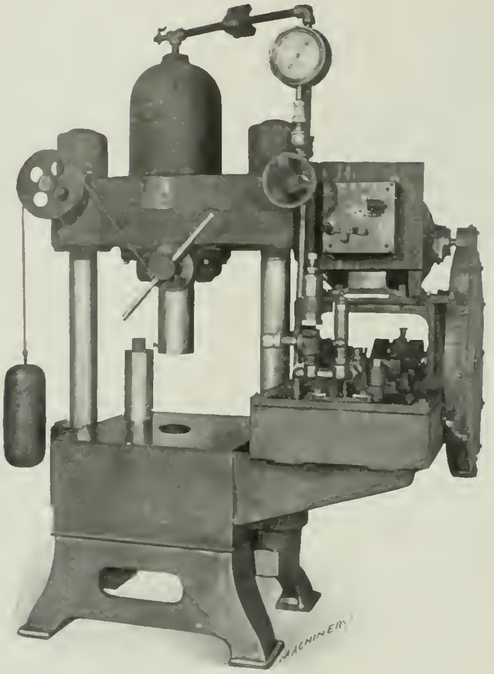
The machine shown in the accompanying illustration is the No. 3 size, which has a capacity for trimming the heads of bolts up to ½ inch in diameter by 6 inches in length. Attention is called to the fact that this machine is made with a back-geared drive which provides ample power for handling the work. Another feature is the compactness of the design, which reduces the amount of floor space required to a minimum. This is a particularly valuable feature in factories located in congested districts where rent is very high.

HYDRAULIC BROACHING AND FORCING PRESS

The accompanying illustration shows a self-contained hydraulic broaching and forcing press which has both the motor and pump mounted on a base which extends out at one side of the machine. This constitutes a recent addition to the line of the Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. It is of sturdy, though compact construction, and is suitable for a wide range of broaching and forcing operations in machine shops, garages, etc. The ram is counterbalanced and controlled by a hand windlass which enables it to be raised or lowered for handling various sizes of work. When the ram is moved down by the hand windlass, the cylinder is filled with water by suction, so that the pressure is applied as soon as the pump is started. Extension blocks may be used on the ram varying in shape and length according to the size of the pressing surface.

The ram is operated by a two-plunger, horizontal pump which has plunger diameters that may be varied from ⅝ inch to 1 inch, with a constant stroke of 3½ inches. The pump is equipped with an automatic knock-out attachment which limits the pressure to a predetermined maximum value according to the requirements of the work. All parts of the pump are easily accessible so that it is an easy matter to make adjustments or re-pack the pump plungers when necessary. The gearing shown in the accompanying illustration has a single reduction, but double reduction gearing may be provided on the pump, if required. The motor and starting rheostat are conveniently located within reach of the operator. A 2-horsepower motor is required.

The speed at which this press may be operated varies with the diameter of the pump plunger; the larger the plunger the more rapid will be the movement



Self-contained Hydraulic Broaching and Forcing Press

of the ram, as more water is forced into the cylinder at each stroke of the pump. The press shown in the illustration has a ram 10 inches in diameter and has a capacity for pressures up to 75 tons. The stock space of this press is 18 inches and the traverse of the ram 12 inches. The working surface of the bed is 24 inches square and there is an opening directly under the ram to receive the broach as it passes through the work, a wooden box being placed to receive the broach when it drops.

BUFFALO DOUBLE-END SHEAR

The Buffalo Forge Co., Buffalo, N. Y., is now building a double-end shear which is especially adapted for use in cutting angle irons up to 6 by 6 by ¾ or tees 4 by 4 by ⅜ inch in size. In order to make the machine as compact as possible, and still provide ample strength, the frame is made of armor plate. The drive is from a 10-horsepower 440-volt, 25-cycle 3-phase alternating-current motor, belted to the flywheel of the machine. The power is transmitted through heavy double reduction gearing, the high- and low-speed shafts running entirely through the housing. A jaw clutch on the flywheel side of the machine provides for engaging or disengaging the power as required. This clutch is thrown out automatically by means of a cam mechanism, so that the plunger can make but one stroke unless the engaging lever is held down.

The shaft on which the clutch is mounted carries an eccentric which is located inside the housing of the machine. When the clutch is engaged, this eccentric transmits the motion to both of the plungers on which the shear blades are mounted. The clutch is controlled by the lever shown near the center of the frame in Fig. 2. The machine is especially useful for making right- and left-hand cuts for mitering. When used for this purpose, the operator makes the first cut on one end of the machine and then brings the work over to the other end on the same side to make the second cut. When used for straight cutting, two gangs of men can be employed, working independently, each gang using one of the two sets of shear blades. An adjustable hold-down provides for holding the work in place while it is being cut. The weight of the machine is 12,000 pounds.

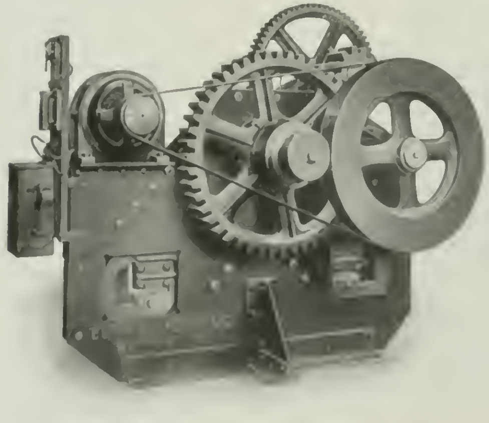


Fig. 1. Buffalo Shear showing Arrangement of Drive

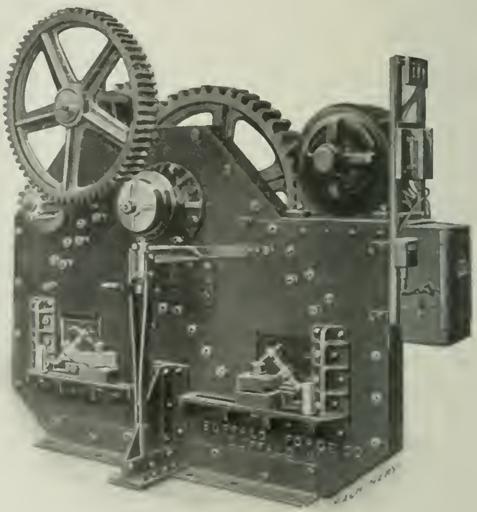
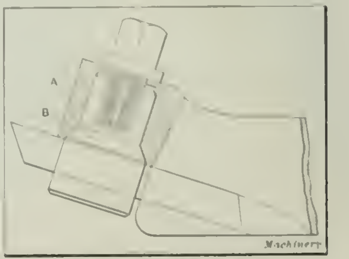


Fig. 2. Operating Side of Buffalo Double-end Shear

FALES COMBINATION TOOL-HOLDER

The important feature of the combination tool-holder which forms the subject of this article is the simplicity of its design combined with the possibility of using it as either a straight, left-hand or right-hand holder. The holder may also be used in connection with a threading tool, for which purpose it gives very satisfactory results. Practically the entire reaction of the cut is carried by the shank of the tool; this result is obtained by the close fitting bearing *A* of the clamp, the binding screw being merely depended upon to keep the cutter from slipping. The enlargement of the clamp provided through the taper *B* gives an exceptionally long support for the cutter and greatly reduces the possibility of breaking it. Another

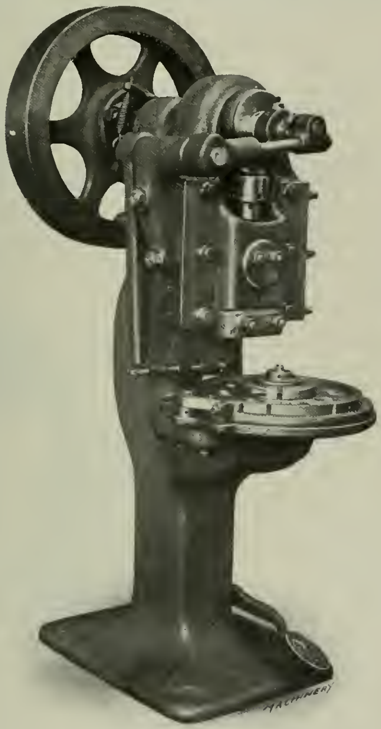


Fales Combination Tool-holder

feature is the ease with which a broken screw may be replaced. When the screw is broken, the clamp and cutter drop out of the holder so that the tension of the screw is released and it may be removed with the fingers. This tool is known as the "Duckett" combination tool-holder, and is a recent product of the C. E. Fales Machinery Co., Kerr Bldg., Detroit, Mich.

FERRACUTE DIAL FEED

The Ferracute Machine Co., Bridgeton, N. J., has recently developed an improved dial feed attachment which is shown in the accompanying illustration mounted on a power press of this company's manufacture. The mechanism which imparts intermittent motion to the circular plate is made quite heavy so that ample strength and rigidity are provided. As the press shaft revolves, it transmits motion to a bellcrank lever, the lower end of which is connected to the yoke surrounding the dial by a horizontal pitman. In this way the yoke is given a reciprocating motion, and a pawl attached to the yoke moves the dial, the angular position of which is exactly located by means of a spring lock. The tension of the spring which governs the position of the dial is made adjustable, which is also the case with the brake at the center of the dial. The pitman is provided with a universal joint at each end and has means for making ample longitudinal adjustment.



Ferracute Power Press equipped with Improved Dial Feed

BAIRD TANDEM PRESSES

Power presses are made in various types, but the two most important classes are single-action and double-action presses. Each class is adapted for handling certain kinds of work, and each has its limitations. The single-action press is by far the more commonly used and the operations sometimes attempted on it require tools which are both costly to make and to operate, owing to their complicated construction and the difficulty experienced in adjusting them. It is common practice to handle work on a single-action press which requires more than one stroke to complete it, but it is not so easy to utilize more than one stroke of a double-action press at one feeding of the work. There are, however, many articles which require subsequent operations after the blank has been cut from the stock and drawn. To meet the requirements of such work, the Baird Machine Co., Bridgeport, Conn., has brought out a new line of presses. These are styled

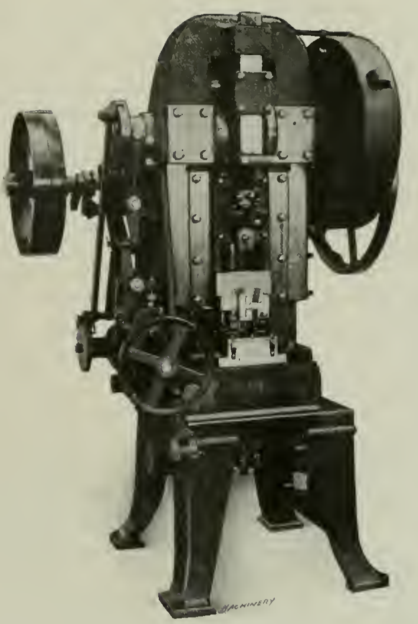


Fig. 1. Baird Tandem Press with Double-action Front Slide and Single-action Rear Slide

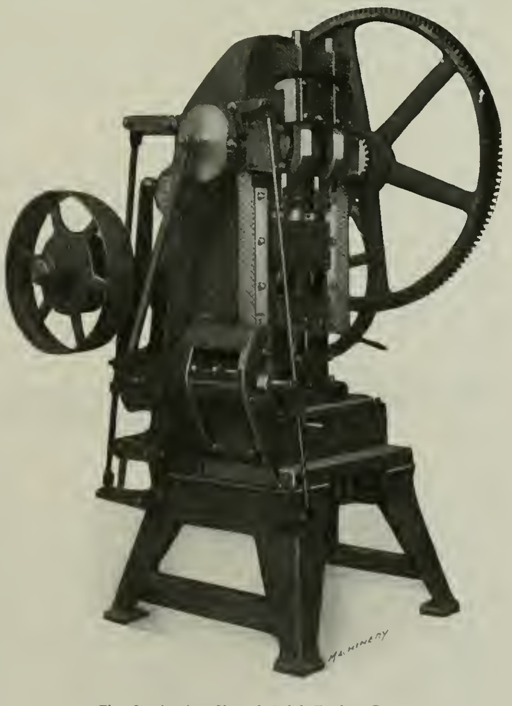


Fig. 2. Another Size of Baird Tandem Press

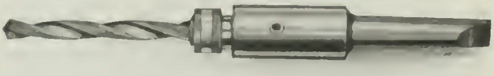
"tandem presses" and consist of a double-action front slide combined in the same frame or housing with a single-action rear slide. An automatic roll feed mechanism, a transfer mechanism for automatically moving the work from the front to the rear slide and lifting pins or knock-outs for both slides, constitute part of the regular equipment of these machines.

The blanking stroke of the front slide is cam-actuated, allowing the blanking tools to hold the work and preventing it from wrinkling while the drawing operation is taking place. Both the blanking slide and the drawing plunger are provided with means of adjustment to compensate for wear of the tools. The transfer mechanism is of an improved design and equipped with two fingers suitably shaped to fit the work. The mechanism for gripping and releasing the work is independent of that employed for moving the transfer from the front to the rear slide of the press. The distance through which the transfer moves can also be adjusted to suit the shape and character of the work which is being handled. The rear slide of the press is single-action and crank-actuated, the crankshaft, connection slide and ways being entirely independent of the front slide of the press. It may be set to act in unison with or slightly before or after the front slide according to the requirements of the work. The connection is provided with the usual means of adjustment to take up wear in the tools. In the standard type of machine, the stroke is suitable for stamping or forming operations, but the stroke can be varied to meet the requirements of redrawing operations.

The class of work for which these presses are particularly adapted is a shell with the bottom stamped or pierced; or a ferrule made by drawing a shell and blanking out the bottom. The drawing motion of the front slide may, however, be used to carry a shell or partially formed blank down into the transfer slide instead of performing a drawing operation. On this class of work the tandem press is far more efficient than a single-action press equipped with a transfer mechanism, because each slide may be adjusted independently of the other. These tandem presses are made in four sizes weighing from 1500 to 8500 pounds. All sizes are back-geared, the back-gear shaft being provided with a handwheel by which the press can be easily turned over while tools are being set up. The driving pulley is of the friction type and operated by a lever which is conveniently located for the operator. A separate friction operated by the same lever is used to overcome the momentum of the machine and bring it to a stop after the power has been shut off.

STANDISH DRILL SOCKET

The Standish Tool Works, Inc., Sebago Lake, Maine, has recently improved the duplex drill socket of its manufacture by splitting the end of the collet in which the drill is held, and providing a knurled nut which fits the tapered threaded end of the collet and is screwed up to hold the drill. For the benefit of those who are not already familiar with this tool, it may be stated that it is particularly adapted for use in connection with the Standish double-end drill, the drill being driven by two tool steel pins that fit into the flutes. In this way the tendency to break the drill by twisting off the tang is overcome. These sockets have also been found useful for using up ordinary drill's on which the tangs have been broken.



Improved Standish Drill Socket

The collet in which the drill is held fits into a socket, a semicircular extension on the collet engaging a corresponding member in the upper end of the socket. The collet is held in place in the socket by a large safety set-screw. As the semicircular extension on the collet which does the driving is several times larger than the tang on a drill of the same size, ample strength is provided These sockets are made of any desired taper number, and in three different sizes. The Standish Tool Works is also in a position to furnish bars of twisted high-speed steel from which drills can be made.

KELSEY NUMBERING STENCIL

Duane J. Kelsey, 411 Y. M. C. A. Bldg., New Haven, Conn., has recently added to his line of draftsmen's instruments and drafting-room equipments, a transparent celluloid stencil for use in outlining numbers on a drawing preparatory to inking them in. It will be seen that the stencil contains all numbers, and by sliding it along the edge of the T-square, any desired combination may be secured. The use of this stencil enables good looking numbers to be put on a drawing with great rapidity.

Kelsey Transparent Celluloid Stencil for outlining Numbers on Drawings

HAUCK KEROSENE TORCH

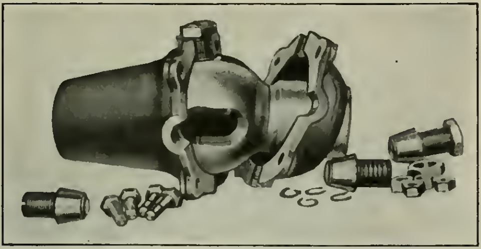
There are many shops which have work for which a portable heating torch could be advantageously employed, but where conditions are such that the fire regulations prohibit the use of gasoline. With the primary object of overcoming this prohibition, the Hauck Mfg. Co., 140 Livingston St., Brooklyn, N. Y., has recently developed a torch which is adapted for burning kerosene in place of gasoline. The general design is the same as that of a gasoline torch, the usual form of air pump being employed to apply pressure above the oil and force it up to the burner. But as kerosene is less volatile than gasoline, it was found necessary to make the drip cup and burner larger, to have the burner heavier and to provide a longer duct through which the kerosene passes through the heated burner before reaching the needle valve. The larger supply of oil in the drip cup and the provision of this extended passage in which the kerosene is heated, provides for vaporizing it ready to be burned at the needle valve.

Hauck Portable Kerosene Torch

The use of kerosene in place of gasoline has several features to commend it. In the first place, kerosene can be bought almost anywhere, so that when these torches are being used outside the shop it is usually an easy matter to secure a fresh supply of oil. Furthermore, kerosene lasts longer than gasoline, possesses a higher number of heat units and is also cheaper than gasoline, so that a three-fold economy is secured through its use. The higher heating value of kerosene gives the torch in which this fuel is used a greater capacity, thus allowing it to handle heavier work. In using this kerosene torch out of doors, satisfactory service can be obtained in the highest wind or on the coldest winter days. The construction is very simple and the flame may be easily regulated by means of a special needle valve. The flame is guaranteed not to smoke or deposit soot on the work.

ROLLER BEARING UNIVERSAL JOINT

An improved form of universal joint made by the Universal Machine Co., Bowling Green, Ohio, is illustrated herewith. It will be seen that this consists of a ball and socket joint which takes care of the up and down motion, the end thrust and all other strains, while four roller bearings mounted on pins carry the driving torque. The wearing surfaces of the joint are hardened and ground. These joints were recently tested in the laboratories of the Ohio State University, and pronounced perfectly universal with neither "lag" nor "catch-up." It is necessary to grease the joint at infrequent intervals and only a few minutes are required for greasing. Centrifugal force distributes the grease to the required joints. These universal joints are finding application in automobile work and are adapted for various other classes of service.

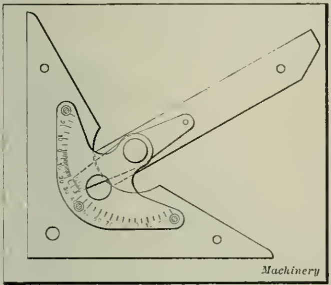


Universal Machine Co.'s Roller Bearing Universal Joint

KELSEY COMBINATION SQUARE AND PROTRACTOR

In nearly all classes of mechanical drafting, it is required to draw lines at various angles in addition to those which are available with the 30-60 and 45 degree triangles. For this purpose, two triangles and a protractor are customarily used. With the view of reducing the number of instruments which a draftsman must have on his board, Duane J. Kelsey, 411 Y. M. C. A. Bldg, New Haven, Conn., has recently developed the combination square and protractor illustrated herewith. It will be seen that this consists of a celluloid square with which angles of 30, 60 and 90 degrees can be drawn.

In addition, there is an adjustable blade which may be set by means of the protractor scale to draw lines at any required angle. The ruling blade has an extension which projects under a transparent plate that supports the bushing for the swivel pin. The protractor scale is graduated on the under side of this plate and in order to set the instrument for ruling a line at any required angle, the binder nut is loosened, after which the blade is swung to bring the index on the extension into coincidence with the required graduation on the protractor scale. The binder nut is then tightened. The extension on the ruling blade is provided with a vernier which enables settings to be made within a limit of accuracy of 10 minutes.



Kelsey Combination 30-60 Degree Squara and Protractor

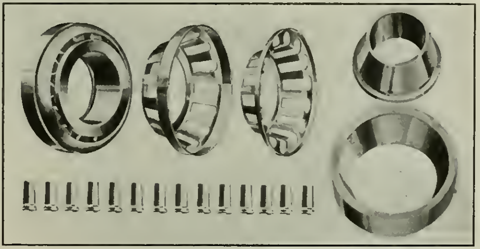
A simpler form of this instrument is also made, which is not provided with the extension and vernier scale on the ruling blade. In this case, there is a central line down the blade which passes through the axis about which the blade is pivoted. To set the instrument, this line is brought into alignment with the required graduation on the protractor scale, which is graduated on the under side of the square that forms the body of the instrument. A slot is cut in the ruling blade of this type of instrument, to enable the blade to be used as an erasing shield.

BOCK ROLLER BEARING

The application of worm gears or spiral bevel gears results in the introduction of a thrust load. In automobile transmissions and in other geared drives where smooth, quiet running is essential, it is necessary for this thrust load to be supported by an anti-friction bearing. Those who are familiar with the extreme accuracy which is necessary in gearing for such classes of service will realize that the least wear or inaccuracy in the bearings results in the introduction of errors which more than offset the refinements of modern gear cutting practice.

To meet the requirements of such classes of service, the Bock Bearing Co., Toledo, Ohio, has recently perfected a roller bearing which combines the features of the tapered roller and the ball thrust bearing. The rollers employed in this bearing are of the usual tapered form but have a head at the large end which engages the cone flange. The running surface of this head is spherical and the contact is in direct line with the bearing surface of the roller. As a result, the Bock bearing is said to run without slippage or consequent wear. In addition to its capacity for carrying thrust loads, this bearing has a very satisfactory capacity for sustaining radial loads.

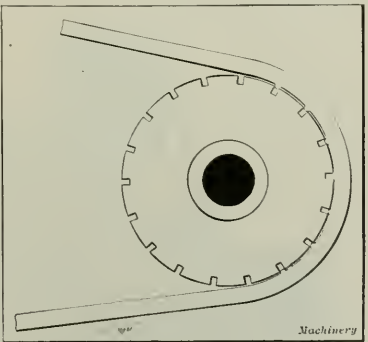
The accompanying illustration shows the parts of a bearing after it had been running continuously for 100,000,000 revolutions at 2050 revolutions per minute, under a thrust load of 1000 pounds. For three days of this time the bearing was subjected to a thrust load of 3000 pounds. After this severe test it is said that none of the bearing parts showed any wear. This result demonstrates the advantage of the Bock bearing for use in connection with worm gears or spiral bevel gears where it is absolutely necessary for the gears to be held in perfect running position in order to avoid wear. In this connection it may be mentioned that the bearings can be adjusted very tight so that lost motion is eliminated.



Parts of the Bock Roller Bearing after being subjected to the 100,000,000 Revolution Test

EXCELSIOR PULLEY

In bending a leather belt over a pulley—particularly if the pulley is of small diameter—there is a tendency for compression ridges to form on the side of the belt nearest the pulley. This reduces the area of the surface of contact between the pulley and the belt, causing the belt to slip and reducing the transmission efficiency. Another cause which contributes to a reduction of efficiency is the "trapping" of air between belt and pulley.



End View of Excelsior Pulley

With a view of overcoming these difficulties, the Excelsior Pulley Co., Cuba, N. Y. has brought out a line of Premier wooden pulleys which are at present being made in sizes from 3 to 14 inches in diameter. Referring to the illustration it will be seen that there are grooves in the face of these pulleys which are said to serve the double purpose of taking up the compression ridges in the belt, and preventing air being held between the pulley and the belt. As a result, it is claimed that the transmission efficiency obtained is 50 per cent higher than with a plain wooden pulley.

NEWTON SAW AND ROTARY PLANERS

The Newton Machine Tool Works, Inc., Philadelphia, Pa., recently furnished the Bureau of Standards, Washington, D. C., with a cold sawing machine for use in preparing samples for test purposes. This machine, which is illustrated in Fig. 1, is equipped with a blade 32 inches in diameter. The capacity is for miter cuts on structural steel up to and including a 30-inch I-beam held flat on the top table; and for square or miter cuts on sections up to a 24-inch I-beam, when held in a vertical position on the bottom table. Stock up to round sections 9½ inches in diameter can be cut in a single operation, and larger stock may be cut by turning the bar. This machine can be converted into a rotary planer, as shown in Fig. 3, by removing the long table mounted on the shears and the clamping yoke and auxiliary parts of the main work-table. It will be seen that the main work-table has hand in and out adjustment for use in regulating the work for the length to be cut off when sawing or for the depth of cut when the machine is used as a rotary planer.

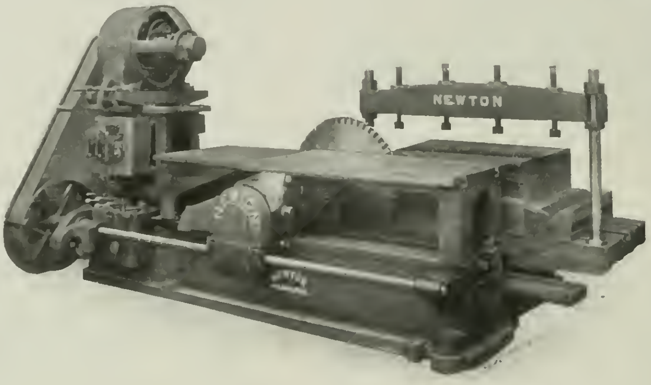


Fig. 1. Newton 32-inch Cold Saw built for the Bureau of Standards, Washington, D. C.

The drive is from a General Electric variable speed motor which is belted to the main driving shaft. It will be noticed that guards are provided over the belt to provide for the safety of the operator. The saw saddle has underlocking gibs which are cast integral with its base, and vertical and horizontal adjustments are made by means of tapered shoes. The feed is obtained through a gear-box which gives six changes without the removal of gears, the different feed combinations being obtained by sliding the sleeves on which different groups of gears are mounted. Provision is made for releasing the feed at any predetermined point to enable duplicate cuts to be made. It is also possible to release the feed automatically and engage the power quick return, or *vice versa.*

Another form of Newton rotary planer is illustrated in Fig. 2. These rotary planing machines were originally developed for finishing the bases of columns and other structural shapes, but their rate of production was found so satisfactory that they are now being applied on various other classes of work. It will be seen that the machine is driven by an individual motor belted to the driving shaft, the motor in this case being mounted on the saddle with which it travels. Working in the manufacturer's shops, this machine finished an iron casting 20 inches wide with the saddle advanced at the rate of 6 inches per minute, the depth of cut being ¼ inch.

The cutter head is a steel casting surrounded by a steel band into which the tool clamping screws are fitted. The drive to the head is transmitted through internal gearing, the teeth of which are cut from solid metal at the back of the head. Six changes of feed are provided through a gear-box of the same type as that on the machine shown in Figs. 1 and 3. It will be seen that the table is of the fixed type, the depth of cut being controlled by adjusting the spindle saddle. Only three control levers are employed. A single lever controls the feed and the rapid power traverse, the arrangement being such that it is impossible to engage both mechanisms at the same time. The handwheel controls the in and out adjustment of the spindle saddle for regulating the depth of cut.

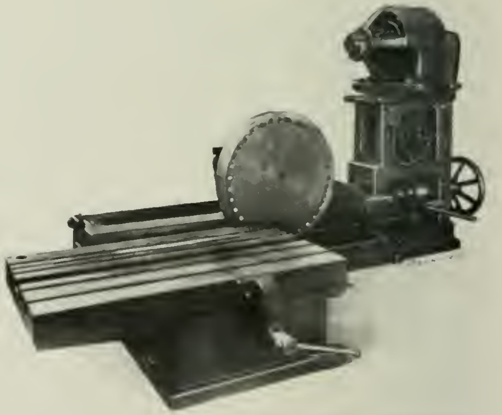


Fig. 3. Machine shown in Fig. 1 equipped for Use as a Rotary Planer

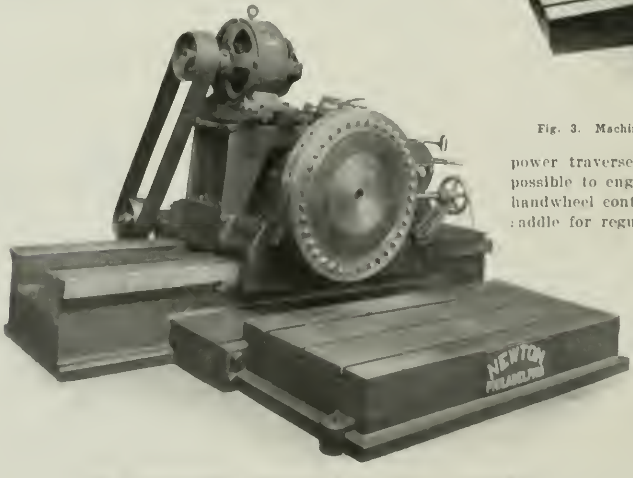


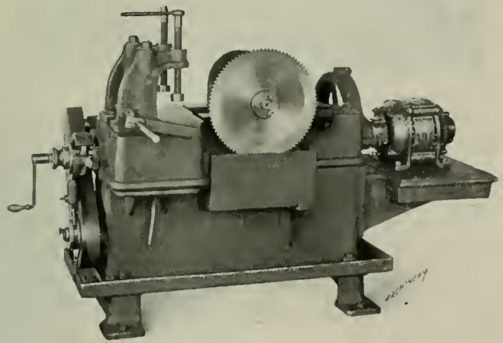
Fig. 2. Newton Rotary Planer with Motor mounted on Cutter Saddle

BURR NO. 2 COLD SAW

The No. 2 cold saw described in the following is a product of John T. Burr & Son, 429 Kent Ave., Brooklyn, N. Y. It is equipped with an alloy steel saw-blade 14 inches in diameter, and will cut up to 5-inch round or 4-inch square stock. The vise arches are removable and such work as small beams and other sections may be clamped to the table by means of straps and bolts.

For some years this company has been

making a No. 2 cold saw of similar design, the improvements of the present machine consisting of the application of individual motor drive and a positive feed mechanism. The drive consists of a splined rod running parallel to the bed, on which a steel worm is carried. The worm is provided with a ball thrust bearing, and meshes with a bronze rimmed worm-wheel, from which power is transmitted through a pair of steel gears to the saw arbor. The feed is transmitted through a screw actuated by ratchet and double pawls, either one or both of which may be employed. The travel of the pawls is varied by changing the pin in the double eccentric which is driven from the side shaft through a chain and sprocket. The feed is engaged by simply throwing in the clutch, and is automatically disengaged at the end of the carriage traverse.



Burr No. 2 Motor-driven Cold Saw with Positive Feed

NIAGARA HEAVY BEADING MACHINE

The accompanying illustrations show a machine designed and built by the Niagara Machine & Tool Works, Buffalo, N. Y., for the purpose of performing beading, swaging and similar operations along the edges of sheet metal. The machine is particularly intended for use in factories engaged in the manufacture of automobile bodies, steel barrels and other sheet metal products. A novel feature of the design consists of the belt-driven raising and lowering device for the upper main shaft. The clutch pulley *A* drives a worm and worm-wheel by means of bevel and spur gears, the worm-wheel being keyed to the shaft *B* which carries on each end an eccentric and adjustable pitman which are pivoted to the upper main shaft bearings. The motion is controlled by the hand lever *C* to enable the operator to start and stop the upper shaft in any position. This is a very important feature, as it is frequently necessary to engage the work gradually or to hold the upper shaft in a specified position while the beading and swaging operations take place.

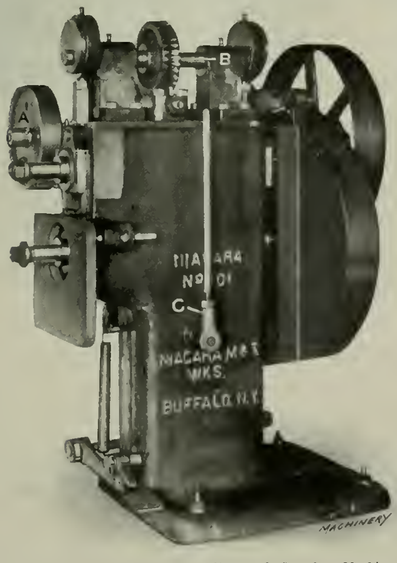


Fig. 1. Niagara Heavy Beading and Swaging Machine

The worm which transmits the motion from the driving pulley runs in an oil chamber and anti-friction bearings are provided to take up the end thrust. The main shaft is driven from a clutch pulley controlled by a foot treadle, and gears on the two main shafts are always kept in proper mesh with each other. The operating lever for the shaft raising device and the clutch treadle are located in front of the machine in convenient positions for the operator. The principal dimensions of the machine are as follows: Diameter of main shaft, 2½ inches; minimum distance between shafts, 6 inches; maximum distance between shafts, 8 inches; ratio of gearing, 1 to 7½; and weight, about 1600 pounds. The working parts and gages for use in connection with this machine are made to suit the particular requirements of the work on which it is to be used.

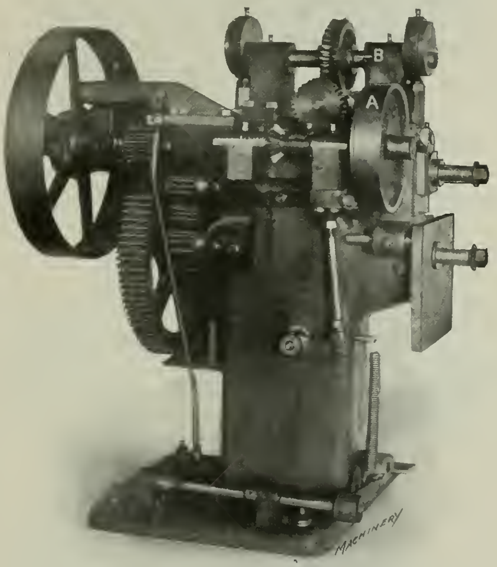


Fig. 2. Opposite Side of Niagara Machine shown in Fig. 1

HENDEY NO. 5 LINCOLN MILLER

The Lincoln type milling machine which forms the subject of this article is a recent addition to the line of machines built by the Hendey Machine Co., Torrington, Conn. This machine is particularly adapted for milling bridge reamers, and it will be seen that a double or elevating table is provided, the top section of which is pivoted at the rear end and rises and falls between substantial guides which are cast integral with the lower half or slide, at the front. Provision is made for bolting suitable cams or forms to the side of the table which engage with a roller carried by a bracket bolted to the face of the saddle. These cams are formed and applied in a way which allows for continuous fluting of reamers having both initial and secondary tapers, or a tapered leader and straight body.

The eight spindle centers shown in place on the table of the machine are indexed simultaneously, making a very efficient equipment for handling the classes of work for which this machine is intended. These centers swing 1½ inch and the spindles in the headstock are fitted with centers and coupling drivers adapted for holding the tangs of Morse No. 2 and No. 3 tapered shanks. The ratchet index plate is drilled for twelve holes, giving 2, 3, 4, 6 and 12 divisions; and other divisional rows of holes can be drilled if desired. The footstock centers are provided with spring tension and lever release, while the binding plugs for the centers are operated by two handles on each side of the block.

Spring chucks may be provided for holding the ends of pinion shafts and similar work, thus enabling it to be handled in multiple. These chucks have a maximum capacity of $\frac{7}{8}$ inch. When the spring chucks are used, the headstock is fitted with special binding plugs controlled by two levers, each of which binds four spindles through the action of two plugs and a connection compression block. Head- and tailstocks of similar design can be provided with four centers if such equipment is better suited to the requirements of the work which is to be handled.

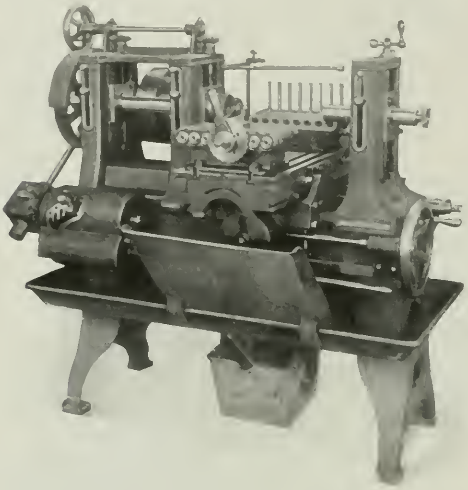


Fig. 1. Hendey No. 5 Lincoln Miller

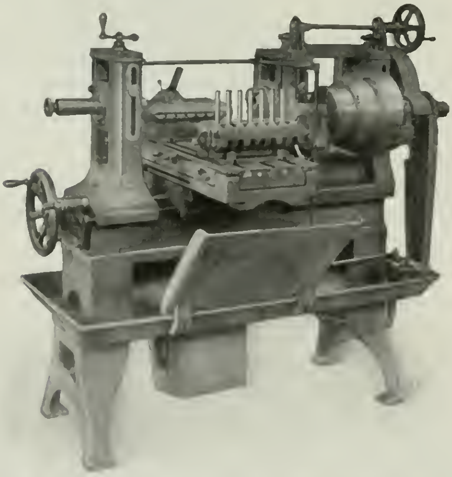


Fig. 2. Opposite Side of Hendey Lincoln Miller shown in Fig. 1

KEMPSMITH TRIPLE INDEX CENTERS

For use in cutting small ratchet wheels, spur gears, rotary pump cams and similar parts which can be mounted on mandrels, the Kempsmith Mfg. Co., Milwaukee, Wis., has recently designed and placed on the market a set of triple index centers. The three spindles of this attachment are indexed simultaneously and all of the spindles are clamped at the same time by means of the lever shown at the lower right-hand side of the headstock. Each spindle has a No. 10 Brown & Sharpe taper hole at the front end and a hole 1 inch in diameter extending through the spindle. A $\frac{5}{8}$-inch draw-in bolt in each spindle provides for holding the mandrel firmly in place. The index plate and crank used on this attachment are the same as those furnished with the Kempsmith universal dividing head, and all numbers up to 60, all even numbers and multiples of 5 up to 120, can be obtained, in addition to many other divisions up to 300. The total number of divisions obtainable with these index centers is 195, and a chart showing how each different number of divisions is obtained is furnished with the index centers.

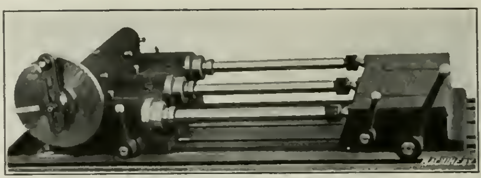


Fig. 1. Kempsmith Triple Index Centers

The tailstock is of an improved quick-acting type with the centers held in place by coiled springs. In withdrawing the centers from the work-holding mandrels, the entire tailstock is moved back, thus releasing all three centers at the same time. Conversely, when the work has been set in place, the tailstock is moved forward and locked in position by means of the right-hand lever. The steel centers are then clamped by means of the left-hand lever. Any inequality in the length of the work-holding mandrels is automatically compensated for by the coiled springs which adjust the positions of the centers independently of one another. The principal dimensions of this set of triple index centers are as follows: Center distance of mandrels, $6\frac{1}{4}$ inches, and distance from center lines of mandrel to table, $3\frac{1}{4}$ inches.

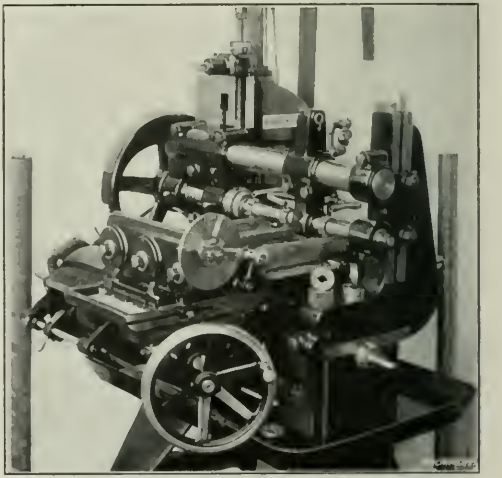
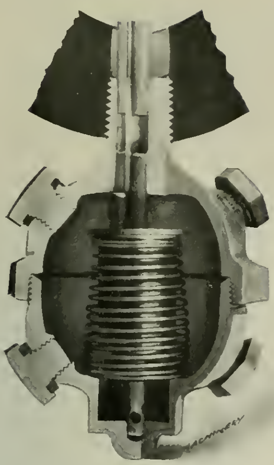


Fig. 2. Application of Kempsmith Triple Index Centers

BIGGAR BROS. "OIL FIRST" OILER

The oil cup which forms the subject of this article is particularly adapted for use on loose pulleys, and the principle of operation is such that a sufficient supply of oil is delivered to the bearing at the time the pulley starts to revolve, to keep it properly lubricated. While the pulley is in movement, the admission of any more oil to the bearing is prevented through the action of centrifugal force, but when the pulley stops and is again started, another supply of oil is delivered to the bearing.

The oiler can be filled in any position of the pulley by un-



Biggar Bros. Loose Pulley Oiler

screwing either of the hexagon headed plugs. These plugs can easily be turned with the fingers without requiring the use of a wrench. The oiler is made of aluminum and is so light that it is unnecessary to provide a counterbalance on the pulley. There is no waste or leakage of oil. The method of operation is as follows: When the pulley starts to rotate, centrifugal force causes the oil to move out to the part of the oiler farthest away from the hub of the pulley. This fills the small cylinder with oil, and at the same time centrifugal force causes the plunger which works in this cylinder to move toward the head of the cylinder. The oil is thus compressed and a suitable supply for lubricating the bearing is forced down through the tube which runs from the cylinder to the bearing. It will be seen that there is a second tube in the threaded stem of the oiler which screws into the hub of the pulley. This second tube is to allow the oil to flow into the bearing and displace a corresponding volume of air which would otherwise prevent the oil from entering. This oiler is a recent product of Biggar Bros., Oneida, N. Y.

ETNA SWAGING MACHINE

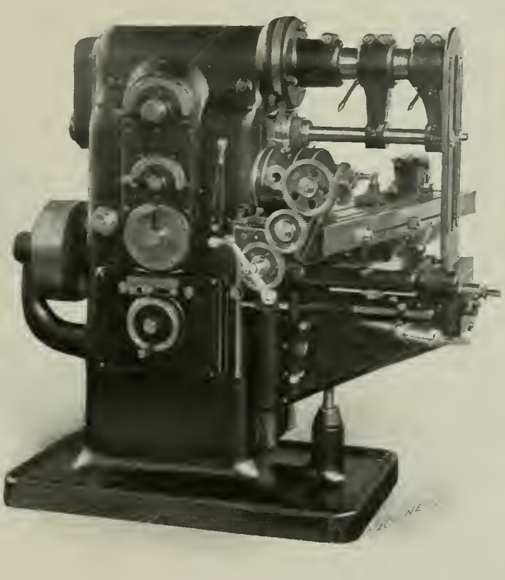
A machine for swaging tubing up to 4 inches in diameter is the latest product of the Etna Machine Co., Maplewood Ave. and Castle Boulevard, Toledo, Ohio. It will be evident from the illustration that this machine is of exceptionally rigid construction, and this, combined with the design of the swaging mechanism, enables it to handle large work at a very satisfactory rate. The flywheel, which is 36 inches in diameter and carries a 5-inch belt, is supported between two large bearings which are bronze bushed and insure keeping the shaft in proper alignment. The shaft is 6½ inches in diameter and the bearings are 44 inches long. Sight-feed lubricators keep the bearings properly oiled.

Large Etna Swaging Machine

ROCKFORD NO. 2 UNIVERSAL MILLER

The latest addition to the line of milling machines built by the Rockford Milling Machine Co., Rockford, Ill., consists of the heavy all-geared No. 2 universal miller which is illustrated herewith. It will be seen that this machine has single pulley drive so that it may be belted to the lineshaft without requiring a countershaft to be used. The driving pulley is 16 inches in diameter, carries a 4-inch double belt and should be driven at 325 revolutions per minute. When individual motor drive is employed, a 5-horsepower motor is recommended. The spindle is made of crucible steel and accurately ground to size; it runs in bronze-bushed bearings which are provided with means for taking up the wear of both bearings at a single operation. There is a No. 11 Brown & Sharpe taper hole at the front end of the spindle, and the hole extending through the spindle is 1 inch in diameter, a draw-in rod being provided. Sixteen changes of spindle speed are available, these changes being in geometrical progression and covering a range from 15 to 376 revolutions per minute.

The feeds are all automatic and positive, the maximum movements of the table in the three directions being 28, 8 and 19 inches, respectively. The overhanging arm is 4 inches in diameter and made of solid steel, the patented flange support used on other Rockford machines being employed in this case. Having the over-arm bolted to a seat on the column in this way provides greater stiffness and reduces vibration, thus increasing the cutting capacity. The distance from the center of the spindle to the under side of the overhanging arm is 7 inches. Two bronze-bushed arbor supports are supplied. The table is of exceptional depth to prevent the possibility of its springing when clamping heavy pieces of work in place. The working surface of the table is 50 by 11½ inches, and three T-slots ⅜ inch in width are machined in the table, in addition to oil grooves at the sides and oil pockets at the ends. The spiral dividing head swings 10½ inches and the spindle has a 1-inch hole extending right through it with a No. 11 Brown & Sharpe taper hole. The nose of the spindle is threaded to receive a chuck, and the spindle can be set in any position from 10 degrees beyond the vertical to 10 degrees below the horizontal. The swivel vise is graduated in degrees; the jaws are 6 inches wide by 1⅝ inch deep, and the vise is opened 3½ inches.



Rockford All-geared No. 2 Heavy Universal Miller

All shafts, with the exception of the main spindle, run in high-duty Hyatt roller bearings which are self-oiled; and all shafts are hardened and ground to size. If so desired, an automatic pump can be provided, together with a system of return piping for carrying the lubricant back to the reservoir. The equipment furnished with the machine includes the spiral dividing head, a set of centers, index plates, change gears, a 6-inch three-jawed universal chuck, a swivel vise, a 1-inch arbor and all necessary wrenches. The net weight of the machine is 4200 pounds.

SPRINGFIELD SINGLE-PULLEY LATHE

To meet the demand for a high power lathe equipped with rapid change gears, the Springfield Machine Tool Co., 631 Southern Ave., Springfield, Ohio, has added to its line a 14-inch by 6-foot machine which is illustrated herewith. The design and method of operation are simple, and provision is made for securing the correct speed for all classes of work for which the machine is adapted. The drive is direct from the lineshaft to a single friction clutch pulley, and this arrangement makes the application of individual motor drive a simple matter. Owing to the fact that all journals, with the exception of the main spindle journals, are equipped with ball bearings, a high degree of transmission efficiency is obtained.

Twelve speeds which are in geometrical progression, are obtained in the geared headstock. The power is transmitted through the least possible number of gears, no gears being engaged which are not actually required in the drive. Any speed may be obtained direct without the necessity of passing through a series of speed changes to reach the correct one. The entire head mechanism is enclosed in an oil-tight case; the gears run in an oil bath and the bearings are lubricated by a constant stream of oil. The main spindle bearings are supplied with sight-feed oilers which provide a liberal supply of clean oil.

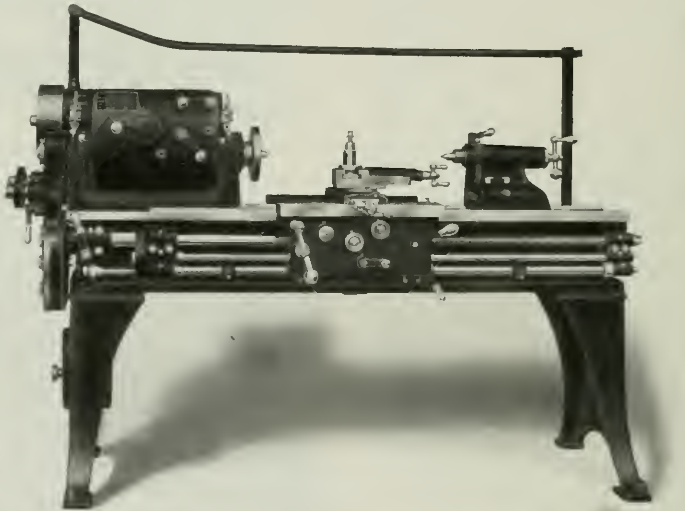


Fig. 1. Springfield 14-inch "Ideal" Single Pulley Engine Lathe

The clutch pulley is located at the rear of the head and the friction clutch is operated by a push-rod which allows the lathe to be started or stopped instantly. If desired, the head can be furnished with reversible drive; and the position of the clutch pulley places the belt out of the operator's way. Where individual motor drive is employed, the motor may be placed in any position on the floor, ceiling, at the back of the lathe or on the top of the head. All operating levers are located at the front where they are readily accessible.

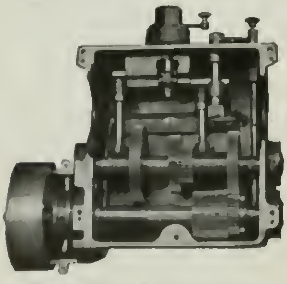


Fig. 2. Interior of Geared Head of Springfield Lathe

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The American Consulate in Moscow, Russia, has cabled to the Government in Washington that reduced freight rates will be granted to American importers via Vladivostok, according to the *Daily Consular and Trade Reports*. For further information address Bureau of Commerce and Labor, Washington, D. C.

NEW MACHINERY AND TOOLS NOTES

Combination Pocket Rule and Level: Lufkin Rule Co., Saginaw, Mich. A two-foot folding box-wood rule fitted with a spirit level.

Power Press Clutch: Bauroth Machine & Stamping Co., Toledo, Ohio. A safety clutch which is now being applied to the entire line of power presses manufactured by this company.

Steel Pulley: Oakes Pressed Steel Co., Indianapolis, Ind. A pressed steel pulley with a piece of tubing brazed at the center, which provides sufficient material to enable a keyway to be cut in the hub.

Taps: Winter Bros. Co., Wrentham, Mass. Two styles of taps, one of which has two, and one three flutes and lands. The claim is made that these taps are more effective for working in steel than taps made with four flutes.

Adjustable Strap Support: Henry Perkins Co., Bridgewater, Mass. A strap support made in two styles, each style being made in three sizes. One style of strap is plain, while the other is provided with a locking device.

Slot Milling Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. A machine for use in electrical manufacturing plants, for milling the dovetail slots for the laminations in the rotors and frames of electrical machines.

Grinding Machine Chuck: Diamond Machine Co., Providence, R. I. A work holding attachment for use in connection with the face grinding machine built by this company. This is intended for handling circular work such as piston rings, pipe flanges, etc.

Polishing Machine: Challenge Machine Co., Philadelphia, Pa. A polishing machine equipped with a double-end spindle. The head may be set up on the bench or mounted on a column, according to the requirements of the shop in which the machine is to be used.

Flexible Shaft: United Mfg. Co., Kansas City, Mo. A flexible shaft built up of alternate links of steel and bronze. Each link is provided with a circular flange which affords a bearing against the casing. The flexible outer casing is made of steel and is oil-tight.

Tube Swaging Machine: Langelier Mfg. Co., Providence, R. I. A special machine built by this company for swaging small sizes of tubing with walls 0.0393 inch thick. The tubes to be swaged have a taper at two sections and they are formed over a suitable mandrel.

Flexible Coupling: Clark Flexible Coupling Co., 90 West St., New York City. This coupling consists of two hubs with sprocket teeth cut in them to provide for flexible connection by means of a roller chain. By this means ample adjustment is provided to compensate for errors in alignment.

Roll Turning Lathe: United Engineering & Foundry Co., Pittsburg, Pa. A heavy-duty machine built in sizes ranging from 18 to 50 inches swing. The machines

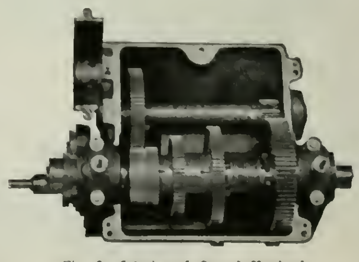

Fig. 3. Interior of Geared Head of Springfield Lathe

are motor-driven, and provided with means for making speed adjustments. When so desired they may also be equipped for belt drive.

Punch Press Guard: Southern Stamping & Mfg. Co., Nashville, Tenn. A press guard consisting of a gate which drops down in front of the die. When the gate is raised to place work in the die, it is impossible to trip the press, it being necessary to first lower the gate into contact with the bed.

Adjustable Bearing: Stow Mfg. Co., Binghamton, N. Y. This company has recently applied an adjustable bearing in the motor cases of its electric center grinders. This consists of a split bushing which is assembled in the bracket of the motor case, and adjusted to provide the required running fit.

Turbine Bucket Miller: Newton Machine Tool Works, Inc., Philadelphia, Pa. A duplex milling machine built for the purpose of finishing turbine buckets. The machine is equipped with two horizontal spindles, each of which has means of adjusting to regulate the depth of cut. Each spindle is mounted in an independent saddle.

Twist Drill Grinder: Automatic Twist Drill Co., Cincinnati, Ohio. A machine for grinding twist drills ranging from 5/16 to 2 inches in size. It is claimed that this machine will hold a two-, three- or four-lipped twist drill or a flat twisted drill in the correct position for grinding. The drill is revolved at a uniform speed while being ground.

Motor Starters: Allen-Bradley Co., Milwaukee, Wis. Starters for use in connection with large direct-current motors ranging from 150 to 300 horsepower. These starters act on the compression principle. By compressing a series of graphite disks, the resistance of the circuit is varied to meet the requirements of different operating conditions.

Swivel Vise for Hacksaw Machine: Millers Falls Co., Millers Falls, Mass. In the August, 1914, number of MACHINERY the No. 90 power hacksaw of this company's manufacture was illustrated and described. Since that time the Millers Falls Co. has equipped this machine with a swivel vise to provide for cutting off work at any required angle.

Electric Driven Truck: Cowan Co., Holyoke, Mass. This consists of the regular type of transveyor manufactured by this company which is equipped with a storage battery and electric motor drive. The same type of auxiliary loading platforms are employed with this truck as are used in connection with the Cowan transveyor that has been previously described in MACHINERY.

Duplex Milling Machine: Rockford Milling Machine Co., Rockford, Ill. This machine consists of the No. 2 milling machine of this company's manufacture, equipped with a second cutter spindle carried in a bracket. The auxiliary spindle is opposed to the main spindle of the milling machine and driven through gearing from a shaft running through the overhanging arm.

Semi-automatic Boring Mill: Reed-Prentice Co., Worcester, Mass. A double-spindle semi-automatic vertical boring machine designed to do all the machining on the brake and transmission drums of the Ford automobile. Although designed for this particular purpose, this is not essentially a single-purpose machine, as the provision of proper tools would adapt it for handling a variety of other classes of work.

Tapping Attachment: Moline Tool Co., Moline, Ill. A light auxiliary table for use on the table- or rail-feed multiple drilling machines of this company's manufacture. The parts of such machines are necessarily made heavy with the result that they possess considerable inertia when in movement. This inertia may result in stripping the threads of small taps, and to overcome this difficulty the light auxiliary table is provided.

Safeguard for Presses and Hammers: H. C. Hart Mfg. Co., Unionville, Conn. This device consists of a strap resembling a glove with the fingers cut off. A chain fastened to the strap extends to a lever on the machine which is connected with a suitable train of mechanism to provide for drawing the operator's hand out of the "danger zone" before it is possible for the ram to descend. It is claimed that the use of this device does not reduce production in any way.

Vertical Drafting Board: Improved Drafting Board Co., Nashua, N. H. This board is suspended on a frame and is raised or lowered to bring the part of the drawing being worked on into a convenient position. The draftsman may either stand or sit in front of the board and is always in a comfortable position. The convenience of this arrangement will be readily appreciated by draftsmen who have occasion to work on large drawings held on a horizontal drafting table.

Small Grinder and Attachments: Union Twist Drill Co., Athol, Mass. A radial grinding machine for grinding convex or concave milling cutters. The use of this tool provides for grinding such cutters accurately and the capacity is for cutters of from 3 to 7 inches in diameter, with the radius of the curved teeth to be ground ranging from 1/16 to 2 inches. This company has also recently developed attachments for use in connection with the universal cutter and reamer grinder of its manufacture for use in grinding side-mills and end-mills.

Multiple Spindle Drilling Machine: Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass. A machine built for drilling all the holes in an automobile transmission case without requiring the work to be reset. The holes are drilled regardless of their size, position or angle; and the design is such that each tool runs at the correct speed. Each spindle may be adjusted independently for drills of different lengths. The machine is equipped with three heads, one of which is vertical, and the other two horizontal and opposed to each other.

Motor-driven or Single-pulley Lathe: Bradford Machine Tool Co., Cincinnati, Ohio. In the November, 1913, number of MACHINERY, the 18-inch heavy pattern lathe of this company's manufacture was illustrated and described. Since that time machines of 26-, 28-, 30- and 32-inch capacity have been added to the line of lathes built by this company. These are adapted for either individual motor drive or single-pulley drive. A suitable speed range for the classes of work handled on machines of this capacity is provided by the gearing in the head, so that a standard motor can be employed.

* * *

NEW YORK ELECTRICAL EXPOSITION

The annual New York Electrical Exposition and Motor Show was held in the Grand Central Palace, New York City, October 7 to 17 inclusive. Over one hundred exhibitors showed a wide variety of electrical apparatus and applications of electricity for manufacturing, therapeutics and the home. The United States government gave three exhibits showing the minting of money, the manufacture of army rifle cartridges and naval apparatus. The mint exhibit comprised a complete section of the mint from the furnace for melting the metal to the massive coining press for impressing the designs on the coins. The manufacture of cartridges was shown in part only, but sufficient machinery was exhibited to give a fairly good idea of the process of making the shell, primer and nickel-jacketed bullets, to complete which requires eighty-three distinct operations.

The general exhibits filled three floors. On the third floor was a model garage equipped with the following machines and machinists' tools: Fay & Scott 32-inch extension bed gap lathe; Cincinnati No. 1½ universal milling machine; U. S. Electrical Tool Co.'s electric drills; Gould & Eberhardt shaper; Rockford Drilling Machine Co.'s upright drill; Cincinnati Pulley Machine Co.'s "Avey" sensitive drill; Union Twist Drill Co.'s milling cutters; S. W. Card Co.'s taps and dies; J. H. Williams & Co.'s wrenches, clamps and lathe dogs; Champion Blower & Forge Co.'s blacksmith drill and "Champion" forge. All of the machines were driven by individual electric motors.

The object of the exhibit is to make ocular demonstration of the many advantages and uses of electric power in the factory, shop and home for facilitating manufacture, making repairs and promoting home comforts. The section devoted to electro-therapeutics comprised a number of interesting exhibits useful to physicians, surgeons and dentists. A comparison of a carbon filament electric lamp made in the early days of incandescent electric lighting and one of the latest "Mazda" lamps showed something of the wonderful advance that has been made in electric lighting during the past thirty years.

* * *

FOREIGN ORDERS FOR MACHINE TOOLS

Many exaggerated statements have been current in regard to foreign government orders for machine tools placed with our manufacturers in October, one order for 1000 lathes being a favorite story. The facts as nearly as can be ascertained are that orders for about 1600 lathes in all were placed, principally for 14, 16 and 18 inches swing. One large Cincinnati concern obtained an order for 300, and an Eastern concern for 250. Besides these, orders have been received from a number of foreign dealers, probably also for government use. These orders were not confined altogether to lathes, but a few other machine tools were also called for. The total amount, figured conservatively, is between $800,000 and $1,000,000. These sales are very welcome to our manufacturers and have imparted a brighter aspect to the trade situation. They are undoubtedly the forerunner of future orders which will probably continue during the war and doubtless extend to other lines.

NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION CONVENTION

The thirteenth annual convention of the National Machine Tool Builders' Association was held at the Hotel Astor, New York City, October 22-23. William A. Viall of the Brown & Sharpe Mfg. Co. presided. Notwithstanding the general business depression and the dullness of the machine tool trade in particular, a fairly good representation of the association was present. The membership comprises 162 concerns and 126 names were registered, of which over 100 were accredited members.

President Viall, in his opening address, referred to the fact that the great and sudden changes caused by the European conflict have directed the attention of American manufacturers to the South American trade, and this is now receiving the attention it deserves. It will soon be apparent, however, that South American business is not waiting like over-ripe fruit to be plucked, but in order to secure the business of these countries close attention and careful study for long periods of time, and the establishment of American banking connections will be necessary. It was not the wish to take advantage over our friends in Europe engaged in a great war, but a plain duty lies before American manufacturers and it would be foolish and unwise not to take advantage of it. Reference was made to the agitation for higher railroad freight rates and the move to re-classify the freight ratings on some of the products of the members of the association. The belief was expressed that the members of the association are in accord with helping the railroads to get fair returns on their investments, and would not stand in the way of giving them proper compensation for services rendered.

C. Wood Walter of the Cincinnati Milling Machine Co., chairman of the legislative committee reported on legislation affecting the machine tool trade and membership. He spoke of the bill creating the federal trade commission, and the Clayton anti-trust law as undoubtedly being directed toward creating better social conditions, and therefore commendable. So far as could be seen by the chairman, these laws did not interfere with the customs of doing business as approved by the members of the association or with the aims of the association as a body.

S. H. Bullard of the Bullard Machine Tool Co., chairman of the catalogue committee, reported on the progress of the collective catalogue of machine tools and accessories which is to be printed in several languages. This catalogue has been under consideration for two or three years, and considerable preliminary work has been accomplished. The outbreak of the European war, however, has changed conditions, and in discussion, some doubt was voiced of the advisability of going ahead with the project now. The difficulties of distribution were touched on, and admitted to be serious.

W. H. Barr, president of the National Founders' Association, was given the privilege of the floor to call attention to a safety exhibit made by the National Affiliated Safety Organizations which embraces the safety work of the National Founders' Association, National Association of Manufacturers, National Metal Trades Association and National Electric Light Association. A movement is on foot to combine all organizations for promoting safety in shops, mills and factories in one common body (N. A. S. O.) and thus secure uniformity and standardization of practice with respect to signs, regulations and methods for promoting safety in manufacturing plants.

H. R. Eldredge, vice-president of the National City Bank, New York City, made an address on foreign trade, particularly South American trade, which was most interesting and inspiring. The National City Bank has established a branch in Buenos Aires and will open another branch soon in Rio de Janeiro. The functions of these branches were explained, showing how helpful American banking institutions can be to American commerce. It was pointed out that financing foreign enterprise was a great advantage to a nation because the supplies needed for the projects were invariably required to be purchased in the country furnishing the capital.

The second session, in the afternoon, was opened with a paper, "Reform in Drawings," by E. H. Fish, New England editor of the *American Machinist*. Mr. Fish touched on the practice of making drawings, the conventions in use and the lack of uniformity. It was unfortunate, in his opinion, that many draftsmen were too proud to make their drawings understandable by using the English language. Many men today are working in machine shops earning good wages, thanks to specialization, who have had no training whatsoever in reading drawings and therefore are unable to grasp the meanings of the common and uncommon conventions in use. These men, however, are able to understand English and wherever there is doubt of the meaning of a drawing or the possibility of a mistake, legends should be inserted to make the matter clear. The paper was illustrated with a number of sketches showing examples that have caused trouble even in shops where mechanics were used to reading drawings. The more liberal use of cross-section views was advocated.

Magnus W. Alexander of the General Electric Co., made an address, "Waste in Hiring and Discharging Men," which dealt with the enormous waste annually incurred by manufacturing plants in indiscriminate hiring and firing of help. It is extremely difficult to determine the exact costs of hiring and training an employe—in fact impossible, because of varying conditions. Mr. Alexander's figures indicated that the cost ranged all the way from $8.50 to $65 per individual, and estimates received from employers of labor in other plants than the General Electric with which Mr. Alexander is connected, were higher, ranging up to as much as $200 per man. One large concern, in an endeavor to increase its working force, hired 42,000 persons and out of that vast number secured a permanent increase of working force of only 7000. It was conceded that the waste could be greatly diminished if more care was exercised by the hiring department in selecting men suitable for jobs. A new man requires instruction and is often the cause of considerable damage to machinery and tools in the breaking-in process. It seems highly important to reduce this economic waste both from a purely business point of view and from a broader social standpoint.

The morning of the second day of the convention was given up to committee meetings comprising lathe, sensitive drilling machine, boring machine, gear cutting machine, grinding machine, hand screw machine, radial drilling machine, planing machine, milling machine, shaping machine, vertical drilling machine and turret lathe committees. In the afternoon, a number of resolutions were read by S. H. Reck of the Greaves-Klusman Tool Co., one of which put the association on record as favoring the requested advance of five per cent in freight rates for the eastern railroads. Another resolution was read, expressing sympathy with all the nations at war, and the hope that the war will come to a speedy end.

The members were favored with a long paper by James Logan of the United States Envelope Co., entitled "A Closer Commercial Relationship with Latin America." Mr. Logan sketched the conditions of life in the principal countries of South America and pointed out some of the difficulties in developing trade between the United States and the Latin-American people. The relations between these people and Europe are very close and in Mr. Logan's opinion, it will take years of hard, persistent work to secure a large trade. His views are based on the experiences gained in a trip with a party, with the view of extending commercial relations and securing acquaintances that would be helpful.

All the officers were re-elected as follows: President, William A. Viall, Brown & Sharpe Mfg. Co., Providence, R. I.; first vice-president, J. B. Doan, American Tool Works, Cincinnati, Ohio; second vice-president, D. M. Wright, Henry & Wright Mfg. Co., Hartford, Conn.; treasurer, A. E. Newton, Reed-Prentice Co., Worcester, Mass.; secretary, C. L. Taylor, Taylor & Fenn Co., Hartford, Conn. Charles L. Hildreth, Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass., continues as general manager.

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The subscription price of $2.50 a year has been fixed for the *Daily Consular and Trade Reports* published by the Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C. The new plan of distributing the reports, which became effective July 1, 1914, enables all firms and individuals who desire the publication to obtain it.

REFORM IN DRAWINGS*

HOW TO MAKE DRAWINGS THAT GIVE THE SHOP ALL NECESSARY INFORMATION

ONE of the most prolific sources of inefficiency in a machine shop is its drawings. In one place the drafting room may dominate the shop, in another the shop may ignore the drafting room. The result is friction and loss. The object of this article is to see if there is any way by which this friction can be reduced with satisfaction to all concerned. A drawing may be said to be an order to the shop showing *what* to make; and a route sheet is an order *how* to make it. The drawing, however, should have one other and equally valuable function. It should be an accurate record of what *was* made. In order that it may perform all these functions, the man that makes the drawing must know what is going on in the shop. If his drawing is wrong in the slightest particular, or if the exigencies of the case call for changes, he should be notified at once in unmistakable terms, and there should be some way of checking his work to know if he has made the needed changes promptly.

Changes may not be reported to the drafting room for a number of reasons. The shop may have made a mistake and in order to save a casting or a string of castings, a change is made in another piece and no report is made because no one is anxious to own up to the mistake. The machinist may have been snubbed by the draftsman and he may be literally afraid to report an error, due to the imaginary advantage that an educated man has over an uneducated one. Draftsmen as a class are better educated than machinists. Too often the latter's lack in English results in the substitution of profanity for descriptive adjectives, and the outcome is that the man whose selection of adjectives is the better ordinarily wins even though his arguments may be altogether wrong. Consequently, the very first point of attack should be to give the machinist a better opinion of the draftsman by helping the draftsman to become better himself, and also by giving the draftsman a clearer idea of the machinist and his limitations. When a drawing is once made, even though we may have arranged for its correction if wrong, there are two possibilities that it may not be good for anything; one because the man who made it was incompetent or careless, the other because the system was wrong. Draftsmen come from all sorts of sources, but enough of them come from the technical schools so that the trade is dominated by them. The technical schools teach drawing today as they did years ago when machine shops were filled with men that had mechanical intelligence. Drawing has been called a universal language so long that we have come to believe that it is, while as a matter of fact there have been so many conventionalities introduced that its language is, like English, swallowed up in its slang. Anybody can start a new conventionality—there is no penalty—and there is hardly a shop that does not have some peculiarity that identifies its drawings. Even Brown & Sharpe give the number of threads per inch in Roman numerals. Hardly any other shop does but each has its own idiosyncracy.

While the route sheet is supposed to be the order *how* to do the work, and the drawing an order *what* to make, it is too much to ask of human nature that a man should make an intelligent order unless he knows how the thing will be made. This has been given as a reason for having the draftsman route his own work through the shop. Possibly the suggestion was based on the idea that if the draftsman found that that was part of his job, he would throw it up in favor of a man who was a machinist first and a draftsman second. It seems unlikely that we can get real satisfaction from a draftsman who has not in some way gotten a pretty clear idea of what is done in the shop at all stages of the work. Fortunately a few men can get this without actually working in the shop, but for almost every one it means two or three years of actual work. If the shop of a technical school is anything like a commercial shop it ought to be able to give men of the quality that attend a pretty fair insight into shop methods. If it is run on exercises that are twenty-five years behind present practice, it will have more trouble doing it. The fault with "tech" draftsmen is more apt to lie in their shop practice than in their drafting practice.

The technical graduate may have a hard time learning to make a neat drawing, but if his shop practice has been good he should soon be able to make a usable drawing. If he is not it is because he is not duly impressed with the idea that every error that he makes is multiplied by the number of pieces that are made before he is found out, and added to the cost of every preceding operation that has been performed on them. The first thing that the green "tech" man or any other draftsman should get firmly fixed in his mind is that the men in the shop are no longer mechanics exclusively, but that modern systems have made it possible to give employment at wages that compare favorably with those paid to mechanics, to a vast body of men who would otherwise be on the bread line. His drawings must be made so that these men can read them. It may be hard on the draftsman, but it is worse for the shop if the drawings are not made with the utmost possible clearness, for if this is not the case, the foreman must act as interpreter and waste time that he might spend to better advantage in other ways. Nor is it necessary for the draftsman to assume that because he has made his drawing clear and accurate there is nothing further for the shop to concern itself about. More improvements have originated in the shop than in the drafting room, and always will, even though our draftsmen may come from the shop, for in so doing they will lose their point of view and acquire another. Probably we have not demanded enough from the draftsman. We have accepted him much as we have the stenographer. We do not expect that stenographic

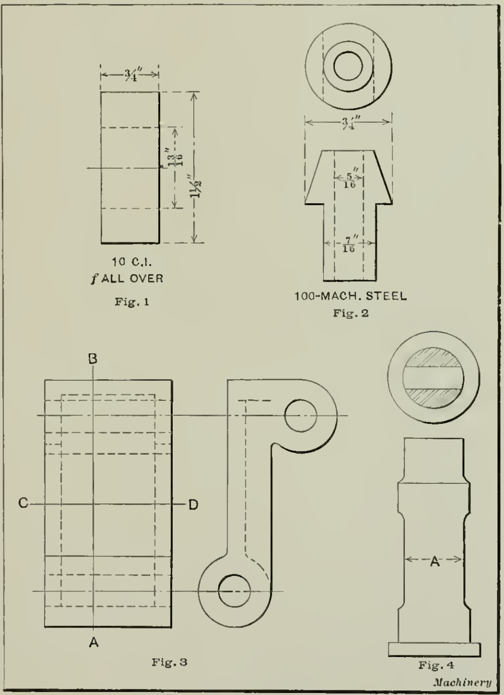

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Figs. 1 to 4. Examples of Drawings which fail to give Complete Instructions to the Machinist

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* Abstract of a paper read by E. H. Fish before the convention of the National Machine Tool Builders' Association at the Hotel Astor, New York City, October 22-23, 1914.

notes can be read, even by the next girl, and if a stenographer rises to the height of using the same technical expression that we dictated, we are surprised and gratified. The case is similar to that of the draftsman, who realizes plainly what he is attempting to delineate, and is prone to assume that every one else can read what is in his mind and what he forgets to put on paper. These "sins of omission" include necessary views, dimensions, and specification of material and finish wanted. The draftsman's chief "sin of commission" is the introduction of a cobweb of dotted lines that mean nothing without a drawing board and tee square with which to follow them across the drawing.

Fig. 1 shows a simple collar as the drawing is usually made. It seems like a pretty complete drawing; but, first of all, it is impossible to make ten of these collars that will be correct as dimensioned. We may happen to realize that our reamer is 0.001 inch under size, and we cannot afford to buy a new one for these ten collars, concerning the use of which we know nothing. So we send upstairs to know if it will do to have the holes 0.001 inch small. The reply comes back that if the hole is smooth it will be all right and as we have to make the shafts anyway they don't see why we care. So we know that 0.001 inch small in the hole will be all right but we do not know how much more would go. Then we look at the material; if it was only cold-rolled steel we could chop the things out on the screw machine in no time, but of course the pattern was made and the castings in the shop before we heard of the job. So we call up again and find the steel would be all right but they never heard of doing such a thing. Then we chase around for some steel and find that all we have is 1½ inch and 1¾ inch. Then we wonder why the outside needs to be 1½ inch, so we go up ourselves this time, and find that this outside diameter must fit snugly into the surrounding atmosphere, so that it will be all right if we use any size stock that we happen to have and just run a chip over it. By this time we know better because we got a glimpse of the assembly drawing and saw that this collar goes on a little shaft to which it is secured with a pin. The only jig we have for drilling pin holes in collars anywhere near this size takes a 1 7/16-inch collar. We get that changed and while we are there we try to find out how near to size the thickness must be and what character of finish it should have. It seems the thickness may vary 1/16 inch if necessary; and that the outside should be polished, with the corners neatly rounded, and the sides trued up square and left without polishing. In fact that is the only thing about the job that requires care. In this one simple piece we had the four chief "sins of omission": there were no limits given, the material was not given consideration from the shop point of view, the kind of finish was not specified, and no attention was paid to the use of tools already available.

Some draftsmen will tell you that there is such diversity of practice that they do not know what system to use. As to that you may very well tell them to take no chances that their drawings will be misunderstood. If there is no agreement as to conventionalities, drop them. If a drawing fails to express your meaning, try English. If you want a piece turned and ground to a mirror finish, say so without abbreviations. Don't simply say "f ALL OVER." If the piece is good enough, if it is simply rough-turned so that it will balance, say so and stop the machinist wasting time on it. If it must be in running balance, say so before anyone asks, or forgets to ask. Look over any drawing that has been sent out of the home shop and the number of notes pencilled on it will give you an idea of the value of English to the machinist. Don't be so afraid to use your own language. Look at every drawing from the point of view of the man that wants to show you up, and find out what else he can make that the drawing will excuse. Fig. 2 shows a piece ¾ inch in diameter, flatted off on each side so as to be only 7/16 inch across. The drawing is correct but it is misleading in that there is no danger sign. It is as bad as a railroad crossing without a sign post. You are almost sure to get a hundred pieces with shanks 7/16 inch in diameter. This drawing needed another view, a bottom view with full lines only, and it needed a note to the effect that the sides are flat. Dotted lines are an invention of Satan, valuable to the man that made them because he has imagination, an attribute denied the rest of us. Take the case shown in Fig. 3; how can anyone guess what the dotted lines mean without a drawing board and T-square? A cross-section on *A B* and another on *C D* would have simplified matters, and machinists like cross-sections. So do other workmen. An architect uses little else except cross-sections for elevations; his floor plans and his details are all cross-sections. Don't be too literal. The tool-post, Fig. 4, is literally correct, but it is liable to be misunderstood and you may get a piece turned small at *A*. A cross-section added would fix things.

There are still many shops where limits are not used. We should not deceive ourselves about that. They turn out good work and lots of it but they cannot do it with the class of men with which the larger shops are being filled. They must hire machinists to do machine work, and they must fit each part to its place. In such a shop nothing has beaten the assembly drawing with dimensions. If a man gets an assembly drawing of a planer head, and what he is doing is turning the swivel, he knows at once that a considerable variation from size is allowable, and if the part is one of the miter gears he knows that its hub must fit freely enough so that if no one oils it for a year or two, it will not stick. The operative, working from a detail drawing, cannot be expected to know these things. He must make a piece or do his work on it and it must be inspected in the light of the orders which were given him. If he was told to grind a shaft with a tolerance of 0.001 inch either way, he can expect to have it accepted whether it fits or not, because it can be shown that the fault was in the hole rather than in his work. If no tolerances are established, then, of course, the draftsman is not to blame if he does not use them; the system or lack of system is to blame. Then there is the failure to consider the material from the standpoint of the shop as well as the finished product. While the shop may be expected to have the best information as to what it can make a thing out of in the least time, that information should be in the hands of the drafting room in as complete a form as possible. Likewise, information should be in the hands of the drafting room as to the limitations of the shop equipment. If a draftsman specifies a thread R 4⅝ diameter 5 pitch, when the nearest tap on hand is 4¾ diameter 4 pitch, there should at least be an inquiry. If the draftsman had known what taps were available he very likely could have varied other details so as to have used one of them. If the drafting room calls for a shaft 2 inches longer than the longest lathe in the shop will take, it may be possible to turn it by taking out two of the tail bolts and sliding the tailstock over the end of the bed; but if he could have found a way to get along without those 2 inches, the thing might have been turned with some degree of efficiency instead of having to nibble off the stock. If the draftsman had been given full particulars he could have avoided this difficulty, but if he had no information except what he could get by going into the shop on sufferance, he could not be blamed.

There is another thing that is the fault of the system, and that is the conflict of ideas as to what the designer should do and what belongs to the draftsman. A designer is apt to be a poor as well as an expensive detailer, because he hates to get into the puttering end of it. It is easy for him to sketch the larger and more important parts and then turn them over to the draftsman with instructions to fill in the details, but the filling in may be the most important thing of all. A good idea may be all that makes a machine possible, but it is attention to details that determines whether it can be made at a profit or not. There is need of some man intermediate between the designer and draftsman, who can decide manufacturing details. He would provide for oil holes and grooves, keys and set-screws, materials to be used, and the hundred and one little things that make it possible to utilize the idea of the man higher up. This position is one to which a draftsman or a machinist might aspire, but which neither could reach unless he was willing to learn to do the other man's work. My ideal would be a machinist who had learned to draw were it not for the limitations which his lack of early practice has put upon him. If the public schools could only be persuaded to give real courses in mechanical drawing so that boys could use pencil and pen freely by the time they were sixteen years old, then they could serve an apprenticeship in a machine shop and in a short time make nearly ideal draftsmen, in line for promotion to any height to which their ability might lead them. Men of this type might not command high pay, but they would surely get steady work and a chance for promotion that would be worth more than immediate returns.

Take the man from the technical school. He is in the drafting room merely because he hopes to grow on the job; he has no intention of staying there a lifetime, and if he does it is because someone made a mistake. If his work is not satisfactory, there is an easy way to get it corrected in the future and that is to tell the college faculties what you want. They do not know the demands of the times and there is no way for them to find out unless you tell them. They are shut off away from the business world, busy about problems that are peculiar to their work and with neither the time nor the money to go about and find out at first hand what their graduates must know. When they come to see you, you are polite and do not talk shop too much, and they go away feeling that you are well pleased with their product, while what you should have done was to tell them wherein their young men are weak. They need to know it—it is their bread and butter—and I believe from my acquaintance among them that they would welcome every suggestion you might make, reserving only the right of counter-suggestion.

Another thing that should be possible in technical schools is the teaching of materials of construction in terms of material that is on the market. We may not want to advertise Novo or Blue Chip steel, but if we want to have it used we must say so. If we specify machinery steel we should know that what we want is a cheap grade of steel with little strength and wearing quality. Names of brands will change but it will not be any worse than teaching geography the next few years. I am also convinced that a stiff course in routing work for the shop, given to technical men before graduation, would be a great help to them as an "eye opener," as well as being of advantage to their future employers. A man who has sat down with pencil and paper to consider exactly what should be done first on a piece which he has detailed, exactly how the work is to be held at each stage of its progress, what kind of tools will be needed and how expensive a machine it will tie up, has inevitably begun to get an idea of the problems that lie before the man in the shop. He is also one step further from the idea that because a machinist takes pride in being able to do a difficult job, he ought to be supplied with a plenty of them to do.

To sum up this rather rambling paper, let me suggest: First, that the advent of large numbers of operators and changes in methods of manufacture during the past few years have made a totally new demand upon the drafting room. Second, that technical school graduates, who are apt to have considerable influence on drafting room methods are apt to be insufficiently trained in modern shop methods. Third, that professors of drawing have not been sufficiently informed of the new requirements in drafting rooms. Fourth, that the public schools should teach machine drawing in a thoroughly mechanical way to all boys who show any aptitude along mechanical lines, with emphasis on neatness and good lettering. Fifth, that a drawing should constitute an order and a record; and to that end, it should be followed implicitly in the shop or returned for correction; and requests for correction should be made in writing and in form to be filed away if accepted, so as to constitute a check on the draftsman's ability. Sixth, that the shop should keep the drafting room posted as to its possibilities and limitations in the way of tools and machinery, and its preferences for materials from a manufacturing point of view. Eighth, that very few boys should be encouraged to enter drafting as a trade unless they are willing to work for a considerable time in the machine shop, and some man with a thorough knowledge of shop work, preferably gained in a number of shops, should be placed in charge of detailing the ideas of the designer. Ninth, freer use of English notes supplemental to the information given by the drawing alone, should be encouraged.

ESTABLISHMENT OF AMERICAN BANKING FACILITIES IN SOUTH AMERICA*

The industrial history of the United States may be studied with no little pride by our citizens. What has been accomplished during the comparatively brief life of the nation is truly remarkable and is evidence of what a determined people of intelligence, industry and ability are capable. The resources of our country are very great and even yet have been but lightly touched, our productive power is not impaired and thousands of acres still await the plough, so that we not only produce sufficient to provide food for our own large and growing population but are enabled to spare a very substantial amount for export to less fortunate countries. American inventive genius and skill have permitted our manufacturers to yearly increase their products until now we find it necessary to broaden our market. Our export statistics show that without very great effort, rather because of merit and demand, our manufactured articles go to foreign countries in increasing yearly volume. In years of dull local business, spasmodic efforts have been made to expand our exports of manufactures generally but a revival of home trade operations invariably brought with it a decline of interest in foreign trade. The truth is that only within the past few years has any real attention been paid to the possibilities of other markets for our wares than our own. Our exports in the main have been those the world sought rather than what have been sold by systematic effort. Such attention as has been paid to a foreign export trade has encountered so many obstructions and rough places that it was too often diverted. Prior to the Civil War, the United States did a considerable over seas trade but with that memorable struggle passed our merchant marine and the better part of our foreign trade. The minds of our business men turned to the needs of our country, the possibilities of an immense internal trade based upon our tremendous agricultural production were realized, and the remarkable growth of our railway system permitted rapid development. The opening of the country west of the Mississippi offered a great business field, and it is small wonder that we have, in watching the remarkable progress of our own country, but seldom permitted our business fancies to stray beyond our own borders. We have now reached that period in our industrial history when it behooves us to take cognizance of the foreign field. That we have been aware of this for some time is evidenced by the formation of various associations for the promotion of foreign trade, by the investigation of possibilities by some of our larger concerns and the increasing activity of our consular service and its effective work.

The results of such investigations made bring us face to face with the fact that a large foreign trade is not to be had for the asking, but is only to be realized by energetic methods and in the face of sharp competition. The field is a large one and the achievement of our purpose will only be realized after much patient work and a considerable revision of our methods. It is well said that it is "hard for an old dog to learn new tricks." Likewise it will prove hard for many ambitious manufacturers to dispose of their wares in foreign lands, to understand the necessity of consulting the particular needs of the countries they desire to enter, and the customs and ways prevailing there. But few of our merchants and manufacturers have had any considerable degree of experience in export and import trade; to the great majority it presents an entirely new field. It is obvious that a great deal of preliminary work must be done before we can be in position to reap the full rewards in the way of trade, which the excellence of our products entitles us to. Not the least of the lessons to be learned is to adapt ourselves to the customs and characteristics of the people whose trade we hope to enjoy. We Americans are just a little too much inclined to expect those we come in contact with to adapt themselves to our ways, rather than adapting ourselves to theirs. One of the complaints often made is that we will not pack our goods according to specifications given, frequently occasioning the rejection of the articles to the dissatisfaction of our shippers.

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* Abstract of a paper read by H. R. Eldridge, vice-president of the National City Bank, New York City, before the convention of the National Machine Tool Builders' Association at the Hotel Astor, New York City, October 22-23, 1914.

It may be readily understood that if a shipment is made in ordinary packing cases of just sufficient strength to allow safe carriage in railway cars and of 100 or 200 pounds instead of medium sized cases strongly put up, the merchant receiving them on lighters, often on a rough sea, and required to transport them inland on the backs of animals, cannot be censured if he refuses the shipment rather than undergo the expense of repacking the articles. Errors of this nature are all too frequent and the criticisms offered are just. We must be careful to observe instructions and we should learn that orders must be filled exactly as given. Good service always means satisfied customers. We know that our chief competitors in the world's markets have been studying the situation for years, that they have built up a system giving them many advantages and that we cannot hope to make great progress until we ourselves have developed our facilities far beyond that which they now are. We cannot fail to realize what the lack of a merchant marine means, what great advantage their wonderful banking system gives to our competitors and the value of their years of experience. We must therefore not be disappointed if our progress in developing these markets for our products is slow, nor must we lose heart if the problem appears difficult of solution.

A great deal of attention has been paid recently to the possible development of good trade with the various countries of South America. Manifestly we are entitled to a considerable share of the trade of those countries. Our geographical location alone prompts that belief, and the further fact that we are a very large customer for their products. In looking over the possibilities in South America we must bear in mind that much preliminary work must be done, that we must study the situation carefully and build for time to come, rather than for the moment. The three greatest aids for the development of trade with South America; namely, a merchant marine, an effective banking system and the ability to finance large enterprises, have been at the disposal of our chief commercial rivals for many years and have been most advantageously used. It is not at all probable that we will have a merchant marine worthy of the name for several years to come, and then only when congress passes an act placing our ships on an equality with those of our competitors. The banking systems of the principal nations we must compete with are most important adjuncts and have done much to increase the trade they enjoy. Fortunately the new Federal Reserve Act has made some provision by which we can in a measure cope with the banking situation and this will be done in as intelligent a manner as the law permits. It is difficult, however, to see how we can well cope with the very decided advantage the financing of large projects gives to our commercial rivals. The United States has not yet reached that period in her history where she is financially independent and ready to take hold of large undertakings in other countries. We are yet young in the life of nations. Much of our prosperity, indeed the greater portion, is due to the liberal investments of foreigners in our securities, and it will be some little time before we can conveniently discharge those obligations if called upon. It is therefore apparent that our ambitions in the direction of expanding our trade in South America depend upon our genius and skill, the excellence of our products, and our tact and ability in handling business entrusted to us, rather than advantages due to our shipping and financing strength.

The sudden outbreak of hostilities in Europe some ten weeks since has had a profound effect upon the business interests of the world and for the time has made it impossible to foresee with any degree of certainty what the future holds in store. We do know that for a while at least, European nations involved will be but little inclined to invest liberally abroad and that obligations there maturing will be called for payment in many instances. When we consider that some of the European nations involved have been the principal financial bankers of some, if not all, of the South American countries, we can better understand the keen interest in conditions those countries display and with what apprehension they look to the future. Conditions in South America generally have not been good for several years, in some countries they have really been acute, and with the complication produced by the war the situation has become most interesting and calls for much solicitude. That we could sell goods in South America in liberal quantities at this time is more than probable in view of the disrupted relations necessarily caused by the war, but that we would be justified in granting the European long terms of credit to which they are accustomed, is not so clear. The long terms of credit enjoyed by our Southern neighbors are directly the result of keen competition, and are likewise responsible in no little degree for the financial conditions there prevailing. All leniency should be shown in granting credit to responsible concerns, but when those terms go beyond the bounds of reason the road is paved toward the slough of speculation. If a merchant buys on six months time, an article which will be sold and realized upon within ninety days, he holds in his hands the proceeds ninety days longer than he should and the temptation is constantly before him to either buy more goods, often beyond his needs, or to employ the funds in some line of speculation, both leading to undue expansion and often to financial failure. It would be well, therefore, not to be too liberal in terms of credit, even though the development of trade be retarded thereby, yet not unreasonably chary of granting terms of a favorable nature when conditions justify.

The National City Bank of New York will open a branch at Buenos Aires, Argentine, and as soon as practicable another at Rio de Janeiro, Brazil. It is further intended to open other branches in other countries as occasion requires. The bank desires to do all it can to promote the increase of trade relations, and through its banking department offer a cheap and effective method of handling the exchanges between buyers and sellers. It is fully alive to the inconvenience probable exporters and importers suffer by the lack of dependable information of trade conditions, demands for certain lines of goods, shipping requirements, custom house regulations and dues, a knowledge of the products of the various countries which could be imported in the United States to advantage, their character, the avenues through which they could best be had, and the numerous other branches of information so requisite for the proper handling of the business obtainable. To permit of the dissemination of such information among American exporters and importers, it is the bank's intention to maintain a corps of trade experts at each branch, whose duty it will be to gather all the data possible that can be of benefit and to make it available in an intelligent manner through the columns of *The Americas*, which will be issued from time to time, and special bulletins when deemed advisable. Information of this character will no doubt be found quite valuable and may possibly prove the source of no little saving of expense to houses operating in South America. The service of this corps will be available to American merchants and special reports can be arranged for when desired. The bank will establish a credit department in each branch and hopes within a reasonable space of time to be able to furnish exporters and importers valuable information as to the standing of South American dealers. It may be readily understood that it will take some little time to perfect such an undertaking, but when once the work is done, the service should prove of great value. The National City Bank earnestly desires to cooperate with the business interests of the country and sincerely hopes its efforts in this direction will do much to stimulate and increase the present trade relations we now enjoy with our neighbors to the South. The bank is not unmindful that it is entering a field with which few American financial institutions are familiar, that it will encounter many obstacles and perhaps often suffer inconveniences both to itself and its customers, and that it has much to learn from experience. It embarks upon the enterprise filled with a sincere desire to serve American trade as advantageously as possible. Its great hope is to do all it can to remove the many disadvantages our trade has suffered from the lack of American banks in foreign countries and to give the "dollar draft" its well deserved standing in the markets of the world.

In conclusion it may not be amiss to say that the effect of the Federal Reserve Act will be to considerably improve our ability to handle foreign trade. Not only does it serve to mobilize and make more effective credit extension power, but it puts a premium upon paper arising from actual commercial transactions and serves as at least a beginning toward the establishment in this country of a long needed discount market. The Federal Reserve Act marks the greatest step forward we have ever made in the perfection of our financial system, and though it lacks much of completing the task, it will surely make many needed amendments so pronounced that before many years have passed it will be so revised as to give to our country the advantageous position in the money marts of the world to which our large gold stock, our resources, our abilities, our wealth and our great commerce entitle us.

* * *

AN IMPROVED PROTRACTOR SCALE

BY ARTHUR E. BLOFIELD[*]

In order to make a protractor scale which can be accurately set and read, and at the same time to avoid the necessity of making the dial very large, I have recently invented and patented a method of graduation shown in Fig. 1. It will be seen that the scale is graduated from zero to 90, both ways from the center, by intervals of 10 degrees; and that there are ten circles on the dial concentric with the outer circle on which the graduation marks are numbered. Each of the inner circles has a degree mark graduated on it for each interval of 10 degrees on the outer circle, these degree marks running from the center to the outer circle and forming the intermediate graduations between zero and 10, 10 and 20, etc. The concentric circles on the dial on which the degree graduations are marked, are continued across the indicator and numbered from 1 to 9, thus making it an easy matter to read the odd degrees. Graduated in this way, it is possible to have a dial on which the graduations are sufficiently separated to make it possible to set and read the instrument accurately; and at the same time, the dial need not be more than 1½ inch in diameter.

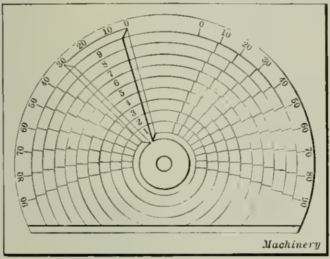

Fig. 1. Improved Method of graduating a Small Protractor Scale

Fig. 2 shows a combination tool which I have made, that is equipped with one of these patented dials. This tool can be used as a protractor, a square, a depth gage or a caliper. The method of using the tool as a protractor will be evident from the illustration. In this connection, it may be mentioned that for certain classes of work where long legs are required, the scale A may be drawn out to expose its full length beyond the end of the blade B. Likewise, the extension C would be set parallel with the stock D. The tool would then be adjusted to bring the edges into contact with the surfaces forming the angle to be measured. To use the instrument as a square, the blade B and stock D are set at right angles to each other by means of the protractor scale, and for measuring large work advantage may be taken of the extra length provided by the use of the scale A and the extension C, as mentioned in describing the use of the tool as a protractor. When used as a caliper, the blade B and stock D are set at right angles to each other—as in the case where the tool is used as a square—and the extension C is also set at right angles to the stock D. The wing nut E is then loosened to allow the blade B to be brought into contact with the work, after which the dimension is secured from the scale on the stock D. For use as a depth gage, the blade B is set around at right angles to the stock D, the wing nut being left loose and the end of the blade B pushed down to the bottom of the hole. The wing nut is then tightened and the depth of the hole read on the scale. In using a combination tool of this kind, many mechanics would doubtless find other uses to which it could be put.

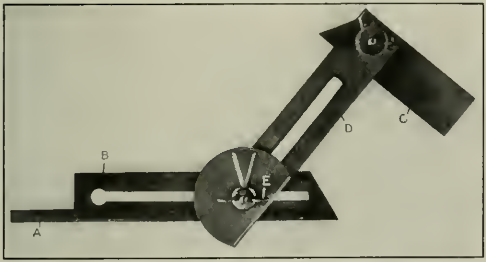

Fig. 2. Combination Tool provided with Improved Protractor Scale

* * *

WHEELS FOR CYLINDRICAL GRINDING

We call your attention to the following statement in the article "Selection of Wheels for Cylindrical Grinding," by F. B. Jacobs, in the October number of MACHINERY. "The best and purest corundum is found in Canada. * * * It cannot be denied that pure corundum makes a fast cutting wheel for most purposes, but *owing chiefly to the prohibitive cost of the raw material, corundum wheels are not commonly sold in competition with wheels made of artificial abrasives.*" The italics are ours.

We object to this statement, as being inaccurate and malicious. Mr. Jacobs is too well acquainted with the grinding wheel industry not to know the facts. Wheels made of Canada corundum (formerly called Craig Mine) are in use throughout the entire world. Corundum wheels have proved their superiority, not only for a few purposes as inferred by Mr. Jacobs, but for a vast number of grinding operations. Corundum wheels are being made in large quantities now, not only by us but by a dozen other American wheel manufacturers and they will continue to be made. The supply of Canada corundum is practically unlimited.

Our output of Canada corundum wheels amounts to hundreds of thousands of dollars worth annually, and these wheels are sold in competition with wheels made of artificial abrasive. We hold no prejudice against artificial abrasives, but on the contrary we ourselves make wheels of artificial abrasives, using both bauxite and silicide of carbon, as we have found that both artificial and natural abrasives have their advantages on certain kinds of work.

We wish to correct the impression given by Mr. Jacobs that corundum wheels are *passé*, that they are higher priced than artificial abrasives, or that corundum wheels are not and cannot be sold in competition with wheels made of artificial abrasives. Being the largest user of Canada corundum in this country, and actually interested largely in the Manufacturers Corundum Co. which operates all of the Canadian Corundum mines, we know whereof we speak.

Providence, R. I. AMERICAN EMERY WHEEL WORKS
J. O. Smith, V. P.

* * *

PERSONALS

Otto Abrahamsen, treasurer of Beaudry & Co., Inc., Boston, Mass., has returned from a five months' trip through Europe.

William J. Sansom, formerly tool supervisor with the Hart-Parr Co. of Charles City, Iowa, and later in the employ of the state of Wisconsin at Madison, Wis., is now instructor in mechanical practice at the University of Wisconsin.

Carl H. Clement, until lately chief engineer and sales manager of the Metal Products Co., Detroit, Mich., has resigned and gone on the road as sales engineer for the Bock Bearing Co., Toledo, Ohio, manufacturer of roller bearings.

Ellis F. Muther, formerly Eastern sales manager of the Gisholt Machine Co., Madison, Wis., with headquarters at New York City, has been appointed general sales manager in charge of general sales and advertising work, with headquarters at the Madison office.

Prof. Frederick R. Hutton, honorary secretary of the American Society of Mechanical Engineers, addressed a joint meeting of the Engineers Club of Cincinnati and the Cincinnati Section of the A. S. M. E., October 15, on the subject: "The Testing of Motor Vehicle Engines."

J. E. Brandt, for a number of years manager of the Philadelphia office of the Gisholt Machine Co., has become associated with the Swind Machinery Co., Philadelphia, in the capacity of vice-president. The Swind Machinery Co. has been appointed selling agent for the Gisholt Machine Co. in the Philadelphia district.

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[*] Address: 204 E. 124th St., New York City.

WHEN you have stopped to figure out what was really responsible for continuous useful service in milling machines, have you ever thought of how big a part good bearings play? Because this point is not immediately noticeable less attention than it deserves is paid to it. Think this over when you buy your next milling machine.

Scraping for a Good Bearing—Not for Finish

Our New Book

"Practical Treatise on Milling and Milling Machines" is ready. It gives you the information you need to operate modern milling machines successfully.

Useful to operators, shop foremen, superintendents, technical school instructors and students. 332 pages—210 Illustrations.

Flexible cardboard covers $1.00
Stiff cloth covers 1.50

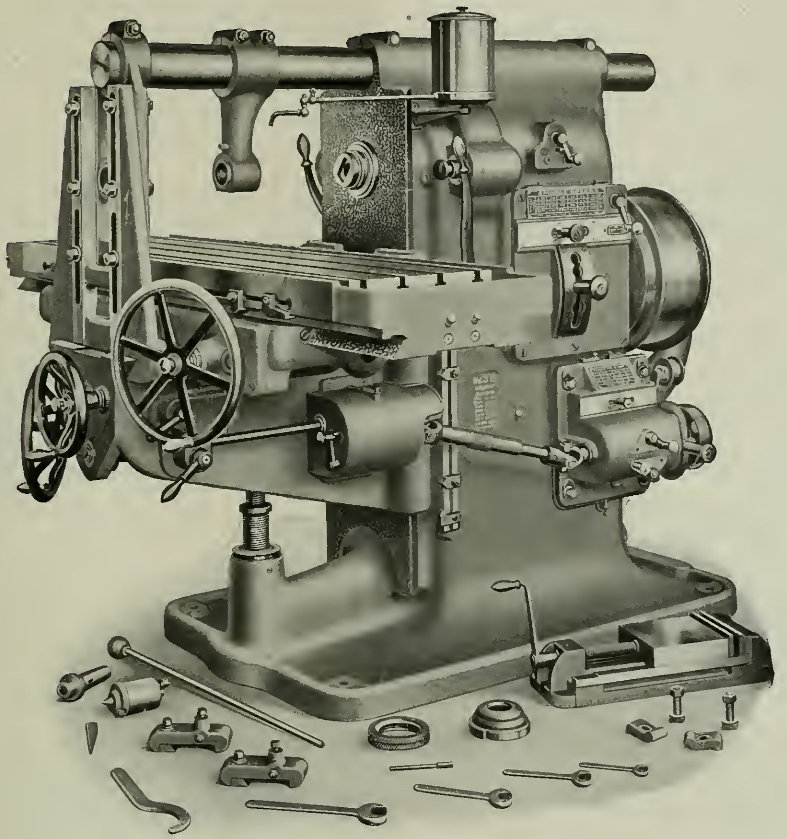
Quality in bearings is difficult to detect at once. Time is the final test of worth. Bearings may look alike, but constant service soon shows up any inferior work to the detriment of both the machine and its product.

Our methods of getting correct and properly aligned bearings are such as to insure the best of results. To begin with, the iron that goes into our castings is hard and close grained, giving superior wearing qualities. Bearings are liberally proportioned and solidly supported. These features are highly important if alignments, once made, are to be permanent. Again in scraping, our expert scraper hands carefully secure full, flat, correctly aligned bearings in every case, thus insuring a high degree of accuracy and efficiency.

Cylindrical bearings too are finished just as carefully, and they are proportioned and arranged so that as efficient and durable a drive as possible is secured throughout the machine.

That is why B. & S. Machines remain accurate through years of constant service, because the bearings—the life of the machine—are large, solidly supported, and true.

Brown & Sharpe Mfg. Co.,



A Powerful Heavy Service Milling Machine

that is rugged enough for the heaviest kind of milling is something that can be used to good advantage in any shop doing heavy work. Railroad shops, engine builders, and machinery plants handling similar lines of work will find our line of heavy service milling machines unusually complete and well adapted to their various needs.

Our No. 5-B Heavy Plain Machine shown above is a good example of this line. The massive proportions, large bearings, powerful drive, and the general ease with which a machine of this size can be handled make it indispensable in a shop interested in economical production of heavy work. There are features such as our efficient speed and feed changing mechanisms, automatic fast feed, locking device for back gears, fine adjustment for the spindle, and many others which mean better work with less effort for the operator. Can you use such a machine? Think it over and write for descriptive literature.

No. 5 B Heavy Plain Milling Machine

Capacity: longitudinal feed, 50"; transverse feed, 12"; vertical feed, 21". Either automatic or hand. Size of table, 81" x 21". Working surface, 68" x 21".

Providence, R. I., U. S. A.

READ PAGE 79

George W. Kerr, for a number of years automobile body engineer of the Stevens-Duryea Co., Chicopee Falls, Mass., has resigned. Upon leaving, Mr. Kerr's associates and employes gave evidence of the high esteem in which he was held by presenting him with a beautiful jeweled Knights Templar charm, together with their best wishes for future success.

Frederick W. Gates has resigned the position of publicity engineer with the Greenfield Tap & Die Corporation, Greenfield, Mass., the resignation taking effect November 1. Mr. Gates will open an office at 30 Church St., New York City, for a sales and advertising service limited in its scope to mechanical subjects. His familiarity with mechanical details and knowledge of technical data fit him for giving service to clients in the mechanical field.

Samuel Insull, president of the Chicago Commonwealth Edison Co., Chicago, Ill., recently donated $6000 to the Franklin Institute of Philadelphia for the maintenance of a Franklin gold medal which was thereby founded. The Franklin medal is to be awarded from time to time in recognition of distinguished achievements in science and technology. The medal was designed by Dr. R. Tait McKenzie of the University of Pennsylvania; it bears on the obverse a medallion of Benjamin Franklin taken from his portrait by Sully.

* * *

OBITUARIES

Erwin Riecke, brother of Herman Riecke of Ernst Krause, Vienna, was killed in battle near Verdun, France. He was well known among the machine tool trade in the United States, having been employed by Lodge & Shipley Machine Tool Co., Cincinnati-Bickford Machine Tool Co., Cincinnati Milling Machine Co., and other Cincinnati concerns. He had recently arranged to handle the Lodge & Shipley line in some parts of Europe in connection with the company's agents there.

Edwin Hawkridge, president of the Hawkridge Bros. Co., Boston, Mass., died October 21 of Bright's disease, aged sixty years. He was born at Valley Stream, Long Island, N. Y., and first entered the steel business with Hogan & Burroughs, New York City in 1877. He went to Boston in 1881 as manager of the steel department of Fuller, Gaynor & Fitz. With his brother, John F. Hawkridge, he started the firm of Hawkridge Bros. in 1883, which was incorporated in 1909 under the name of Hawkridge Bros. Co.

Charles S. Stallman, president of the Pacific Coast Tool & Supply Co., San Francisco, Cal., died September 24 after an illness of but five days of pneumonia. Mr. Stallman was well known in the machinery trade, and his many friends both East and West will regret to hear of his untimely death. He possessed the qualities that win friends and make for success. His business was practically wiped out by the fire and earthquake in San Francisco, but on the ruins he and his associates had again built up a successful business.

Spencer Van Cleve, treasurer of the Erie Foundry Co., Erie, Pa., died September 29, following an illness of eight weeks with pneumonia, aged forty-five years. Mr. Van Cleve was a graduate of Princeton University, and became interested in the Erie Foundry Co. when it was a small concern with a capital of only $10,000. He was made president of the company at that time, and was successful in building up the business. At the time of his death he was also vice-president of the Duntley Products Co. and the Fulton Mfg. Co.

COMING EVENTS

December 1-4. Annual meeting of the American Society of Mechanical Engineers, New York City; Engineering Societies Bldg., 29 W. 39th St., headquarters. Calvin W. Rice, secretary.

December 9-12.—Eighth annual convention of the National Society for the Promotion of Industrial Education, Richmond, Va. C. A. Prosser, secretary, 140 W. 42nd St., New York City.

December 12-19.—Second International Exposition of Safety and Sanitation, Grand Central Palace, New York City. F. W. Payne, manager, Department of Exhibits, 29 W. 39th St., New York City. The exhibit offers the opportunity to manufacturers of safety and sanitation devices to bring their products to the attention of large numbers advantageously. Last year 110,000 attended the exposition and the attendance expected this year is about 125,000.

SOCIETIES, SCHOOLS AND COLLEGES

American Society of Mechanical Engineers, 29 W. 39th St., New York City. Condensed catalogue of mechanical equipment. 307 pages, 6 by 9 inches.

The Franklin Institute of the State of Pennsylvania, Philadelphia, Pa. Year Book for 1914, 104 pages, 6 by 9 inches, containing a list of officers, committees and membership of the institute, and a historical note relating to the work that has been done, as well as the 1914-1915 lecture program.

NEW BOOKS AND PAMPHLETS

Safety in Moving-Picture Theaters. 40 pages, 4 by 6 inches. Published by the Travelers Insurance Co., Hartford, Conn.

Practical Handbook for Beet-sugar Chemists. By Werner Moeller-Krause. 140 pages, 19 illustrations. Published by the Chemical Publishing Co., Easton, Pa. Price, $1.25.

United States Coals Available for Export Trade. By Van H. Manning. 15 pages, 6 by 9 inches. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Bulletin 76.

Hints on Coal-mine Ventilation. By J. J. Rutledge. 22 pages, 6 by 9 inches. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Miners' Circular 16.

Thermal Properties of Steam. By G. A. Goodenough. 69 pages, 6 by 9 inches. 10 diagrams. Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill., as Bulletin 75. Price, 35 cents.

A Study of the Oxidation of Coal. By Horace C. Porter and O. C. Ralston. 30 pages, 6 by 9 inches. 12 illustrations. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Technical Paper 65.

The Explosibility of Grain Dusts. By David J. Price and Harold H. Brown. 60 pages, 6 by 9 inches. Illustrated. Published by Millers' Committee of Buffalo, N. Y. George F. Urban, secretary, George Urban Milling Co., Buffalo, N. Y.

Illuminating Power of Kerosenes. By William Kunerth. [illegible] pages, 5¾ by 8¾ inches. Illustrated. Published by the Engineering Experiment Station of the Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa, as Bulletin 37.

Statistics of Railways of the United States, 1900-1912. 76 pages, 6 by 9 inches. Published by the Bureau of Railway Economics, Washington, D. C., as Bulletin 66.

This valuable compendium of statistics pertains to population and area; railway mileage; capital, securities and dividends; revenues, expenses and taxes; employes and compensation; equipment; freight traffic statistics; and passenger traffic statistics. The data is segregated by areas, classes of employes, locomotives, cars, etc., and hence is a mine of information on subjects difficult to find in ordinary statistical records.

Die-making Practice. 46 pages, 6 by 9 inches. 36 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

There are too few good books on die-making and punch and die work. This book, which is No. 131 of MACHINERY'S Reference Books, will, therefore, be welcomed by those interested in this subject. It contains a great deal of practical information on die-making, and descriptions of tools used in multiple-plunger presses. Sub-press die construction is also dealt with, and the making of one-piece armature disk tools is described in detail. The book is especially adapted for toolmakers and tool-designers and will appeal to those responsible for production by means of punches and dies.

Pattern Making. By Frederick W. Turner and Daniel G. Town. 114 pages, 4¾ by 7 inches. 88 illustrations. Published by John Wiley & Sons, Inc., New York City. Price, $1 net.

This little book is not intended primarily for the general patternmaker, but rather for the younger members of the craft and other learners of the trade. It deals with general trade relations and qualifications of the patternmaker; foundry and machine shop practice; allowances and their effect on patterns; bench machine and special tools; lay-outs and templets; materials of construction, fastening and finishing of patterns; types of patterns; core prints; construction of patterns; core-boxes and cores; skeleton patterns and sweeps; and specialization in the pattern shop and foundry.

Gaging Tools and Methods. By Franklin D. Jones. 48 pages, 6 by 9 inches. 39 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

This is MACHINERY'S Reference Book No. 130. It deals with the various forms and types of gages and measuring instruments used in machine shops and tool rooms. In the four chapters, the author takes up classes of standard measurements, calipers and micrometers, fixed and adjustable gages, miscellaneous gaging tools, and measuring machines. The book covers quite completely the measuring instruments ordinarily found in machine shops, and is one which every mechanic, whether at the bench, at the machine, or at the drafting-board, should add to his library of trade literature.

Sheet Metal Working. By F. Georgi and A. Schubert. 160 pages, 5½ by 8¾ inches. 125 illustrations and two folding plates. Published by Scott, Greenwood & Son, London, and D. Van Nostrand & Co., New York City. Price, $2.

This book on sheet metal working, translated from the German, is intended for the instruction of beginners. It comprises cutting, punching, bending, folding, pressing, drawing and embossing metals and machinery for same. The first chapter gives a brief history of the iron and sheet metal working industry, and then the properties of metals are taken up, following which is a chapter on devices and machines for bending bar iron, etc. Treadle presses, foot presses and tools for same are described, following which are chapters on curling and flattening sheet metal, raising and hollowing, slot punching machine, machines for making cutting tools, press tools for making water pails, burr trimming device, clamps, rolling, tool materials, etc.

Patents. 48 pages, 6 by 9 inches. Published by the Industrial Press, New York City. Price, 25 cents.

This book, which is No. 134 in MACHINERY'S series of 25-cent Reference Books, deals with the principal provisions of the patent law, the procedure in obtaining patents, and covers in detail actual and constructive patent infringements. Many of the provisions of the patent law, in their legal form, are rather obscure to the average reader. In this book these provisions have been explained in a popular manner, and numerous examples of the workings of the patent laws have been given. Every mechanic will, at some time in his career, meet with conditions where knowledge of the patent law is necessary. He will either want to apply for a patent himself, or to acquire a patent owned by somebody else; or he may be in doubt as to whether or not he is infringing somebody else's patent. This book will prove of considerable value under all of these conditions.

Examination of Lubricating Metals. By Thomas B. Stillman. 129 pages, 6 by 9 inches. 110 illustrations. Published by the Chemical Publishing Co., Easton, Pa. Price, $1.25.

The efficiency and durability of machines are to a large degree affected by the kind of lubricating oil used on their bearings. The importance of efficient means of testing lubricating oils can, therefore, hardly be exaggerated. This work, which is based on many years of experience of the author, deals with specific gravity, cold test, viscosity, iodine absorption, flash and fire tests, acidity, Maumene's test, color reactions of oils with nitric and sulphuric acids, separation of mineral from a vegetable or animal oil, gumming and sulphur tests, tests for water, test for gasoline, carbon residue test, microscopical examination, fixed carbon in oil, estimation of paraffin in mineral oils, soap test, greases, coefficient of friction, value of graphite as a lubricant, fuel oil specifications, etc. An unusual feature of the work is quotations of wholesale prices of various substances, many of which are used in lubricants.

Practical Iron Founding. By J. G. Horner. 403 pages, 5 by 7 inches. 283 illustrations. Published by D. Van Nostrand Co., New York City and Whitaker & Co., London. Price, $2.

This is the fourth edition of a work on the principles and practice of iron founding, written both for the student and the practical man. During recent years, great changes have taken place in iron founding and the fourth edition has been doubled in size in order to deal adequately with the improvements such as machine molding, etc., that have been developed. The contents deal with principles, molding sands and their preparation, melting and testing of iron, cupolas, blasts and ladles, the equipment of foundries, molding boxes and tools, shrinkage, curving, fractures and faults, principles of green sand molding, examples of green sand molding, dry sand molding; cores, loam work, elements of machine molding, molding machines, machine molded gears; sand mixtures, etc. The work is of a strictly practical character, containing many illustrations and being one that can be recommended to all in need of a work of its nature.

GRIND RIGHT

Milling Cutters must be ground with the correct clearance to give maximum production

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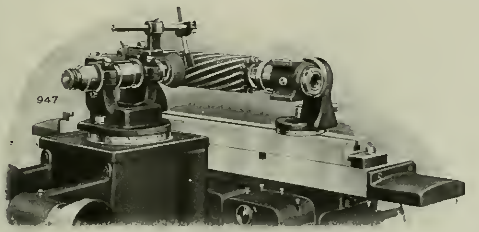
The Cincinnati No. 2 Universal Cutter and Tool Grinder

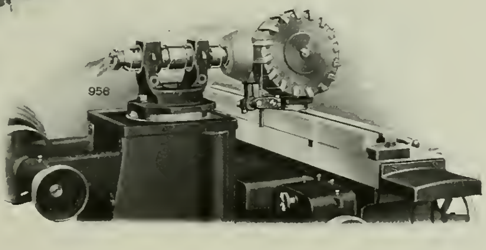
rapidly and correctly sharpens all styles and sizes of milling cutters within its range



Spiral Mill

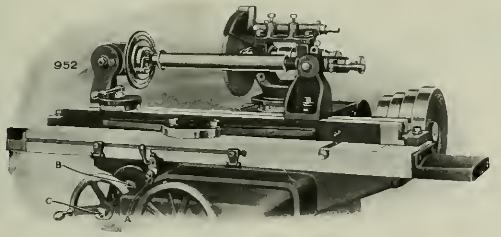
Clearance angle for all cylindrical cutters is read directly from the swivel head.

End mills, face mills, etc., held for sharpening operations just as they are held in the milling machine spindle.



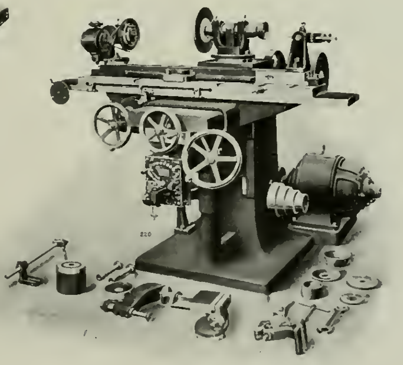
12" Face Mill

Equipped with cylindrical, internal and surface grinding attachments, it grinds all work in the tool-room.



Circular Grinding Attachment
Automatic Feed

Motor driven entirely self-contained. Countershaft driven requires only one belt from line shaft.



No. 2 Grinder Motor Driven

New catalogue gives complete details

THE CINCINNATI MILLING MACHINE COMPANY

CINCINNATI, OHIO, U. S. A.

Boring, Recessing and Multiple-turning Tools. By Albert A. Dowd. 48 pages, 6 by 9 inches. 33 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

Whether the planning of the tool equipment in a shop is done by a designer employed exclusively on this work or by the foremen and machinists, the directions for the design, construction and application of the boring, recessing, adjustable and multiple turning tools illustrated and described in this book, which is No. 128 of MACHINERY'S Reference Books, will be found of great value. The book is made up of articles on this subject published by the author in MACHINERY during the past year. These articles describe fundamental principles and constitute the most nearly complete descriptions of tools and devices for turning and boring operations ever published. The devices shown and described are examples of design actually employed in practice and successfully applied to productive work in a great number of manufacturing establishments. The book contains complete drawings and descriptions of thirty-three different tooling arrangements and tool-holding devices actually used in practice to increase production and facilitate the turning out of accurate work.

Hendricks' Commercial Register of the United States. 1600 pages, 7¼ by 10 inches. Published by the S. E. Hendricks Co., Inc., New York City. Price, $10, carriage prepaid.

The twenty-third annual edition of Hendricks' Commercial Register of the United States for buyers and sellers, is the most complete edition of this work that has been published. Many new features have been added to enhance its value, and thousands of trade names and titles of identification have been inserted, and numerous duplications expurged. The "Assistant Buyer," formerly published by the Sullivan System, has been incorporated with the Commercial Register, and the entire work has been revised and improved in details. It contains about 350,000 names and addresses, and upward of 45,000 business classifications. An indication of the extent of the work is the fact that 138 pages are required to index its contents. The work needs no introduction to buyers, having been in existence nearly a quarter of a century. It is used extensively throughout the United States and many foreign countries by corporations, associations, manufacturers, exporters, purchasing agents and sales managers, and can be heartily recommended to all having use for a work of this sort.

Modern Blanking and Piercing Dies. 48 pages, 6 by 9 inches. 41 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

Punches and dies are made in such a variety of designs and for so many different purposes that it is difficult to treat the subject of die construction and design in a general way and present fundamental principles that can be applied universally in the art of die-making. For that reason, die-makers in describing their methods have almost invariably confined themselves to specific die designs instead of attempting to deal with uncertain theories. These examples, by being properly classified, can be made of great practical value because they show what has been accomplished and suggest methods for other classes of work. The book under review, which is MACHINERY'S Reference Book No. 132, describes a great number of designs of blanking and piercing dies laid out according to the most modern approved methods. Special attention has been given to sectional punch and die construction. The tools described are illustrated by numerous engravings showing the exact method of design and construction. The subject is handled in a way that will meet the requirements of toolmakers, tool-designers, and others responsible for the successful application of punches and dies.

Experiments. By Philip E. Edelman. 256 pages, 5¾ by 7¾ inches. Illustrated. Published by Philip E. Edelman, Minneapolis, Minn. Price, bound in cloth, $1.50, bound in leather, $3.

The work is divided into two parts, the first part being devoted to selected experiments, easily carried out, which include demonstrations in science physics, chemistry, electricity, wireless communication and mechanics. The second part is devoted to the principles of original experimenting in science, invention and the industries. Chapters are included on industrial testing and commercial experiments. The general contents comprise: Models, Copies and Makeshifts, Simple Experiments in Chemistry, Miscellaneous Applications of Chemistry, Simple Catalytic Experiments; Deposition of Metals and Electroplating; Electrochemistry; Small Electric Motors, Electric Heating Devices; Electric Arc, Electromagnetic Experiments, Electric Transformers, Induction Coils and Their Applications; Wireless Telegraphy, Telephony and Control Apparatus; Telegraphy and Picture Telegraphy, High Frequency Currents; Phosphorescence and Ultra-violet Rays; Graphite Particles, Radiography and X-rays; Static Electricity; [illegible] Aeronautics, Microscopy and Microphotography, Science and Invention; Essential Processes in Experimenting, Fundamental Experimental Principles, How to Conduct an Original Research, Testing, etc.

Hobs and Gear Hobbing. By John Edgar. 48 pages, 6 by 9 inches. 47 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

The hobbing process for cutting the teeth in spur and spiral gears is now widely used. It is a comparatively new process and one on which for that reason, there is little or nothing published in book form covering the need for a practical treatise on the subject. MACHINERY has, therefore, compiled material for one of its Reference Books, giving all the available and essential information of interest to mechanics. The principles of the hobbing process are first dealt with, after which the design of hobs for spur and spiral gears is taken up, the shape of hob teeth, their relief, the number of flutes, and other questions pertaining to the making of hobs being dealt with. Special attention is given to the defects in hobs and the means by which these can be partially or wholly avoided. One chapter deals with special hob tooth shapes, including application of the hobbing process to the cutting of ratchets, spline shafts, square shafts, etc. Still another chapter deals with the important subject of centering the hob in gear hobbing, showing how the effect of defective hobs may be eliminated by the careful application of a few simple rules. A comparison between the hobbing and milling of gears is also given. The book should be of interest to all mechanics having to do with gear cutting or gear hobbing.

Heat-treatment of Steel. 278 pages, 6 by 9 inches. 73 illustrations. Published by the Industrial Press, New York City. Price, $2.50.

In the development that has taken place in the methods and processes pertaining to the machine-building trades during the past fifteen years, most remarkable changes have been wrought in the heat-treatment of steel, including the hardening, tempering, annealing and casehardening of the various kinds. This book places on record the modern methods now employed in the heat-treatment of steel and includes also a treatise on the methods used for measuring the hardness of metals by the various hardness testing apparatus that have been developed in this country and abroad. Special attention has been given to a number of methods recently developed, making this book a most modern and complete treatment of the subject; as an example of the new methods dealt with may be mentioned the comprehensive treatment given to electric hardening furnaces and to casehardening by carbonaceous gas. The best idea of the contents of the book may be obtained from the various chapter heads which are as follows: Hardening Carbon Steel; Heating the Steel for Hardening; Quenching and Tempering; Heat-treatment of High-speed Steel; Heat-treatment of Alloy Steel; Heat-treatment of Steel by the Electric Furnace; Metallic Salt Bath and Miscellaneous Types of Electric Furnaces; Miscellaneous Hardening Methods, including Packhardening, Local Hardening, Heat-treatment of Steel Castings, etc.; Casehardening; New Casehardening Methods; Heat-treatment of Gears for Machine Tools; and Testing the Hardness of Metals. As a reference book, giving specific and detailed directions for the heat treatment of steel, the book can be thoroughly recommended.

Spiral and Worm Gearing. 274 pages, 6 by 9 inches. 132 illustrations. Published by the Industrial Press, New York City. Price, $2.50.

The subject of spiral and worm gearing has often been presented in so theoretical a manner that many have assumed it to be very difficult to master. It is possible, however, to present the principles of the design and calculation of spiral and worm gearing in such a way that they can be readily understood, without resorting to a highly theoretical treatment; and in preparing this book, the first consideration has been to treat the subject in such a way as to meet the practical requirements of the machine building trade. As a result, mere theory and academic discussions have been avoided; the rules, formulas and instructions are illustrated with engravings whenever necessary, and numerous examples are given to show their application to problems met with in machine design. The scope of the book can be most easily understood by giving the headings of the twelve chapters of which the book consists: Principal Rules and Formulas for Designing Spiral Gears—Formulas for Special Cases of Spiral Gear Design—Herringbone Gears—Methods for Forming the Teeth of Spiral and Herringbone Gears—Hobs for Spur and Spiral Gears—Calculating the Dimensions of Worm Gearing—Allowable Load and Efficiency of Worm Gearing—Design of Self-locking Worm-gears—Hindley Worm and Gear—Methods for Forming the Teeth of Wormwheels—Gashing and Hobbing a Worm-wheel—Hobs for Worm-gears. The book is one which can be thoroughly recommended to anybody interested in spiral and worm gearing, as it places on record a great deal of information that has not previously been available in book form and which has been selected and used in this book because of its practical value.

Turning and Boring. By Franklin D. Jones. 307 pages, 6 by 9 inches. 216 illustrations. Published by the Industrial Press, New York City. Price, $2.50.

In his preface to this book, the author states that the specialization of machine tool manufacture has been developed to such a degree that there is need also for treatises which specialize on different classes of tools and their application in modern practice. This book has, therefore, been prepared to deal exclusively with the use of various types of turning and boring machines and their attachments. On this subject it is unusually complete, and, in addition to standard practice, describes many special operations seldom or never dealt with in books on machine shop practice. A unique feature of the book is that very little space has been given to mere descriptions of different types of machine tools, the principal purpose having been to explain the use of the machines and to solve the problems that are met with in their operation, rather than to dwell on constructional details. In selecting the examples by means of which the methods of operation are illustrated, care has been taken to select those important and useful operations that would best exemplify general principles. In preparing this book, the author, who is well known as the author of MACHINERY'S 25-cent Reference Books on machine tool operation, has made use of much of the material published in Reference Books Nos. 91, 92 and 95, which appears here together with a great amount of additional information on modern boring and turning methods. The book contains sections on the following subjects: The engine lathe; turning tools and cutting speeds; taper turning; special turning operations; thread cutting in the lathe; turret lathe practice; vertical boring mill practice; horizontal boring machines and their use.

Science and Practice of Management. By A. Hamilton Church. 535 pages, 5 by 7¼ inches. Published by the Engineering Magazine Co., New York City. Price, $2.

The literature on shop management is becoming quite extensive and a large variety of principles, theories and views on the efficient conduct of industrial enterprises have been set forth. The latest work, by Mr. Church, is well worth the attention of general managers, superintendents and students of practical economics. It is based on the proposition that manufacturing activity can be analyzed into certain well defined factors and that the principles of the art of management can be reduced to one of three main groups, viz: (1) The systematic accumulation and use of experience; (2) the economic control (or regulation) of effort; (3) the promotion of personal effectiveness. The work is divided into two parts, the first part dealing with the science of management and the second with the practical organization of the organic functions. In the first part, the author discusses the two great instruments of management, the organic functions of manufacturing organization, the regulative principles or "laws of effort," and their practical application to the relations of the manager to the instruments of management. In the second part, he deals with organizing the functions of design, equipment, operation and comparison, and the installation of the function of control. The principles and the relations set forth are to some extent illustrated and made clear by means of colored diagrams or charts printed on inserts. The work is not one to be recommended to the individual who would extract from it a ready-made system of management to apply to his particular case, but it contains much food for thought for him who would understand principles and apply them in the intelligent control of his business.

Foremen and Accident Prevention. 80 pages, 4 by 6 inches. Published by the Travelers Insurance Co., Hartford, Conn.

The booklet is based upon the extensive experience of the Travelers Insurance Co. in accident prevention work and will be found of practical help in manufacturing plants generally in securing cooperation of the foremen. The relation of the foreman to the employe is discussed, following which the body of the work is arranged alphabetically, thus making reference to any desired information easy. The contents are indicated by the following heads. Acids; air, alcohol; artificial respiration; belting; belts; blasting; blood poisoning; boards; boilers and other steam apparatus; breathing; building; caisson work; carelessness; caustic; chains; chemicals; chipping; cleanliness; clothing and hair; compressed air, construction work; conveyors; cranes; cuts, dash pots; demolition; devices, safety; digging; doctors; doors; dust; dynamite; electrical apparatus, elevators; emery wheels; engine rooms; excavations explosives; eyes; fans; fire precautions; first aid, floors and passageways; foot-boards; foreigners fumes; gas, gasoline, gears; glass; goggles, governors; grinding wheels; grindstones; guards; hair; hoisting machinery; hooks; ice; idling; injuries, inspections; instruction; interpreters; intoxication; jacks; japan; lacquer; ladders, law and ordinances; light; machines and machinery materials, storage of; metal scrap; nails; neatness; oiling; painting, panics; passageways; physicians; platforms; poisons; pulleys; railings and footboards; railroad dangers, respiration, artificial; respirators; roofs; rope; rubbish; rules; runways; safety belts; safety devices, safety stops; sanitary conditions; scaffolds and stagings; scrap; set screws; shafting, shoes; sickness, signs; slings, slivers; splitting; stairs and stairways; stops; safety, storage; suggestions from employes; switch boards; teaming and trucking; toe-boards; tools, trenches; unemployed persons, vapors; ventilation; visitors, windows, wire rope; wires, wood alcohol, wounds, wrecking; yard conditions.

Gas, Gasoline and Oil Engines. By Gardner D. Hiscox. Revised by Victor W. Page. 640 pages, 6 by 9 inches. 435 illustrations. Published by Norman W. Henley & Son, New York City. Price, $2.50.

The interest in the internal combustion engine is indicated by the fact that this revised work is the twenty-first edition of a book first published in 1897. Since the publication of the first edition, the gas engine has undergone a remarkable development, not only for the automobile and aeroplane but for the general power field. While the demands of the automobile and aeroplane accelerated the improvements in design and efficiency of operation, the public recognition of the general usefulness of gas, gasoline and oil engines for all stationary and marine power requirements has stimulated improvements in these lines also. The minds of many inventors and designers have been at work, and a revised edition of the work became necessary because of the many changes that have taken place. The work deals with the history of the internal combustion engine; the theory of the gas and gasoline engine; utilization of heat and its efficiency in explosive motors; retarded combustion, wall cooling and compression efficiencies; compression in ex

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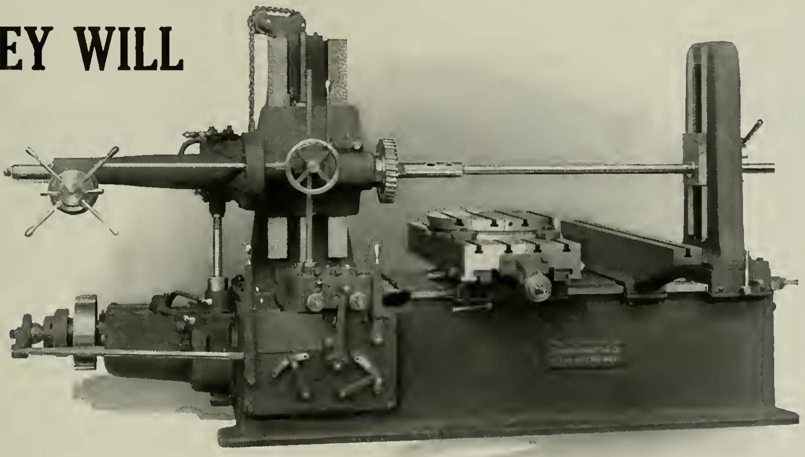

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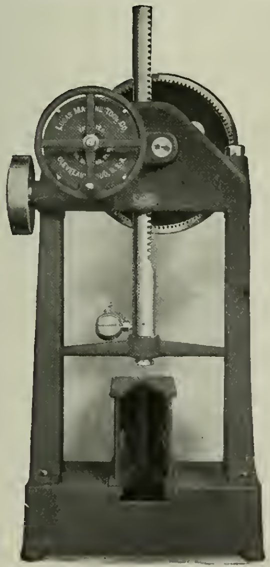

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plosive motors and its value; the materials of power in explosive engines; vaporizers, mixing valves and carbureters; cylinder capacity of gas and gasoline engines; governors and valve gears, explosive motor ignition, cylinder lubrication, cooling and exhaust silencers, construction details and parts of large engines, the measurement of power; explosive motor management and installation; types and details of stationary explosion motors; marine motors; kerosene, distillate and crude oil motors; farm motors, gas tractor power plants, electric lighting plants; design and application of automobile and motorcycle power plant parts; internal combustion motors for aerial navigation; producer gas and its production. The book is well printed on a good quality of paper and clearly illustrated. It is recommended to all looking for an elementary and comprehensive treatise on the internal combustion engine in its many forms.

Scientific Management. By Clarence B. Thompson. 878 pages, 6 by 9 inches. Published by Harvard University Press, Cambridge, Mass. Price, $4.

In presenting this work, Dr. Thompson has done a valuable service to all interested in scientific management of industrial organizations. The work consists of a collection of the more significant articles on the Taylor system of management, and a bibliography of all important papers presented before engineering societies and articles published in the technical press. The articles treat of practically every developed phase of scientific management in a thorough and comprehensive manner. The bibliography, including all articles published in the technical press, of course, makes it easy for the student to study all that has been published. The titles of the chapters are as follows: The Literature of Scientific Management; Industrial Administration and Scientific Management; Unsystematized, Systematized and Scientific Management; Science of Management; Present State of the Art of Industrial Management; Management Principles and the Consulting Engineer; Scientific Management in Business; A History of the Introduction of a System of Shop Management; An Object Lesson in Efficiency; On the Art of Cutting Metals; Prerequisites to the Introduction of Scientific Management; The Spirit in which Scientific Management should be Approached; The Successful Operation of a System of Scientific Management; The Planning Department, Its Organization and Function; The Foreman's Place in Scientific Management; Slide Rules for the Machine Shop as a Part of the Taylor System of Management; A Graphical Daily Balance in Manufacture; The Tool-room Under Scientific Management; Nomenclature of Machine Details; Classification and Symbolization; Elementary Time Study as a Part of the Taylor System of Scientific Management; Scientific Management in Retailing; Scientific Management in the Operation of Railroads; The Application of Scientific Management to a Railway Shop; The Railways and Scientific Management; The Mistakes of the Efficiency Men; Scientific Management; A Piece Rate System—Being a Step Toward Partial Solution of the Labor Problem; Wages and Wage Systems as Incentives; Relation of Scientific Management to the Wage Problem; Scientific Management and the Wage Earner; Another Side of Efficiency Engineering; The Taylor System of Shop Management at the Watertown Arsenal; Scientific Management as applied to Women's Work; Scientific Management as Viewed from the Workman's Standpoint; Preface to the French Edition of "The Principles of Scientific Management," by F. W. Taylor; Bibliography of Scientific Management. The chapters are contributions by men who have made a careful study of their subjects and thus a symposium is presented of the very best material available.

NEW CATALOGUES AND CIRCULARS

McCaffrey File Co., Philadelphia, Pa. Circular of files and rasps.

Universal Machine Co., Bowling Green, Ohio. Circular of adjustable universal joints.

Bock Bearing Co., Toledo, Ohio. Catalogue of the Bock taper roller bearing for both radial and thrust loads.

Standish Tool Works, Inc., Standish, Me. Circular of the "Duplex" drill sockets and double-ended drills for use in same.

D. J. Kelsey, 411 Y. M. C. A. Bldg., New Haven, Conn. Circular of a new 7-inch and 8-inch combination angle protractor.

Sprague Electric Works of General Electric Co., 527 W. 34th St., New York City. Leaflet 906 on electric hoists for the efficient handling of all loads.

Armstrong Cork & Insulation Co., Pittsburg, Pa. Pamphlet entitled, "Saving Fuel," descriptive of "Nonpareil" insulating brick for boiler settings.

E. Horton & Son Co., Windsor Locks, Conn. Leaflet supplementary to catalogue 12 C, describing and giving price lists of Horton solid body geared scroll chucks.

Joseph Dixon Crucible Co., Jersey City, N. J. Supplement to "Graphite" describing the steel fence paint tests made at Atlantic City, N. J., and giving results of the tests.

Waxement Co., Inc., 51 Chambers St., New York City. Circular of "Waxement" describing a material and process for making concrete floors dustless, non-absorbent and stain-proof.

Northern Engineering Works, Detroit, Mich. Pamphlet on Northern type E electric cranes and trolleys. Special attention has been given to safety provisions on these machines.

Kompsmith Mfg. Co., Milwaukee, Wis. Leaflet descriptive of 6¼-inch triple index centers for use when cutting ratchets, small spur gears and similar work that must be mounted on arbors.

Monarch Pneumatic Tool Co., East St. Louis, Ill. Bulletin 18-A on Monarch pneumatic tools, comprising drills, wood borers, long-stroke riveters, rivet busters, chipping hammers, holders-on, etc.

Baird Machine Co., Bridgeport, Conn. Bulletin 208 Series C, describing Baird eyelet machines or multiple plunger power presses, and giving specifications for presses with six, four, five and eight plungers.

Hauck Mfg. Co., 140 Livingston St., Brooklyn, N. Y. Circular of the Hauck kerosene torch for linemen and electricians. The torch is similar in design to the ordinary gasoline torch but uses kerosene as fuel.

Link-Belt Co., Chicago, Ill. Catalogue 21 on Link-Belt steel chains and sprocket wheels. The chains are listed in the order of their strengths, and useful information relating to size and construction is conveniently tabulated.

Sprague Electric Works of General Electric Co., 527 W. 34th St., New York City. Bulletin 48701, superseding bulletin 112, on Sprague electric dynamometers built in all sizes from 1 H. P. to 200 H. P. and for speeds up to 3500 R. P. M.

Lehigh Car, Wheel & Axle Works, Catasauqua, Pa. Catalogue 50 and price list of face-hardened sprocket and traction wheels; also square tooth and spiral jaw clutches, spur and bevel gears, tube mill linings, repair parts of crushing machinery, etc.

New Britain Machine Co., 64 Bigelow St., New Britain, Conn. Circular of the New Britain ball bearing buffing lathe, belt-driven from beneath. The lathe is so designed that the belt is enclosed within the column, and no moving parts except the spindle are exposed.

Keller Mechanical Engraving Co., 70 Washington St., Brooklyn, N. Y. Pamphlet on Keller automatic profiling machine for engraving on the profiling principle in steel, iron, brass, etc. A number of impressions from dies cut on the automatic profiling machine are shown.

Sprague Electric Works of General Electric Co., 527 W. 34th St., New York City. Bulletin 48700 giving specifications, dimensions and weights of Sprague electric monorail cranes and showing a number of installations. Special machines are manufactured to meet individual requirements.

Crescent Tool Co., Jamestown, N. Y. Catalogue 11, illustrating the "Crescent" line of drop-forged tools, comprising wrenches and pliers. The new tools added to the line are the 18-inch wrench, page 7; the 5- and 6-inch motor kit plier, page 13; and the 5-inch "Cee-Tee-Co" plier, page 14.

Van Dorn & Dutton Co., Cleveland, Ohio. Wall hanger showing evolution in street cars from 1850 to 1914; also illustrating "V. D. & D." motor gears and pinions for street car motor drive. The hanger, sent to any address on request, carries a calendar for the last three months of the year 1914.

Excelsior Pulley Co., Inc., Cuba, N. Y. Circular and price list of "Excelsior Premier" wood pulleys made at present 3 to 12 inches face and 4 to 14 inches diameter. These tools are provided with transverse grooves in the periphery to allow the escape of air entrapped between the belt and pulley face.

Link-Belt Co., Chicago, Ill. New catalogue 158 on locomotive cranes, illustrated with photographs showing these cranes in actual use on a large number of different jobs. Some of the views show the machines unloading logs, storing lumber, storing coal, switching cars, handling pig iron with magnet, unloading sand, digging gravel, excavating land, etc.

Bunting Brass & Bronze Co., 748 Spencer St., Toledo, Ohio. Price-list of Bunting's phosphor-bronze shaft bearing bushings from ½ inch outside diameter, ¼ inch inside diameter and ½ inch in length to 3⅝ inches outside diameter, 3 inches inside diameter and 5 inches in length. The prices given for lots of 100, 200, 500 and 1000 apply to plain sleeve bushings only.

Roth Bros. & Co., Adams and Loomis Sts., Chicago, Ill. Bulletin 156 on electric polishing and grinding machines of the floor stand or column type. The motors of these machines are of unusually small diameter, giving the operator a large working arc without interference with the motor, the machines being comparable in this respect to ordinary belt-driven machines.

General Electric Co., Schenectady, N. Y. Bulletin 48800, containing a reprint of an article on electrically driven air compressors in foundries. The article shows the advantages of the centrifugal compressor for this class of work. Bulletin 46190, describing the Thomson direct-current test meter, Type CB-5. Bulletin 48011 on mine hoist equipments treating of the economy of electric drive as applied to underground hoists.

Coffin Valve Co., Boston, Mass. Catalogue on valves, including sluice gates, gate valves, butterfly valves, check valves, flap valves, foot valves, shear and slide gates, automatic regulators, fire hydrants and other devices for the control of water. Interesting information is given on determining the size of valve required, and tables give the discharge and loss of head for Coffin rectangular sluice valves and Coffin circular sluice valves.

Wallace Barnes Co., South and Parallel Sts., Bristol, Conn. Booklet 6 illustrating "Barnes-made" springs, which include special flat springs, spring washers, drop-forged and milled springs, flat coil and motor springs, wire springs, and a large number of special springs. "Barnes-made" screw machine products are also illustrated, and tables of decimal equivalents, weights of flat steel, wire gages and size, weight and length of wire, etc., are included.

Keller Mechanical Engraving Co., 70 Washington St., Brooklyn, N. Y. Pamphlet descriptive of Keller die-cutting machines for dies, molds, rolls, hubs, etc. These machines operate on the profiling principle, in which a pattern or model is automatically reproduced. An idea of the variety of articles produced from the dies and molds cut on these machines can be obtained from the illustrations. Some of the work shown is silverware, jewelry, medals, cutlery, arms and ammunition, brass goods, letters and type, drop-forgings, molds for soft metal, glassware, etc.

Burd High Compression Ring Co., Rockford, Ill. Pamphlet entitled, "A Few Facts About Piston Rings—Their Relation and Importance," containing a reprint of an article published in the "Scientific American" under the title, "How the Efficiency of a Motor Car is dependent upon Gas-tight Ring Joints." The pamphlet calls attention to the fact that the Burd high-compression ring fulfills the efficiency requirements laid down in the article referred to. Special emphasis is laid on the tight joint provided in these rings, making leakage of oil or gas impossible.

Hendey Machine Co., Torrington, Conn. Catalogue of Lincoln type milling machines which are used extensively in the manufacture of rifles, revolvers, sewing machines, typewriters, adding machines, etc. The line of machines made by the company comprises many sizes and models, developed for specific lines of manufacturing from the lightest to the heaviest work commonly done on this type of milling machine. The catalogue contains 73 pages, 6 by 9 inches, and is profusely illustrated. It should be found interesting by everyone concerned with this class of machine work or whose work can be done advantageously on such machines.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Bulletins 4500, 4510, 4520 and 4530 describing the new Cutler-Hammer line of automatic machine tool controllers for use with shunt or compound-wound, direct-current motors, adapted for constant or adjustable speeds, with or without interpoles. Increased output and lower cost of production is claimed for this automatic control, owing to the fact that the operator can start and stop the machine without leaving his normal position, and the possibility of the foreman setting the control at the proper speed for a job. The operator is free to start and stop but is unable to change the speed. The dynamic brake stops the machine immediately, as the motor acts as a generator when the controller is shut off.

Ingersoll-Rand Co., 11 Broadway, New York City. Bulletin 4033 on "Little Tugger" air hoist for mines, contractors, manufacturing and power plants. Bulletin 8013 illustrating and describing "Little David" pneumatic chipping, calking and scaling hammers, made in seven sizes; the five larger sizes are for heavy work, while the two smaller are for very light chipping and scaling. Bulletin 8207, superseding bulletin 8107, treating of "Little David" pneumatic drills for metal and wood boring. The "Little David" drill is completely described, the various parts being shown in detail and different sizes of the reversible and non-reversible types being illustrated. This drill contains few parts and these are readily accessible. Convenience in handling and ready control are especially provided for.

Springfield Machine Tool Co., 631 Southern Ave., Springfield, Ohio. New catalogue 11 on high-grade lathes and shapers. 64 pages, 6 by 9 inches. Springfield lathes are made in two general types, the first having the "Ideal" change-gear system with reversing mechanism for both lead-screw and feed-rod, and the second having the "standard" gear system in which the rapid screw-cutting mechanism is omitted. The latter is adapted for a manufacturing lathe rather than for tool-room use. The various parts of these lathes are illustrated in detail and general views of the different types are shown. An idea of the extensive line manufactured will be obtained from a partial list of the machines illustrated: "Ideal" geared-head engine lathe; "Ideal" engine lathe with five-step cone; heavy-pattern engine lathes; standard engine lathe with double back-gears; single pulley drive lathe; engine lathes with turret, spindle and axle boring machine; and motor-driven engine lathes. The line of shapers made by this company is also illustrated. The excellent half-tone illustrations and general typographical appearance of the book, as well as the concise descriptions, show evidence of considerable care in preparation.

Brown & Sharpe Mfg. Co., Providence, R. I., is issuing a booklet on health and safety intended primarily for its own employes, but the material will be found to contain many valuable hints for the general reader on the prevention of accidents and the preservation of health. The first part of the book gives rules for the prevention of commonplace accidents, such as those resulting from wearing torn sleeves, loose neckties or other loose parts of clothing, disregarding the use of guards on moving parts of machinery, etc. The accidents in the Brown & Sharpe works during 1913 resulting from being caught in or injured by machinery were 23 per cent of the total number of accidents, and those resulting from injuries not due to machinery or lack of guarding, such as the workman's falling or objects falling on the workman, flying chips, cuts, jams, etc., were 77 per cent. This would seem to indicate that the majority of accidents are due to the negligence of the

MACHINERY

DECEMBER, 1914

MAKING VERTICAL FORMING TOOLS*

PRACTICE OF THE WINDSOR MACHINE CO. IN PRODUCING VERTICAL FORMING TOOLS FOR THE GRIDLEY AUTOMATIC

BY CHARLES F. SCHLEGEL†

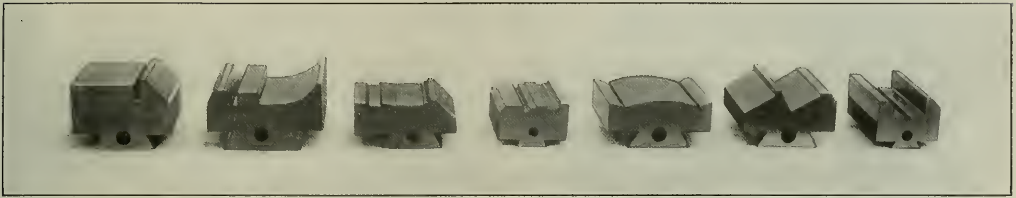

Fig. 1. Vertical Forming Tools that were finished after hardening by Grinding

THE automatic machine tool, in its present state, has materially increased the productiveness of the machine shop and raised the standard of efficiency. Machine parts are now produced by the score in modern automatic turning machines in the same time that a single piece was formerly made on an engine lathe. While we naturally consider the automatic machine as a whole, its remarkable efficiency depends largely upon the tool equipment, and as the manufacture of forming tools presents some rather difficult practical problems, information on making these tools is given in this article. The methods referred to represent the practice at the Windsor Machine Co., Windsor, Vt., in the production of the vertical forming tools such as are used on the Gridley automatic machines.

Forming tools of all kinds were made at first by being shaped to the form required, it being necessary for the mechanic to use his best judgment in allowing for changes in hardening; therefore, this method was, to a certain extent, a matter of guesswork, and as tools of different shapes would not be affected alike by the changes connected with hardening, it was impossible to be sure of accurate results. To overcome this defect, the Windsor Machine Co., a few years ago, began the practice of grinding its vertical style of forming tools after the hardening operation. By this method, the accuracy of the form is limited only by the skill of the mechanic and quality of the tools used in doing the work. This grinding of the hardened forming tools has practically solved the problem of accuracy and has made it possible to turn parts of much more intricate shape, and secure true corners, curves, and angles on the work.

Figs. 1 and 2 illustrate a few of the many shapes of vertical forming tools that have been ground. These tools, with their corners, curves and angles, indicate, in a general way, to what extent the range of the automatic turning machine has been increased, due to the development of the forming tool. Fig. 3 shows a double forming tool-holder on a Gridley automatic, the lower tool roughing out the form, leaving only a small amount of stock to be removed by the upper or finishing tool. This plan results in a great saving of the tools because the finisher does the light work and will hold its edge

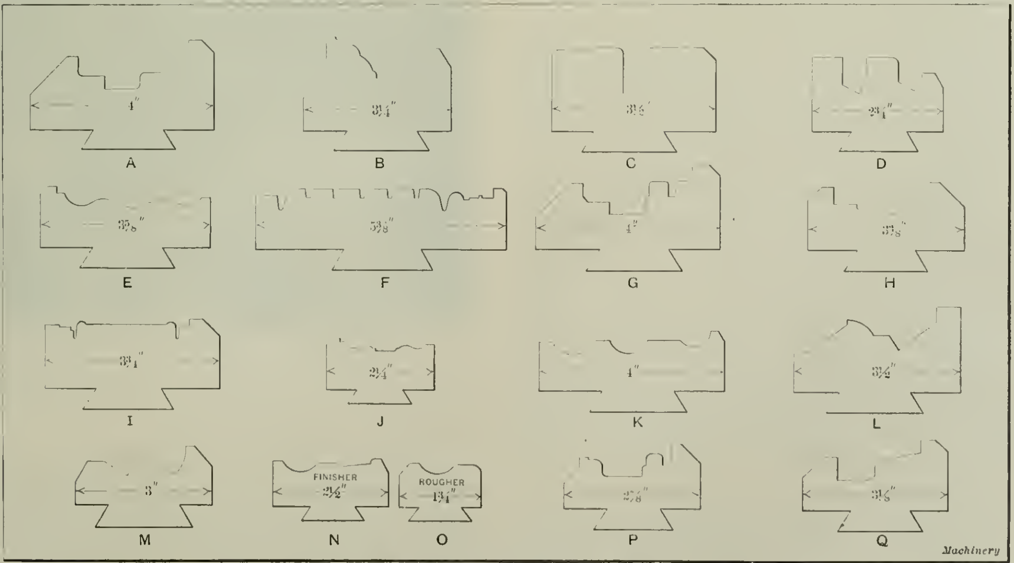

Fig 2. Miscellaneous Vertical Forming Tool Designs

much longer, moreover, the roughing tool can be made more quickly, as its form is not required to be so accurate and the shape can often be simpler than is required on the finishing tool. An example, illustrating the difference between a roughing and finishing tool, is shown at *N* and *O*, in Fig. 2. As will be seen, the roughing tool is much narrower than the one for finishing, because it only operates where considerable stock must be removed. Fig. 4 shows another vertical forming tool in position on a Gridley automatic. These heavy, wide tools are able to withstand severe duty on account of the rigid way they are held, and, moreover, the tool may be removed easily for grinding or sharpening.

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* For additional information on this subject, see the following articles previously published in MACHINERY: "Straight and Circular Forming Tools," June, 1904; "Charts for Forming Tools," October, 1904; "Forming Tools," December, 1904; "Forming Tools for Gear Cutters," July, 1914.

† Address: Care Windsor Machine Co., Windsor, Vt.

One of the most frequent questions arising in regard to grinding forming tools is the expense, many believing that it takes more time than is actually required and that it is not advisable to grind the tools owing to the cost. Within reasonable limits, the time should not be considered, because when a vertical tool is completed it will produce hundreds of parts, to say nothing of the accuracy of production and duplicating qualities of the work. At first thought, one might charge all the time consumed in grinding plus the time it would take to finish a tool in the old way, but this is incorrect as much time is saved on the shaper work because it is not necessary to plane the form so accurately when the tool is to be ground afterward, and coarser feeds may be employed. Because of this advantage, very little extra time is required for grinding, and this additional time is certainly offset by the accurate surfaces and measurements obtained on the work.

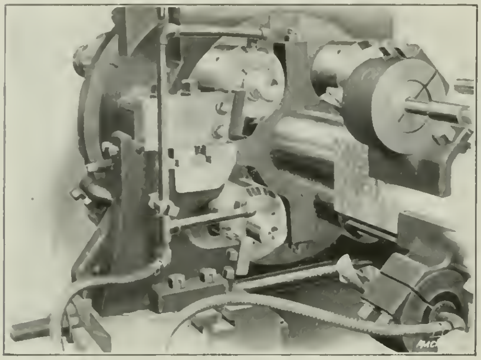

Fig. 3. Gridley Automatic equipped with Double Forming Tool-holder and Tools for Roughing and Finishing

Before grinding a forming tool, it is first roughed out on a shaper, as indicated in Fig. 5, 0.010 or 0.015 inch being left for grinding. The back of the tool or dovetail is finished to size so that no unnecessary grinding is required. The grinding is all done on a surface grinder fitted with a magnetic plate or chuck. The fixture for holding the tools while being ground is a very simple device and is illustrated in Fig. 6. It is essential that the top and bottom of the fixture be perfectly parallel and also that the fixed edge of the dovetail be true with both edges or sides of the base. If the straightedge on the magnetic chuck is true, obviously this holder can be removed and replaced without affecting the accuracy of the work; it can also be changed end for end when grinding, although care should be taken that the holder and magnetic chuck are clean when such changes are made. By inserting a thin piece of steel of the required thickness between the straightedge and fixture, the necessary clearance for the vertical faces of the tool can also be obtained, as will be described more fully later. In order to illustrate the general method of procedure in producing various vertical forming tools, the different operations on the particular tool shown at *G*, Fig. 2, will be described in detail, as this tool is typical in many respects.

Dimensioning and Laying Out a Forming Tool

When making the drawing of a forming tool, the draftsman should make each horizontal measurement correspond exactly with each relative measurement of length on the article to be turned. The vertical measurements should, preferably, be given at right angles to the front face of the tool, so that the mechanic can work directly from the drawing; in this way, the liability of mistakes is lessened and the work can be done more rapidly. Of course, these dimensions at right angles to the face of the tool vary slightly from the actual dimensions on the work, owing to the clearance angle, and must be calculated, as explained under the heading "Vertical Forming Tool Calculations."

The exact method of procedure when laying out a tool depends, of course, largely upon the form of the cutting edge. Fig. 7 indicates, in a general way, however, how this work is done. The tool shown by the diagrams *A* to *F*, inclusive, is similar to the one illustrated at *G* in Fig. 2. After copper-plating the front end or working face of the tool (by using a copper-sulphate solution) place the block on a surface plate with side *x* down; then with a scratch block resting upon a combination of size blocks equal in height to dimension *a* (see sketch *B*) plus 0.010 inch, scribe the first of the vertical lines (sketch *J* indicates how the scratch block is used in conjunction with the size blocks). By using different combinations of size blocks, scribe each succeeding vertical line until all the lines are laid out as indicated at *B*. The first measurement *a* is the only one that is made 0.010 inch greater than the dimension on the drawing, this allowance being left for grinding the left side; the distances between the other lines must be precise.

Next place the block on surface *y* (see sketch *A*), and scribe, in the same manner, all horizontal lines, as indicated at *C*; then with a protractor set at the required angle, draw lines *c–d* and *e–f*, and also the two corner angles as at *D*. With dividers, scribe arcs of the correct radius in each corner that is to be rounded. The block is now ready to be roughed out on the shaper.

It is needless to dwell on the method of removing the stock in the shaper, but when performing this operation, allowances for grinding should be made (as indicated by the dotted lines on sketch *E*, Fig. 7), 0.007 or 0.008 inch being left on a side; that is, measurements between faces such as *g* or *h* (sketch *F*) should be left about 0.015 inch narrow, while a measurement like *k* should be about 0.015 inch wide. No allowance need be made on vertical measurements because the same amount can be ground from each surface, so that there will be no change in the measurements. When roughing the tool out in the shaper, it is preferable to plane the surfaces straight or parallel, making no allowance for clearance on the side faces. The amount to be removed for clearance is so slight that it can easily be ground. When the tool has been roughed out, the upper end or working face should be beveled off to the required clearance angle which, at the Windsor Machine Co., is made 12 degrees.

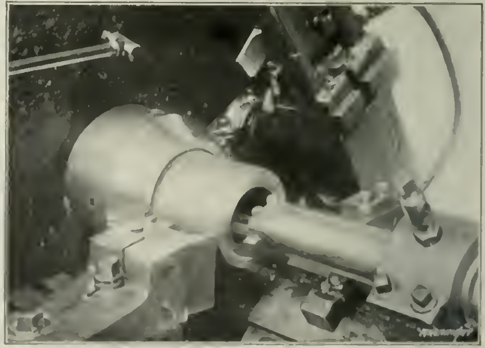

Fig. 4. Forming Tool on Gridley Automatic ready for Forming Operation

Set of Wheels for Grinding Forming Tools

When grinding forming tools, the general rule for the selection of wheels, *viz.*, use soft wheels for hard metal and *vice versa*, cannot always be strictly adhered to. Numerous experiments made by the writer have shown that the best results in grinding are obtained by using a wheel made of alundum, different grades and grains being used according to requirements. The following list gives an ample variety and all the shapes that are required may be obtained by using one wheel or the other and dressing the wheel face off to suit the shape desired on the tool.

GRINDING WHEELS FOR FORM TOOL GRINDING

Style	Diameter	Width	Grain	Grade
Straight...	7	½	46	H
Straight...	6	½	46	K
Straight...	6	1	46	H
Straight...	6	¼	46	K
Straight..	6	½	46	M
Cup.......	6	1	46	I
Cup.......	4	1⅜	46	K
Cup.......	4	1⅜	60	K
Saucer.....	6	5/16	46	K
Saucer.....	6	5/16	60	K

Machinery

Quite a number of wheels is necessary to secure economical results, but when a stock of wheels is secured, the consumption is small if they are handled properly. When first starting to grind form tools, one should not make too radical a change in the shape of a wheel face, but secure another size which is more suitable. In this way, there will soon be a variety large enough so that a wheel can be found which will require but little dressing to reproduce almost any form desired. Some wheels which have been formed from those given in the foregoing list, are illustrated in Fig. 8.

Method of Grinding a Typical Forming Tool

After the tool is hardened, it is ground to the finished dimensions. The first operation is to grind the upper end or working face of the tool. Enough should be ground off to insure sharp corners or edges, without having to grind too much on the formed surfaces. For this operation, the tool may be held in an ordinary vise. The next operation is that of grinding the formed part of the tool. The dovetailed clamping surfaces should first be inspected to see if they are clean. The tool is then clamped in a fixture similar to that shown on the surface grinder in Fig. 6. The tool shown in this illustration, however, does not correspond in form with the one selected as an example and illustrated in Fig. 7.

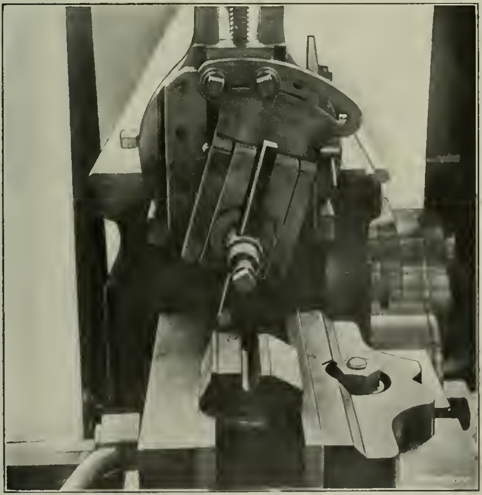
Fig. 5. Roughing Out Forming Tool on Shaper preparatory to Grinding

Naturally, the first surface that should be ground is the one that is highest, thus providing a resting place for the base of the depth gage. All vertical measurements (as held for grinding) should be given from this surface. For measuring vertically when grinding, the writer always uses a micrometer depth gage, while for horizontal measurements, a set of size blocks is employed. These blocks range from 0.031 to 0.063 inch, by one-thousandth inch increments, and then by one-sixteenth inch increments up to one inch. This set gives all measurements required for this work.

If there is a dimension such as *h* of, say ¾ inch (see sketch *F*, Fig. 7), a 7- by ½-inch wheel of 46–H grade and grain would be about right for grinding. First grind the lower horizontal surface to within 0.001 inch of the required depth; then insert a thin strip of steel between the work-holder and straightedge of the chuck, in order to obtain the necessary clearance for the sides of the tool. Use the sides of the wheel to rough off the sides of slot *h* to within 0.003 or 0.004 inch of the width at the narrowest end (working face) of the tool, grinding first the left side and then the right side. Next, raise the wheel and grind off the top surface of *k* and also surface *N*, allowing 0.001 inch for finishing. Adjust the work laterally and rough off surface *o*; then drop to surface *M* and grind that to 0.001 inch less than the required depth. Next, raise the wheel far enough to clear the beveled corner to the left of *M*, and rough off the side surface, care being taken not to grind too much in order to retain dimension *g* at the narrow end, in proper relation to slot *h*. Be sure that the strip of steel is at the proper end of the fixture to allow a clearance on this side.

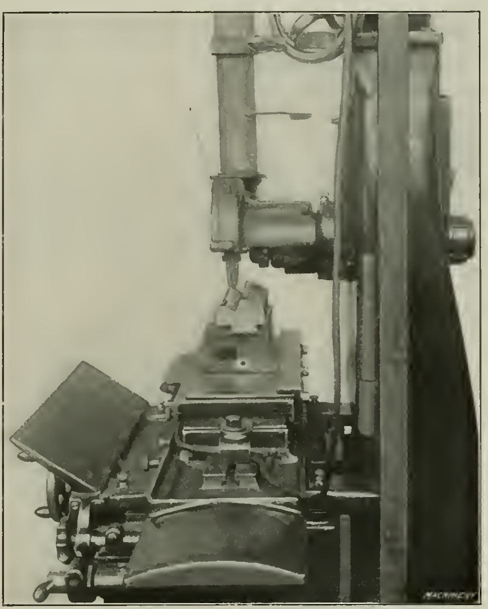
Fig. 6. Grinding a Hardened Forming Tool on Surface Grinder

Now take a 6- by 5/16-inch saucer wheel (60-K) and dress off the face and sides, carefully retaining a sharp corner. With the fixture held as for the previous operation, grind the left side indicated by dimension *h*, great care being taken to grind it smooth and straight. While grinding, the lower edge of the wheel should be down even with the lower surface, and when the side is smooth, feed the wheel down far enough to take off the 0.001 inch from the lower surface that was left when rough-grinding; then feed the wheel to the right, thus finishing the lower surface as far as possible without touching the right-hand side of the slot. Note the reading of the handwheel dial and raise the grinding wheel one or two thousandths inch. Turn the fixture around, adjust the strip for clearance and then grind the other side of slot *h* until the required width is obtained. All measurements should be made at the working end or top face of the tool. Continue the grinding operation by feeding down to the same reading previously obtained and then feed horizontally to join the lower surface that was ground before turning the fixture around, thus finishing the slot.

Now raise the wheel and grind surface *I* and then side *o*, measuring from the slot *h*. Feed the wheel down far enough to take off the 0.001 inch left when roughing; then feed across surface *N* and the top surface of the part *k*. Turn the fixture around again and adjust the strip for clearance. Place a 6-

by ⅜-inch 46-K wheel on the machine and bevel off the left corner of the wheel so that the width of the chamfer is a little less than the width of chamfer *e-f* on the work. Dish the side of the wheel slightly, so that only the corner does the cutting (the same as a saucer wheel), and grind the remaining side of *g* until the width is correct; then feed down until the upper corner of the chamfer is ground to the right depth, after which move the wheel a little to the right and feed down, grinding horizontal surface *M* to the required dimension; then feed to the left until this horizontal surface joins neatly with the beveled corner.

Next dress off the back of a 60-K saucer wheel to the proper angle for side *c-d*, using the fixture for angular dressing illustrated in Fig. 9. (This fixture will be described later.) Make the face of the wheel slightly narrower than the width of slot *P* at the bottom; then with work-holding fixture inclined horizontally to give clearance to the side of the slot, grind the left side of slot *P* until *k* is of the required width, feeding down until slot *P* is of the proper depth. Raise the wheel slightly, remove the clearance strip and with the fixture set parallel to the travel of the table, grind the angular side, feeding laterally and down until slot *P* is of the correct width, when the index reading is the same as when finishing the other side. Care must be taken not to touch the straight side when grinding the angular surface, because the cutting edge would be the first to be ground away by the wheel, thus spoiling the tool. This slot can be roughed out with a coarser wheel, if desired, but should be finished with a 60-K to retain the sharp corners at the bottom. In this case, it is not likely that a roughing wheel would be economical to use, because changing wheels and forming or dressing two wheels would offset the extra time required for grinding with a 60-K wheel so as to prevent burning the tool. For this operation, a light touch with the diamond at short intervals counts when grinding the straight sides.

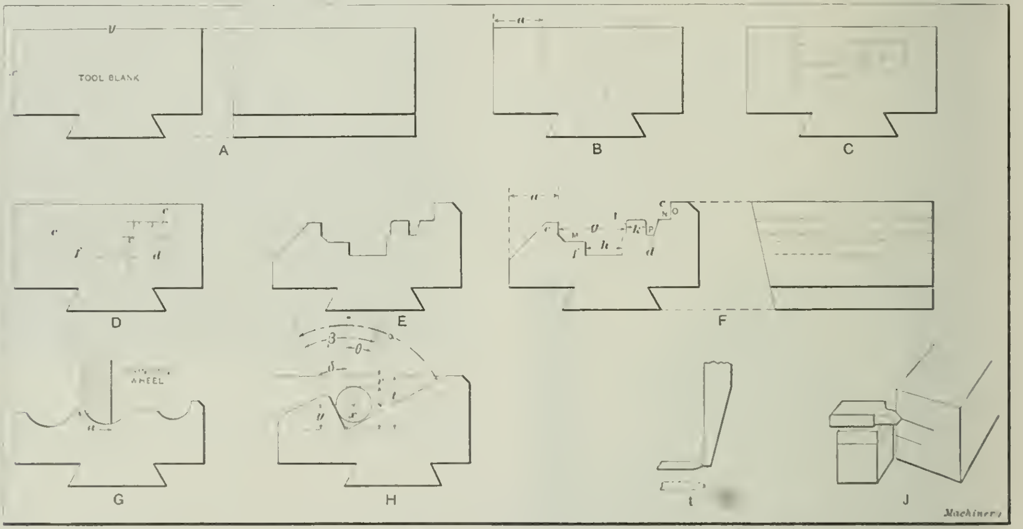

Fig. 7. Diagrams illustrating Method of laying out a Forming Tool and Principles connected with Grinding and Gaging

Next, secure a 46-K saucer wheel and form it for grinding the small round corners. The work-holding fixture should be set in different positions so that the same wheel may be used on all the corners of the same radius. The tool is now finished, excepting the beveled surface at the left and the left side. The beveled surface should extend a little below the largest diameter of the part to be turned, or, in this case, a little below the bottom surface of slot *h*.

In measuring a slot with the size blocks, insert the block or combination of blocks in the slot near the widest end and move them toward the working end of the tool as far as possible. Continue grinding from the side until the block will just pass through at the cutting edge. When measuring the width of a projection, the blocks may also be used by arranging them in the form of a snap gage, two extra blocks being used to form the gage jaws.

When forming tools were first ground by the Windsor Machine Co., a holder that swiveled was employed, but it soon became evident that this holder was unnecessary and, in fact, undesirable, owing to the time taken to change it back and forth, to say nothing of the possibility of a mistake caused by not getting it true for different surfaces. It is much preferable to have a plain holder like the one illustrated in Fig. 6 and then use a fixture to dress off the emery wheel to the required angle.

Grinding Angular Surfaces

The fixture used for dressing grinding wheels at an angle consists of a block which holds the diamond and is traversed back and forth on an inclined block; the latter, in turn, swivels on a stud at the center of the fixture, as indicated in Fig. 9, which shows the fixture applied to a surface grinder. The outer end of the inclined block rests on an adjustable screw, which, being movable in a slot, allows adjustment for any position from the vertical to the horizontal. There are two of these adjusting screws so that settings for two angles can be made at the same time, one on each side of the vertical. This swiveling block is set at any required angle relative to the top of the fixture, the top being ground parallel to the base. The fixture is about 4 inches wide, thus giving a good bearing surface for the bevel protractor. A vernier protractor can be set practically to within 2½ minutes of the given angle, and very few form tools require greater accuracy, although, for very fine work, the sine bar may be used in setting the swivel block. By using this truing fixture, one can dress a surface 1/32 inch wide just as accurately to a given angle as a surface 4 inches wide.

The grain and grade of wheels used for grinding surfaces on an angle are governed by the same condition as for straight grinding, except for a forming tool having two angular surfaces which, at the point of intersection, form a sharp corner as, for example, a tool for turning bevel gear blanks. For such work it is well to use a 46-M wheel; this wheel may seem too hard at first, but experience has shown that the best results are obtained with this grade. As little as possible should be left for grinding, and when using a wheel of the grade mentioned, it will rough out to within 0.001 or 0.002 inch of the size; then, after re-dressing the wheel, the surfaces may be finished smooth and a sharp corner obtained.

The best way to grind forming tools which are to be used for turning bevel gear blanks and similar forms is to take a 46-M wheel, say ½ inch wide, and dress it down so as to make the width of each bevel in proportion to the width of the surface each side is to grind. The bottom of the angular groove is ground first by setting the wheel central, as indicated at *A*, Fig. 10, then feeding the wheel down and cutting to the full width of both bevels until the point of the wheel is 0.002 inch less than the required depth. To grind the remaining surfaces, raise the wheel and move it sideways so that when it is fed down again the wheel face will slightly overlap the surface already ground, as indicated by the dotted lines in sketch *B*. The wheel is then moved farther up the incline, and so on until the entire surface is finished. In a similar manner, the opposite angular surface is ground. For finishing, re-dress the wheel and repeat the foregoing operation, taking off the 0.002 inch left when roughing. If these operations are performed carefully, a tool can be ground quickly without burning it, although it will become quite warm. This angular form of tool and those having large or irregular curves are the only ones that need a templet to work to, as all others can be gaged by direct measurement, using the graduated dials of the grinding machine and regular measuring tools.

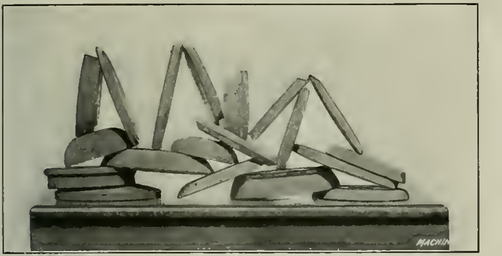
Fig. 8. Set of Grinding Wheels used for grinding Forming Tools

When grinding sharp square corners, dress the face of the wheel off with a diamond attached to the magnetic chuck. When dressing the side of a wheel, the diamond should not be carried beyond the periphery of the wheel as indicated by the dotted lines in sketch *I*, Fig. 7, but should stop just before reaching the edge or in the position shown by the full lines, because the diamond breaks the corner of the wheel more or less if it passes beyond the periphery; therefore, it should be brought up close to the edge and then be returned. A little practice will enable one to grind sharp corners.

Gaging an Angular Tool

When an angular tool for bevel gear blanks does not have a curved surface in conjunction with the angular surfaces, a mechanic versed in trigonometry can save time by a few simple calculations. The diagram *H*, Fig. 7, illustrates how the depth of a V-groove can be accurately gaged by using a cylindrical rod and calculating the distance r to the top surface from which the measurement is taken.

For a tool of the form illustrated, the two angles and the distance t are always given. As depth t is down to a sharp corner, it is difficult to determine it by direct measurement, but by laying a cylindrical rod in the groove and measuring down to this rod, an accurate measurement may be obtained. As dimension r is the one required, the distance s from the top of the rod to the apex of the angle must be determined. As a rod lying in a V-slot will always center itself, a line drawn through the center of the rod and the apex of the angle will be equidistant from each side of the angle, thus giving the angle β which is one-half of angle α. A line drawn through the center of the rod and through the point of contact on either side of the angle will be at right angles to that side. This line, and the one extending from this point of contact to the apex of the angle and the line extending from the apex to the center of the rod, forms a right-angle triangle of which one side (radius of the rod) and angle β are known, so that dimension x may be obtained. (Hypotenuse equals side opposite divided by sine.) Drawing a vertical line through the apex of angle α and also one at right angles to this line through the center of the rod gives a right-angle triangle of which dimension y is desired. Angles β and δ being known, angle θ is easily obtained, and having dimension x, dimension y may also be obtained. (Side adjacent equals hypotenuse times cosine); therefore s will equal y plus one-half the diameter of the rod, and this dimension, subtracted from t, will give the required measurement r.

Points on Grinding Vertical Surfaces

When grinding the sides or vertical surfaces of a forming tool, any neglect or carelessness will be manifest in the action of the tool when it is being used. Care must be taken to see that the wheel is not allowed any side play when finishing vertical surfaces, as otherwise when the wheel leaves the tool at the end, it will grind the corners back on account of the gradual lessening of the wheel area in contact, thus forming a convex surface adjacent to the cutting edge. This will allow the stock, when the tool is in use, to rub on the side below the cutting edge, which causes a "loading" of the tool and makes it impossible to secure a good finish on the work. As this lack of clearance caused considerable trouble the Windsor Machine Co. adopted the plan of grinding a clearance on all straight side surfaces, to avoid any rubbing of the work or loading of the tool when in use. This clearance is obtained, as previously mentioned, by inserting a thin strip of steel between the edge of the grinding fixture, see Fig. 6, and the straightedge on the magnetic chuck, at whichever end of the fixture needs to be inclined outward in order to provide clearance for the cutting edge. This strip should be thick enough to provide a taper of about 0.008 inch in 3 inches, which is approximately the minimum amount for good results. While more clearance would be better as far as the cutting action of the tool is concerned, it would result in too great a change of length, as the tool is ground away on the top for sharpening. In most cases, however, a difference in length of 0.003 to 0.005 inch one way or the other is immaterial, especially on large work. Obviously, this liner can be inserted at either end of the holder, depending upon which side of the tool is being ground for clearance. This clearance is only necessary on straight sides, as all curves and surfaces on an angle, no matter how slight, will clear themselves. The only exception as to curves is when one joins a straight side; then it should be ground at the same time that the straight side is ground for clearance.

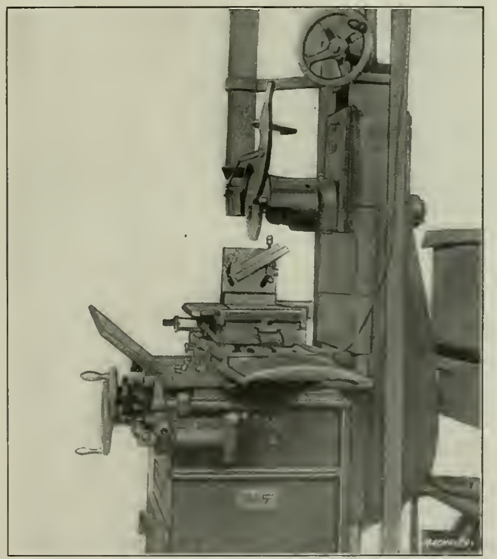
Fig. 9. Fixture on Magnetic Chuck of Surface Grinder is used for dressing Grinding Wheels at an Angle

Joining a Vertical Side and Beveled Surface

Another grinding problem met with when finishing a forming tool similar to that shown at *L* in Fig. 2, is that of joining a straight or vertical side and a bevel, grinding the clearance on the vertical side and, at the same time, neatly joining it with the beveled surface. First, all the surfaces of the forming tool should be ground straight or without clearance; then a thin strip of steel, as previously stated, should be inserted to give the proper slant to the vertical side for obtaining the necessary clearance. This, of course, will throw the bevel out of true so that the wheel, if fed down close enough to it, would grind at the bottom of this surface before touching the top or cutting edge. To overcome this, the working face or upper end of the forming tool should be raised enough so that when a test indicator, attached to the wheel guard, is run along the beveled surface, the pointer will remain stationary.

When finishing sides or vertical surfaces, the table should be traversed back and forth by hand, because a good surface cannot be obtained when the power feed is used, on account of the jar of the mechanism when it reverses. When grinding ordinary forming tools, little difficulty will be met with if the mechanic adheres to the use of the grain and grade of wheels recommended in the foregoing, and bears in mind that this is an operation wherein the old saying, "haste makes waste" is especially true.

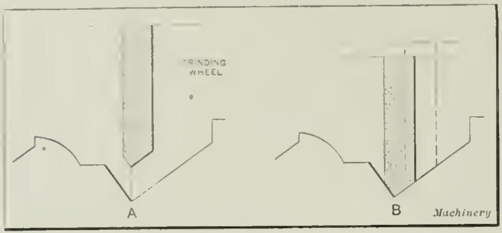

Fig. 10. Diagrams showing how an Angular Surface is ground

Grinding Curved Surfaces

The making of forming tools for producing irregular curves and surfaces is quite a different proposition from that of making tools having only straight and angular surfaces, and here is where experience in grinding tools is required, because these curves are affected by the clearance angle; hence, the curve on the wheel is not exactly the same as the curve to be reproduced on the work. Obtaining the required shape and size depends largely upon ones ability in dressing the wheel to the correct curvature by hand. For instance, when grinding a tool which is to have a circular cutting edge, the wheel is first dressed to fit a true gage of the required radius, and when finish-grinding the wheel face is slightly altered by hand dressing to compensate for the angularity of the cutting face. In other words, it is necessary to make the wheel face slightly elliptical in order to secure a circular cutting edge along the beveled face at the top of the tool.

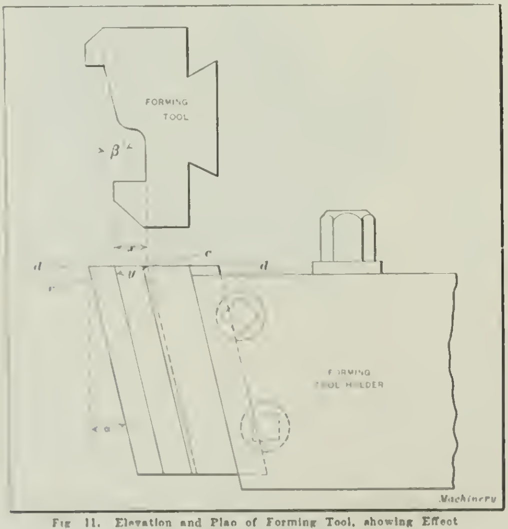

Fig. 11. Elevation and Plan of Forming Tool, showing Effect of Clearance Angle on Dimensions of Tool

In grinding circular surfaces, it is advisable never to work on more than a quarter of a circle at a time because the work can be done more rapidly and better by following this rule. For example, to grind the tool illustrated at *G* in Fig. 7, the wheel should be dressed off so as to form a curve extending a little beyond the center at the bottom, as indicated by arrow *a*, to allow for joining the two halves of the surface neatly and smoothly. When grinding a curved surface of this kind, first grind one side and then note the dial reading on the machine. Next turn the holder around and grind the other side, feeding the wheel down to the same depth as shown by the previous reading. It is also necessary to feed the wheel laterally somewhat in order to compensate for the angularity of the top or working face of the tool. The form of the wheel must also be changed slightly in order to secure a true circle at the cutting edge.

As an example illustrating the grinding of curves of large radii, let us assume that a tool is to be ground and that the radius of curvature required on the work is 17/32 inch. Secure a partly worn 6- by 1-inch cup wheel of 46-I grain and grade and one that is a little wider than half the width of the curve. Dress off the wheel to fit a 17/32-inch radius gage and then grind one side of the curve as indicated by the diagram *G*, Fig. 7, just cleaning up the side. Next raise the wheel and turn the fixture around for grinding the other side. Move the wheel over, and down, gradually, to the same reading as shown by the dial on the handwheel of the machine. Doubtless this will not make the rough-planed recess either deep or wide enough, so that the wheel must be fed down, say 0.002 or 0.003 inch, and laterally proportionately. When making these adjustments the dial readings should be noted. Now raise the wheel slightly and turn the fixture around again; then by moving the wheel over and down, the first side should be ground until the dial registers the same as for the other half of the curve. This operation must be repeated until the required depth is obtained, care being taken to keep the center of the curve in the proper place. The wheel must be dressed off at intervals for grinding the proper shape so that the cutting edge in the plane of the working face of the tool will be a true radius. All gages or templets for irregular surfaces and curves should be made to correspond with the curve required on the work and be held in the same plane as the working face of the tool, or, in this case, on a slant of 12 degrees, which is the required angle of clearance. No allowance should be made on the gage, the latter corresponding to the measurements required on the work and the tool being ground until the gage accurately fits the cutting edge, when held parallel with the top or working face. While the wheel should be dressed to the required form with a diamond tool, the following trick is often worth knowing: After the curve on the work is ground approximately to shape and size, secure part of a broken 46-K emery wheel, and using a flat surface, run this piece lightly back and forth once or twice over the working face of the wheel. Coarse emery cloth may also be used. As this operation dulls the wheel face, it must not be done until the tool is ground almost to the finished size; moreover, one must not attempt to secure the correct shape by dressing the wheel in this way. As previously mentioned, the shape should be obtained by dressing with the diamond tool, and not more than 0.001 inch be taken off the tool after the emery wheel is smoothed with the emery brick. If there is a greater allowance, the tool is likely to be burned, when grinding with the dulled face of

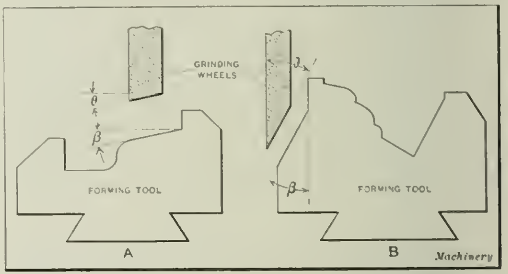

Fig. 12. Angle of Grinding Wheel must be varied slightly owing to Clearance Angle of Forming Tool

the wheel. When grinding curves, the wheel, as it does not feed laterally as in flat grinding, leaves fine scratches, the coarseness of which depends on the grain of the wheel; therefore a piece of emery wheel or cloth is used on the wheel prior to the final finishing operation, merely to obliterate these scratches. Ridges, however, cannot be ground out with a wheel that has been dulled in this way.

Grade and Grain of Wheels for Grinding Curved Surfaces

When grinding curved surfaces, the grade of the wheel should be varied according to the radius of the curvature. For all radii above ¼ inch, the use of a 46-H wheel is to be recommended. Although this grade is a little harder to shape than a softer grade, and secure a smooth surface, it will cut free without glazing or losing its form. For comparatively small radii, however, this grade will not hold its shape very well, and a 46-K is much more serviceable down to a 1/32 inch radius. For a 1/32 inch or a 1/64 inch radius, No. 46 grain is too coarse for good results and a grain and grade of 60-K should be employed. For rapid grinding, 46-H wheels should be used on all broad surfaces such as those illustrated at *C*, *F*, *I* and *Q*, Fig. 2. This grain and grade of wheel should also be used for grinding sides or vertical surfaces whenever a sharp corner is not required, and even then it is well to rough-grind with this wheel, finishing with a finer wheel. A grain and grade of 46-K gives a good finish when a small radius is to be left in a corner, but if a sharp corner is necessary, a 60-K wheel should be used, care being taken to keep it from glazing. If the wheel is touched frequently with the diamond tool, it will last longer than if allowed to glaze over excessively.

Vertical Forming Tool Calculations

The vertical forming tool, as used on the Gridley automatic, is held on a 12-degree angle for clearance, but when grinding, the tool is held horizontally (as shown in Fig. 6) so that it is necessary to make an allowance on all radial as well as angular measurements because there is a difference in the distance from one step to another on the tool, or a slight change in the angle, depending upon whether the measurement is taken along the top face of the tool or at right angles to the front face. To illustrate, if dimension x, Fig. 11, represents the distance that is to be reproduced on the work, it will be necessary, when grinding the tool, to make the depth y, measured at right angles to the front face, slightly less than the required depth x, owing to the angular position of the tool. Evidently the difference between x and y will depend upon the clearance angle α. The depth of y will equal dimension x multiplied by the cosine of angle α, or the side adjacent equals the hypotenuse times the cosine of α. For example, the part made with the tool shown at *C*, Fig. 2, should have a radius difference of one inch from the body part to the outside of the flange produced by the slot in the tool. As the top face of the tool is at a 12-degree angle while grinding, the slot should be ground to a depth equal to the radial dimension required on the work, times the cosine of 12 degrees, or $1 \times 0.9781 = 0.9781$ inch, instead of one inch.

Allowance must also be made when grinding angular surfaces. For example, suppose the angular surface of the forming tool illustrated in Fig. 11 is to reproduce an angle β of 15 degrees on the work. It is evident that in order to grind the tool to an angle β of 15 degrees on the top or along the cutting edge, the angle at right angles to the front face of the tool must be slightly less, owing to the clearance angle. For instance, if angle β is to be 15 degrees when measured in the plane *d*—*d*, the angle when measured along the plane *e*—*e* (which is square with the front face) will be a little less than 15 degrees and will represent the angle to which the face of the grinding wheel should be trued. The change of angle will, perhaps, be more clearly illustrated by holding an ordinary triangle vertically and then tipping it while the base is held in the same position.

To determine the angle at which the tool must be ground, multiply the tangent of the angle required on the work by the cosine of the clearance angle; the product equals the tangent of the angle when measured at right angles to the front face of the tool. Thus, taking the tangent of 15 degrees, which is 0.26795, and multiplying by the cosine of 12 degrees, or 0.97815, we have $0.26795 \times 0.97815 = 0.26209$, which is the tangent of 14 degrees 40 minutes nearly; therefore, the grinding wheel should be dressed to this angle.

For angles larger than 45 degrees, it is preferable to work from a vertical line, or from a line at right angles to the axis of the work, instead of parallel to the axis. When working from a vertical line, divide the tangent of the required angle by the cosine of the angle of clearance, instead of multiplying, in order to obtain the tangent of the angle measured at right angles to the front face of the tool. The difference between the two methods is illustrated by the diagrams *A* and *B*, Fig. 12. When angle β is measured in the plane of the top face of the tool and from a horizontal line parallel to the axis of the work (as at *A*), angle θ of the wheel face equals $\tan\beta \times$ cosine of clearance angle. On the other hand, when angle β is measured from a vertical line at right angles to the axis of the work (as at *B*), $\tan\theta$ of the wheel face equals $\dfrac{\tan\beta}{\text{cosine of clearance angle}}$. Suppose angle β (sketch *B*) is 30 degrees; then, dividing the tangent of the required angle by the cosine of the clearance angle, we have: $\dfrac{0.57735}{0.97815} = 0.59024$, which is the tangent of the angle the wheel should be trued to, or approximately 30 degrees 33 minutes. Thus, we have the following very simple rules for obtaining grinding angles or the angle of the tool measured at right angles to the front face:

When working from a vertical line (at right angles to axis of work) the tangent of the grinding angle equals the tangent of the angle of production (angle required on work) divided by the cosine of the angle of clearance. When working from a horizontal line (parallel to axis of work) the tangent of the grinding angle equals the tangent of the angle of production, multiplied by the cosine of the angle of clearance.

* * *

VANADIUM STEEL FOR HAMMER PISTON RODS

Probably no other machine part is subjected to greater vibratory stresses tending quickly to cause fatigue to the metal and resulting failure, than steam hammer piston rods. In such service the dynamic strength or anti-fatigue properties of the metal are put to the extreme test, and frequent failures of steam hammer piston rods are a common source of trouble and expense in all forge shops. As a solution of this trouble many forge shops have turned to the use of heat-treated alloy steels in order to provide the qualities which ordinary carbon steel piston rods so evidently lack. Heat-treated vanadium steel has proved to be particularly well adapted to this purpose, because of its high dynamic strength and durability, it having been shown by repeated tests to be superior to nickel steels for this service. The A. O. Smith Co., Milwaukee, Wis., well-known manufacturer of automobile parts and drop-forgings, has equipped all its steam hammers with vanadium steel rods. Twenty hammers are operated in this forge shop, ranging from 1000 to 16,000 pounds drop. These were fitted with chrome-vanadium steel rods, oil-treated, having the following physical properties: elastic limit, 80,000 pounds; tensile strength per square inch, 100,000 pounds; elongation in two inches, 20 per cent; reduction of area, 45 per cent.

The Obenberger Drop Forge Co., Cudahy, Wis., another well-known manufacturer of automobile drop-forgings, also has had satisfactory results from the use of heat-treated vanadium steel steam hammer piston rods. The company had been using 40-point carbon steel rods which were breaking and being replaced on an average of one every two months. As a substitute, 3½ per cent nickel steel was tried out, but with no better success. A heat-treated chrome-vanadium steel rod was applied to a 1500-pound open frame hammer in April, 1910. This operated continually night and day until November, 1911, giving a service of over a year and a half. On the failure of this rod, a 3½ per cent nickel steel rod was applied which lasted only twenty-four days. The rods were 5 inches diameter, 94 inches over-all, with a head having a diameter of 12 inches and a thickness of 4 inches.

INTERESTING MILLING ATTACHMENTS

BY LEIGH J. RODGERS*

Recently we had the job of making several dozen worms and worm-wheels of the following dimensions: 1 15/16 inch diameter, four left-hand threads per inch, 1¾ inch long to mesh with a 61-tooth gear; 1 13/16 inch diameter, two double threads per inch, 1½ inch long to mesh with a 31-tooth gear. Chasing the threads of the latter worm in a lathe is, at best, a slow, painstaking operation, and would probably result in a few torn threads if done by anyone except an expert lathe hand. So it was decided to mill the threads.

A Thread Milling Attachment

We had just completed a rack cutting attachment for a No. 1½ milling machine and had on hand an old pair of centers which required very little change to rig up ready for use. This rack cutting head is so simple and efficient that a few words of description may be of interest. The driving gear is of hardened tool steel 10 pitch, 14 teeth, 45 degree spiral, keyed on the regular 1-inch arbor. On each side of this gear is a hardened and ground collar accurately fitting the 2⅜-inch hole. The driven gear is of tough bronze, has 11 teeth and is keyed on the hardened and ground cutter spindle which is 1 inch diameter and has a bearing 6½ inches long with fiber thrust collars and fine thread adjusting nuts. This head has seen some hard service without appreciable wear or trouble of any kind, and would be found useful in any shop. The driving or work spindle of the centers extends back far enough to gear direct to the longitudinal feed-screw.

The regular milling machine feed-shaft having two universal joints was attached to a pinion meshing with the large spur gear shown at the front of Fig. 1. This pinion had its bearing in an angle-plate bolted on the milling machine platen (not shown). This arrangement gave us a choice of sixteen all-geared feeds, driving the work spindle through a pair of spur gears and worm-gearing as shown. The table was swiveled to suit the thread angle which, in the case of the double-threaded worm, was 5 degrees 4 minutes and geared up with a 48-tooth gear on the work-spindle and a 24-tooth gear on the feed-screw, with two idlers between, since the center distance was too great to mesh the 48-tooth gear directly into the 24-tooth gear. (The left-hand threaded worms had to turn opposite to the right-hand feed-screw.) In the case of the double-thread worm, the first method was to mark the gears, disconnect, move the work-spindle around 24 teeth, or exactly one-half revolution, and throw the gears in mesh again. Later it was found that we could divide the thread very accurately, using the dial on the feed-screw. With a stream of oil on the carbon steel cutter, a good clean job without chatter was produced in ten minutes each.

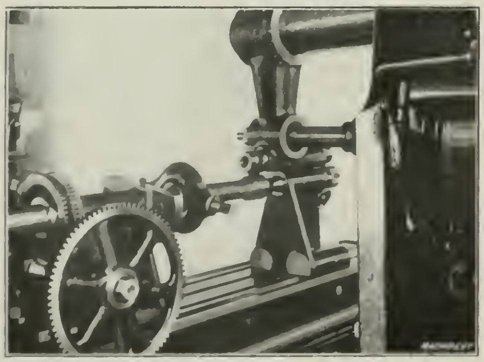

Fig. 1 Thread Milling Attachment for Milling Machine

A Hobbing Fixture

As one can easily guess from reference to Fig. 2, this hobbing fixture was built from pieces selected from the junk pile. The main casting was surfaced top and bottom, and a 2¼-inch hole was drilled and reamed through it. Into this hole was fitted a hardened and ground spindle having a bearing about 5 inches long and a thrust collar to bear on top of the base. The main or driven gear has 61 teeth that were carefully cut on the dividing head with the table swiveled to an angle of 5 degrees, 4 minutes. The driving worm has two double threads per inch. Both worm and worm-wheel were keyed on their respective shafts. Now to hob a 61-tooth worm-wheel blank for a single-threaded worm, it was only necessary to gear up as shown with a 24-tooth gear on the machine arbor and a 48-tooth gear on the fixture spindle, using an idler. The blank was then moved in until the hob began to cut, with the dial set at zero, and then fed in slowly until the proper depth of tooth was secured, as shown on the machine dial. While the fixture as shown worked fairly well, the cut could not be crowded owing to the springing of the work. It was found best to true up the blanks at point A and support the work with a heavy rigid rest, bearing at that point.

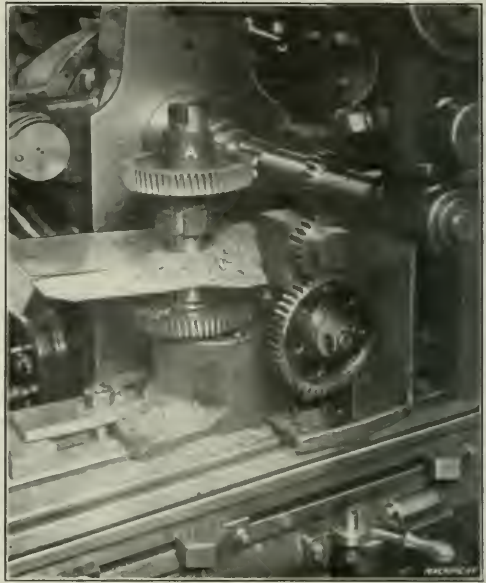

Fig. 2. Crude Looking but Serviceable Hobbing Fixture

To cut the 31-tooth worm-wheel, it was only necessary to put the double-threaded hob and 61-tooth gear on the machine arbor and a 31-tooth gear on the fixture, driving the worm spindle with an idler as before. In a school shop, it is no drawback to have to build simple home-made tools that will embody the principles of the best special machines and accomplish the desired results. In many cases the interest aroused in the mind of the young mechanic, and the inventive reasoning developed by this type of problem, fully compensates for the lack of an expensive special machine in the equipment.

* * *

FANS VS. FIRE

We have all heard of fighting fire with fire, but the use of electric fans as an adjunct to a fire department in putting out a blaze is surely novel. In Boston not long ago a fire broke out in the basement of a building occupied by a wholesale paint and chemical concern. The fumes and smoke became so thick that it was impossible for the firemen to enter the basement or direct a stream with any effectiveness, when someone thought of electric fans. A half dozen of the ordinary sixteen-inch size were quickly requisitioned by the fire chief and their breeze directed down the stairway. As soon as the rear basement windows were broken to allow the escape of the smoke and fumes, the fans gradually cleared the basement so that the firemen could work quickly and effectively in extinguishing the flames.

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THE EFFECT OF DESIGN ON THE COST OF MACHINING

POINTS NECESSARY TO CONSIDER IN THE DESIGN OF MACHINERY IN ORDER TO REDUCE THE COST

BY ALBERT A. DOWD*

THE influence of the design of any mechanical device, whether it be a tool, fixture or machine, on the ultimate cost of machining its parts is a point that should be carefully considered by the designer. The effectiveness of any piece of mechanism must obviously be the first consideration in the design, but the mechanical operations necessary to manufacture the parts should also be carefully studied in order to minimize the cost of production to as great a degree as is consistent with efficiency. Much depends, of course, upon the general character of the work to be designed, and the varied requirements placed on the product. For example, in machine construction the convenience of operation in the finished product should never be sacrificed out of regard to problems of machining, nor should strength and rigidity be lessened in any way in order to facilitate the handling. In automobile construction, weight, strength, convenience and even general appearance are important factors which must be considered in the design, and all machining problems must be to a certain extent subservient thereto. So also in other lines of mechanical work, the requirements differ according to the purpose for which the devices may be intended.

In the design of special tools and fixtures, the cost element of the tool itself depends upon entirely different factors. In fact, the cost of tools and fixtures for rapid production work, when quantities are large, may be almost neglected, providing an elaborate equipment will increase the production sufficiently to warrant the expenditure, and also providing that the design is such as to permit upkeep and replacements at a minimum cost.

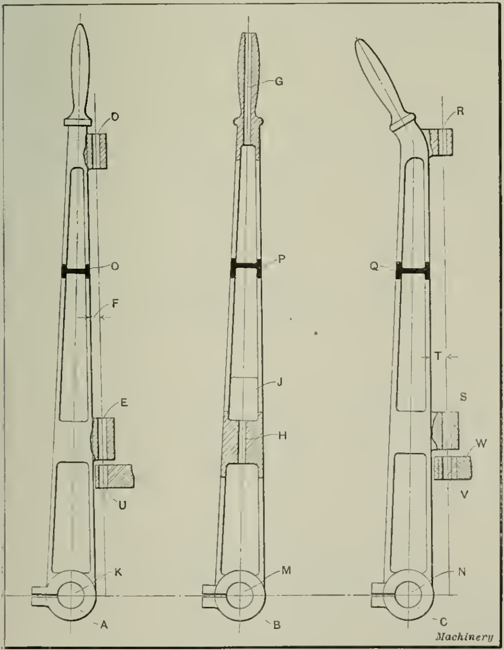

Fig. 1. Various Designs of Levers, showing Difference in Accessibility for Machining

A General Case of Design Considered

The designer naturally considers finished surfaces, bearings, drilled and tapped holes, grooves, recesses, etc., with a view to the possibilities of machining, but he seldom considers the matter from the viewpoint of economy. His analysis of the problems as they come up in the design is something like this: Can it be machined? How? On what machine—drill press, milling machine, turret lathe or boring mill? Can the parts be assembled without difficulty? How? Having satisfied himself that it is possible to machine the work on some of the standard machine tools, he does not consider it necessary to go into the subject further, unless he has been a shop man or tool designer, or perhaps both. If this is the case he automatically considers the machining problems in a more thorough manner on account of troubles which he may have encountered when connected more intimately with the actual machining processes.

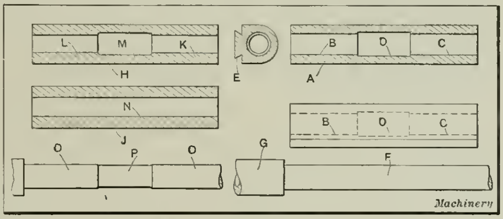

Fig. 2. Sleeve with Machined Recess which greatly increased the Cost

During the progress of the design, the chief draftsman, superintendent, or someone else in authority looks over the work from time to time and passes upon it, occasionally bringing up the matter of machining certain portions which may be a little out of the ordinary, and making suggestions regarding the work as a whole. The machining problems are seldom taken up carefully in detail, unless something very much out of the ordinary is apparent, such as radial boring operations or a multiplicity of angular surfaces or some other matter which is likely to require expensive tooling, in which event the questions are more carefully considered. After suggested changes have been made, the drawings are approved, traced, blueprinted and sent out into the factory. Several days after this the patternmaker appears on the scene to inquire whether certain small changes (affecting the making of the pattern and its removal from the sand) will be permissible. Other questions having to do with coring, draft, partings, finished surfaces, etc., are also brought up at this time and they may or may not affect the design. As a general rule, however, the patternmaker can find a way out of a pretty difficult situation without causing any vital changes in the design.

Patterns having been completed, a trial casting is made and sent into the factory for machining, being completed in due course of time and tested out under working conditions. Having been found to work satisfactorily, with some minor changes which are incorporated on the drawings, it is decided to build a lot of, perhaps, fifty machines, if the work is a machine tool. In a case of an automobile, however, the lot may run from 2000 to 50,000 or even more, depending on the production of the firm manufacturing the product.

The tool designer now takes the matter in hand and decides on the sequence of operations and tooling required to complete the work. Let us now take up and look into the problems of machining from his point of view and see what may be required. Let us also note as we proceed points in the design which involve unnecessary cost in the machining and which might have been foreseen by the designer had he given more thought to this part of the work, or had he taken the matter up with the tool designer during the progress of his own work.

The first question to be decided is that of holding the casting for the first operation, and it is quickly noted that no provision has been made for clamps or lugs by which the work can be secured. Suitable lugs are therefore added to the pattern so that the casting may be firmly clamped in a fixture. This necessitates the return of the pattern from the foundry and a delay of a day or two while the needed changes are being made. The lugs for machining are to be milled off after all the operations have been finished, so that this item adds somewhat to the cost as a whole. In this connection it is well to state that there are many cases where an indented surface can be provided in the casting for holding purposes, instead of protruding lugs which require an extra operation to remove. Indented surfaces may often be made to serve as well and may be incorporated in the design in such a way that they are neither unsightly nor troublesome. A considerable saving in the cost of production can be effected in this way, if the designer gives a little thought to the matter during the work on the design.

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A recessed bearing was next encountered. This recess called for finish, yet it was only an inch in diameter by two inches long. There seemed to be no good reason why it could not have been cored or a relieved shaft used in a straight hole. In order to machine the hole as called for on the drawing, it was found necessary to design a special recessing tool of somewhat delicate construction (on account of the small diameter), so that very light feeds were essential, making the production time correspondingly slow.

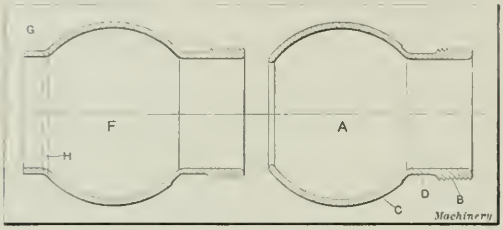


Fig. 3. Ball and Socket Pipe Joint with Suggested Improvement to facilitate Machining

Two inside surfaces were next noted which were in such a position that back-counterboring seemed to be the only method by which they could be economically machined. On looking up the matter it was found that a slight change in their position would have permitted the use of an end-mill, which would have resulted in a saving both in tools and machining time.

There were several other points that required special methods of handling, which could have been saved by a little more thought on the part of the designer; for example, drilled and tapped holes close to the walls of the casting, so that extra long drills and special taps were needed; two small drilled angular holes on the same side of the casting having different angles of inclination, when the same angle would have answered for both. Several other minor points were noted which might have been differently arranged without sacrificing efficiency in the least, but which would have cheapened the machining processes considerably.

The tool designer now takes up some of these points with the designer, who considers them dubiously, with a view to possible changes. Meanwhile a number of castings have been made and are in the shop waiting for tools and fixtures with which to machine them. As the matter becomes known to the tool designer, he takes it up with the superintendent, making clear the improvement both in tool cost and production, if the suggested changes could be made. The superintendent hesitates to scrap the castings already made and therefore decides to use them, instructing the tool designer to go ahead on this basis, making provision for changing the next lot when designing the tools. The result is that the cost of special tools, fixtures, extra operations, etc., is much greater than it should be. In addition to this there is the cost of changing drawings, patterns, tools and fixtures after the first lot has been machined, together with the extra time required to design the tools so that they may be changed over to suit the new conditions, and at the same time making them so that they will be usable for replacement work in case breakages in the first lot occur. The far-reaching effect of design on the cost of machining is apparent in a case of this kind, as it is clear that greater care on the part of the designer with respect to the machining aspect would have resulted in a saving both in production time and in the cost of special tools. A consultation from time to time with the tool designer will be found of great value, as his familiarity with machining methods and problems allows him to note almost at a glance anything of a troublesome nature, and he may frequently be able to suggest a remedy for a difficult condition which will be thoroughly practical and which may be the means of saving a considerable expenditure. A few suggestions are herewith offered in connection with design which will tend to decrease machining costs if applied during the process of designing.

Points in Design which Affect the Cost of Machining

General shape of the work:—This is one of the first points to be considered, as it seriously affects the holding devices which may be necessary for the machining operations. After the design has been worked out sufficiently to determine the general contour of the various components, the question of holding and clamping should be considered, and provision made in the castings either by the addition of lugs or by indented surfaces. The latter are much to be preferred if the nature of the work will permit their use, as they require no extra operations such as might be necessary if lugs were to be removed after machining. If the work is of cylindrical shape such as might be machined on a turret lathe, the addition of a small driving lug may be found of great advantage, providing it can be applied in such a way that an extra operation for cutting it off will not be needed. Very little time is necessary in considering these points, but a little forethought at this stage may effect a considerable saving in the cost of machining.

Drilled or tapped holes:—It is advisable to use as few sizes as possible consistent with good design, and to avoid angular holes wherever practicable. Flange holes should be spaced far enough away from the sides of a rough casting to permit the drill press spindle to pass without interference, so that long special drills will not be needed. Special length drills are more expensive than the regular, and annoying delays are often caused by waiting for them to be made. If it is not possible to design so as to obtain spindle clearance, space enough should be given so that supporting bushings can be used for guiding the drills.

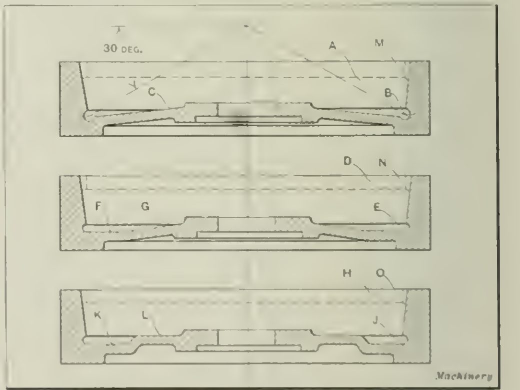


Fig. 4. Different Designs of Flywheels, showing Effect on Ease of Machining

Threaded work:—The expense of machining threaded portions of the work may easily be made to run into a considerable amount of money, unless care is used in the design. Threads of special pitch should be avoided as far as possible, so that special dies or taps will not be needed. Threads on either exterior or interior surfaces should be provided with a clearance groove if they run close up to a shoulder. Any threaded interior surface which must be concentric with a cylindrical adjacent portion should be made with a loose fitting thread so that the cylindrical portion may perform the centering function. If the drawing calls for good fits on both portions, considerable difficulty will be experienced in the machining on account of the tendency of a tap to run slightly eccentric unless it is piloted.

Internal grooves or recesses:—These are frequently the cause of unnecessary expense when machining is called for, on account of the confined situations in which recessing tools are compelled to do their work. Complications in machining often arise on work of this kind which could have been avoided by the designer had he cored the recess so that finish would not have been required. This is not always possible, but should nevertheless be considered with a view to saving machining. The writer has designed a recessing tool which cost about $75 to build for an internal finished recess which could have been avoided by a little more forethought on the part of the designer.

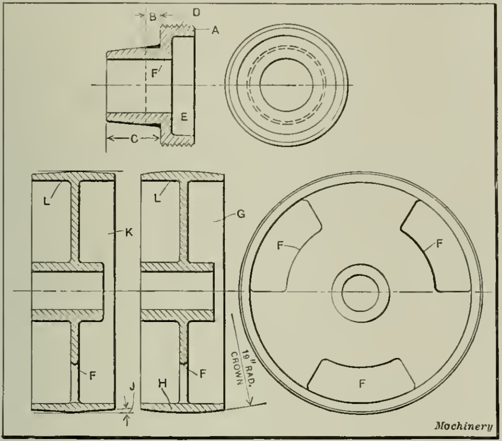


Fig. 5. Other Examples of Designs that influence Cost of Machining

Internal finished pads or surfaces:—If internal finished surfaces are required, an effort should be made to arrange them in such a way that they may be milled off without the use of special mills. Inside bosses are often arranged so that an operation of back-counterboring is necessary, which is both troublesome and expensive. In addition to this, the accuracy obtained is usually far from satisfactory. Whenever these surfaces can be so arranged that they may be milled, the results will be found much better from all points of view.

Angular surfaces:—These generally require an extra operation in machining, and as the expense of an extra operation with its fixture is an important item, it should be avoided as far as possible. Frequently an outside angular surface on a large casting may be made perpendicular to the other surfaces by designing the bracket or other component which matches with it in such a way that the angular surface will come on the smaller casting, for which a fixture can be made at much less expense. The matter of angular surfaces should always be carefully considered so that the cost of special fixtures will not be excessive.

A Few Examples Illustrating Machining Costs Influenced by Design

A few examples which show the effect of design on the cost of machining are given herewith and are for the most part drawn from the writer's own experience. Nearly all the examples given are of a simple nature, but illustrate as well as if more complicated the value of forethought in designing.

Fig. 1 shows at *A*, *B*, and *C* three types of automobile hand-levers, all of which are drop-forged, and which require more or less machining. The drilling of the holes which act as bearings for the operating rods is affected to a considerable extent by the position of these bearings, and although this seems but a small item in the general expense, it will serve to illustrate several points worthy of attention. In the lever *A*, the position of the holes *D* and *E* is such that there is insufficient room for drill jig guide bushings, so that it becomes necessary to use a tool steel plate for the purpose, as shown at *U*. Another bushing of the same kind must also be used at *D* for the other bearing, which is some distance away. As bushing plates of this kind give no chance for replacement, except by making entirely new plates in cases of breakage, and as the amount of stock around the hole is very small, it will be seen that the expense of upkeep might be of some moment. The delay in production while waiting for the jig to be repaired might be even more costly. Special length drills would naturally be required for this work, but this seems unavoidable in this instance. The distance *F* is really the cause of much unnecessary expense and delay, and a slight change in the design would have obviated it all.

The lever *B* is also a drop-forging having a section as shown at *P*, slightly more offset than *O*. The design in this case has been considered with a view to machining the holes *G* and *H*, as the pocket at *J* is evidently so made that a supporting bushing can be located in the jig at this point.

Lever *C* has a section *Q* similar to *O*, but the distance *T* is sufficient to permit a better construction for the bushing, as indicated at *V*. The offset handle also allows the use of a shorter drill than in the other instances, and the drilling can be done from the handle end if desired. The three examples given have as their locating points the holes *K*, *M*, and *N*. The conditions represented here are of the simplest kind and the expense incurred is comparatively slight, but it must be remembered that a number of instances of this kind would add a very appreciable amount to the cost of machining.

A situation which involved much greater expense and which could have been readily avoided is shown in Fig. 2. A bronze bearing *A* is machined at surfaces *B* and *C*, which act as the bearing surfaces for the shaft *F*, which has a diameter of 7/8 inch. A recess is called for at *D* with a diameter of 1/32 inch more, and this recess is to be finished. A straight hole was cored in the piece and it was roughly chucked out on a special fixture on a hand screw machine, being located by the dovetailed portion shown at *E*. A small horizontal boring mill was used for finishing the hole and for the recessing operation, an accurate alignment with the dovetail being essential. On account of the small size of the hole the design of the recessing tool was somewhat troublesome and its construction both delicate and costly. The upkeep of the tool was also expensive and its operation slow on account of its delicacy, making the cost of the recessing operation excessive.

Prior to the designing of tools and fixtures for this piece the matter of recessing was taken up with the designer, on account of the expense of tooling, and an endeavor was made to have the pocket cored as shown at *M*, leaving the two holes *K* and *L* to be machined, thereby doing away with the necessity for a recessing operation. An alternative suggestion was also made, that the hole be made straight as indicated at *N*, and the shaft provided with bearing surfaces *O* and a relief *P*. Neither of the suggestions met with favor, and the design was left as at *A*. As there were twelve of these pieces on each machine built, it may readily be seen that the cost of machining was very materially increased.

An example which illustrates the value of provision for chucking is shown in Fig. 3. At *A* is shown a portion of a ball and socket pipe joint which was to be machined at *B* and *C* on a turret lathe. Several machines were ordered with the necessary equipment to produce the work, and a number of sample castings sent along with the order. The firm for whom the work was being done was located nearly half way around the world, so that changes in patterns were out of the question, and the castings had to be handled just the way they were. So much time would have been lost in obtaining consent to make desirable changes, that the entire contract would have been lost. It was found necessary to machine the work in two settings, and to make special holding devices for both of these, thereby causing much loss of time in machining, in addition to the cost of the equipment.

Had the designer considered the machining he might easily have supplied a supplementary ring by which the work could have been held and machined complete in one setting. The addition of such a ring as that shown at *G* on the redesigned casting *F* would have permitted the use of a set of metal-to-

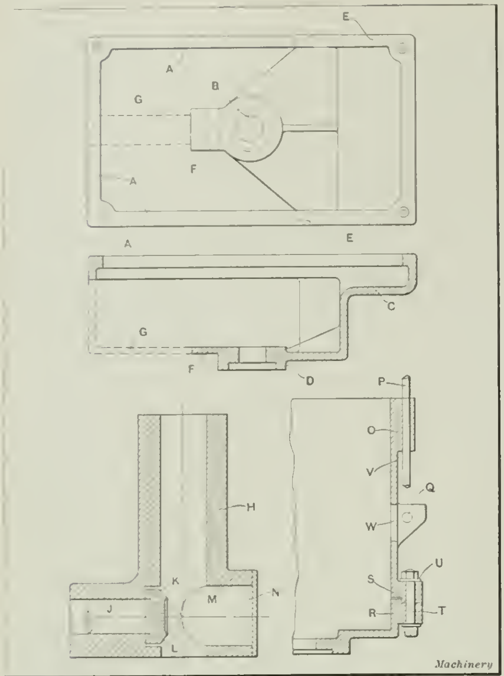


Fig. 6. Castings illustrating Need of considering the Machining Problem when designing

metal hook-bolt jaws at this point, leaving the other portions of the piece free for machining, so that all the work could have been easily done in a single setting. Then, after its completion, it would have been a simple matter to cut off the supplementary ring at *H*, leaving a casting machined in not much more than half the time necessary for the original design, and involving only the loss of the chucking ring *G*, the expense of which need hardly be considered.

Flywheels for gas engine work are usually finished all over on account of the high rate of speed at which they are to be run, which necessitates a perfectly balanced wheel. Several designs for a 16-inch clutch flywheel of this kind are shown in Fig. 4, and attention is called to the differences in design which affect the machining. Essential points in the machining are that the shouldered hole, the small hole and the clutch taper must be concentric and true with each other. It is usually advisable, therefore, to hold the work by the inside of the tapered portion and machine the shouldered and small hole first, together with the web, rims and periphery. A chucking ring should therefore be provided at *M*, as it would not be found practical to hold the work by the taper. In the second setting the shouldered hole is the locating point, from which the tapered portion is machined. In the upper figure *A* it will be noted that a recess *B* is cut at an angle of 30 degrees, so that clearance for the clutch will be obtained. The machining of this recess calls for a special recessing tool or a hand operation in manipulating the feeds to obtain an approximation of the recess called for. The angular web *C* requires a forming attachment of some kind or else a hand operation subject to a certain amount of variation depending on the skill of the operator. Both the cutting of the recess and the machining of the angular web are somewhat expensive, and can usually be avoided.

In the example *D* the recess *E* is cut perpendicular to the axis of the flywheel and therefore may be readily machined without the use of special tools. The web is partially straight, as at *F*, and the remainder *G* is much narrower than *C*, so that it may be machined with a wide faced tool, and does not require the use of a forming attachment. The chucking ring *N* should not be forgotten. The machining of this piece can be accomplished much more quickly than *A*. and the cost of tooling is much less, due to the farsightedness of the designer and his consideration of the machining.

A step further in improving machining possibilities is shown at *H* in the lower figure. In this case the chucking ring is provided at *O* and the recess at *J* as in the last case, but all the angular work on the web is done away with, by using the two offset surfaces *K* and *L*. Attention is called to the fact that all these designs are made for the same purpose, but the difference in cost of machining is apparent.

Fig. 5 shows at *A* a malleable iron bearing sleeve which was made in two lengths *B* and *C*. The work was to be bored, reamed and threaded, preferably in one setting. In attempting to do this, however, it was found that the draft on the pattern was of such a taper that it was impossible to hold the work, even in a set of special jaws fitted to the taper. It became necessary, then, to make a preliminary operation of rough-turning a straight part on *C* of sufficient length to allow gripping in a set of straight jaws. There were several hundred castings on hand and this extra operation had to be performed on all of them, making the expense about 50 per cent higher. The pattern was, of course, immediately changed, but it was found that the real root of the trouble lay in the drafting-room, the pattern having been made to the drawing. This matter, of course, was an oversight on the part of the designer, who undoubtedly made it tapering to save weight and perhaps also on account of the appearance.

Another example of a piece of work which is more expensive to machine than is necessary, is shown at *G* in the lower part of the illustration. This is a cast-iron webbed pulley having three openings *F* in the web (which incidentally give excellent driving facilities) and a face *H* crowned to a circular arc. This method of crowning requires a radius turning attachment or its equivalent, and the work must be machined with a fine feed on account of the varying cutting

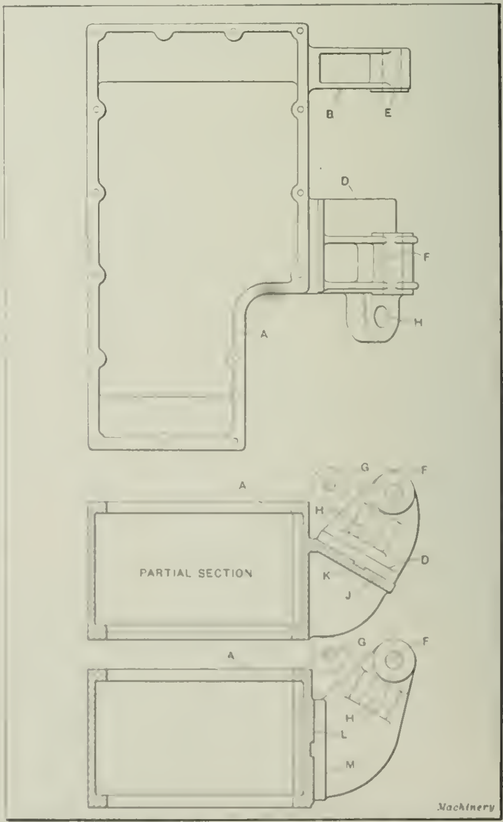


Fig. 7. Wrong and Right Designs of Angular Brackets

faces of the tool which are continually presented to the work. If fine feeds are not used in finishing, a series of ridges will be formed, which would be commercially unsatisfactory. If an angular crown is permissible, such as that shown at *J* on the casting *K*, heavy feeds may be taken both in roughing and finishing with a taper attachment, providing the tool is ground so that the cutting faces have a double angle corresponding to the crown of the pulley. Less than half the time is required for machining a pulley designed like *K* than is necessary for the arc-crowned type *G*.

An intricate aluminum casting of very thin section is shown in the upper part of Fig. 6; the shape of this piece and its fragile nature makes necessary the greatest care both in the design of holding devices to prevent springing, and in the machining itself. Reference to the illustration will show the "open-work" construction which was largely responsible for the excessive cost of the fixtures with which the work was produced. In the milling fixture for the flange *A* several floating clamps and adjustable jacks were found necessary in order to avoid distortion in the finished work. In the chucking operations a like amount of care was necessary on account of the unsupported portions *F* and *B*. The locating was also found difficult for the chucking operations because of the shallow boss *D*, while the milling of the thin lug *F* on the side requiring a shoulder was very troublesome. This casting was an exceptionally difficult one, and its construction was such that very little could be done in adding lugs for clamping. A stiffening angular brace was put in at *G*, but this was of little help. It is barely possible that the designer of this piece was forced by some unknown condition into making the parts as here shown, but the expense of the design is apparent, as are also the difficulties in machining. It would seem to the observer, without further knowledge of the conditions, that no thought whatever could have been given to the machining problems in designing.

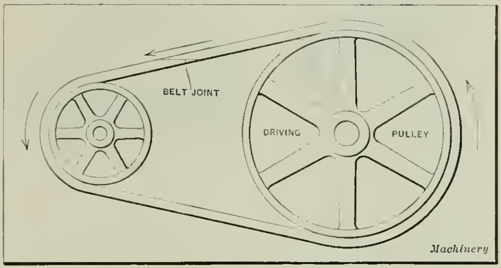
An example is shown at *H* which would have required a difficult back-counterboring operation at *K*, if the design had not permitted an additional hole *M* to be bored in the work so that the surface mentioned could be easily reached. This hole was afterward covered with a steel plate *N*. As the shoulder formed a resting place for the thrust washer behind the bevel pinion *L*, it was essential that it should be square with the bearing *J*, and this would have made a very difficult operation if machined by a back-counterboring operation. In addition to this, there would have been trouble in obtaining the correct center distance.

The partial section shown at *O* in the same illustration, with its mate *R* to which it is fitted at *S*, is an example of close drilling and facing. The surfaces *U* and *V* are very close to the wall of the casting, but are so situated that they may be easily faced with an end-mill. The drilled holes for *T*, *P* and *Q* are also close to the casting walls but their position and arrangement allow bushings to be placed in the jig at the necessary points, as *P* can be drilled from above, *T* from below, and *Q* has a recess *W* very close to it.

Fig. 7 shows in the upper view a plan of a machine component of rather light construction but fairly large size. It is provided with a bracket *B* which is a part of the casting itself, having a shaft bearing *E* in alignment with *F*. The bracket *D* in which the latter is located is a separate casting tongued at *K* to fit a slot provided for it in the angular support *J*, which is a part of the large casting. The dotted circle shows the nearest interference. The bearing *H* is situated at an angle of 30 degrees to the vertical. This entire bracket construction is expensive on account of the machining, for it will be noted that the angular surface on the large casting requires a special fixture for milling, while the bracket *B* might have been made as a separate piece instead of a part of the large casting. A construction such as that shown in the lower figure would have been much more economical to machine, and would have required fewer special fixtures. Attention is called to the fact that the finished pad *L* is at right angles to the other finished surfaces, so that one setting of the work or, at any rate, one fixture would be sufficient. The angular work is all in the smaller brackets which are much more readily handled, and the fixtures are cheaper.

CEMENTED BELT JOINTS

There is a wide difference of opinion as to the correct way of running belts with cemented joints. Diametrically opposite views have been expressed. In the *Travelers Standard* for August, the method shown in the accompanying illustration is recommended. The taper joint should be so placed with relation to the direction of running of the belt that when the belt passes over the pulley on which it is most likely to slip, there will be no tendency for the slipping pulley to pull the joint on the inside of the belt loose, and roll the scarfed-end back, thus weakening the joint. When the loosened end rolls up in this manner, stresses are induced in the belt every time the joint passes over the pulleys, and these strains may be great enough to cause the belt to give way suddenly. In the illustration shown, the belt thickness is exaggerated in order to show the joint more clearly. The pulley on the left is the one most likely to slip, because of the smaller arc of contact with the belt. Hence, the joint is arranged so that if this pulley slips there will be no tendency to roll back the scarfed end. Basing a general rule on this reasoning, it would read as follows: The leading point of the joint should be on the outside when the driven pulley is the smaller, but on the inside when the driving pulley is the smaller of the two.



Arrangement recommended for Cemented Belt Joints

* * *

TRADE IN RUSSIA

The Russian government has authorized the publication of a statement by its minister of foreign affairs, M. Sazonoff, relating to the possibilities for trade with the Russian empire. The article which has been published in the *Times* (London) states that at the present time there is an unusual opportunity for trade and commerce with Russia which means, to England and America, now and in the future, a great deal more than may be ordinarily believed. There is an enormous and lucrative market in Russia for machinery, chemicals and all kinds of manufactured articles. It is stated that the importations from Germany amounted to a grand total of $300,000,000 a year, and as the avenues of supply across the German frontier have now been cut, it is the business of the American and English nations to pave new ways for importation into the Russian dominions for their products. Sazonoff requests in the article mentioned that experts be sent to Russia even while the war is in progress in order to ascertain the requirements of the country and to study the means whereby these can be fully and successfully met. It should be understood that Russian trade generally must be "gone after," but it is there for whosoever is willing to take the trouble of doing so, and those manufacturers who look for foreign trade should arouse themselves immediately, deal firmly and intelligently with this question, and not miss the opportunity now presented for entering into a new and potential market. The sooner they acquire full knowledge of the needs and the extensive possibilities of trade with Russia, the better. Those that are first in this movement will reap a rich harvest.

* * *

Turning chilled cast-iron rolls for paper calenders is slow work. The turning speed when roughing is about ten to twelve inches per minute, six tools sometimes cutting at once. The finishing speed is higher, being about thirty inches per minute. The rolls are turned to within about 0.004 inch of the desired finished diameter when ground.

TWO USEFUL DRILL JIGS

The different types of special automatic machinery built by the American Machine & Foundry Co., 346 Carroll St., Brooklyn, N. Y., call for the use of a variety of bronze bearing bushings. These cover a wide range of sizes, and different bushings must have the oil-hole drilled in different positions. A universal drill jig is used for this purpose, front and rear views of which are shown in Figs. 1 and 2. Referring to these illustrations, it will be seen that the bushings for drilling different sizes of holes are carried in a circular plate that may be rotated on its supporting stud to bring the proper bushing into the operating position. This bushing is then located by the conical shaped pin *A* which enters one of the other bushing holes. It will be evident that the conical point on this pin enables it to center itself in all sizes of bushings. After the required bushing has been located in this way, the bushing plate is clamped by tightening the bolt *B*, which draws up the split bushing about the supporting stud.

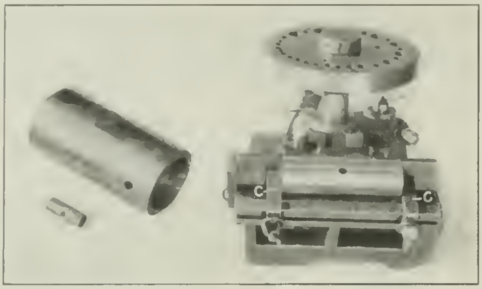


Fig. 1. Front View of Jig for drilling Oil-holes in Bushings

Referring to the front view of the jig shown in Fig. 1, it will be seen that a scale is graduated along the front edge of the V-block in which the bushings are held, and that two gage blocks *C* are provided, which may be clamped in any desired position by means of wing nuts. By adjusting these end gages to the required positions, the jig may be set for drilling the oil-hole in the bushing in any position—either central or at a specified distance from one end. The bolt *B* holds the jig plate at any required height to accommodate a given size of bushing, but after the jig has been set for drilling the first bushing it is not necessary to loosen the bolt *B* to remove the work. This is more quickly accomplished by loosening the handle *D* shown in the rear view of the jig in Fig. 2. When this handle is swung back, the plate in which the drill bushings are mounted can also be swung back to clear the work, which may then be lifted out of the V-block. The jig illustrated is provided with bushings for drilling all sizes of holes from 1/2 down to 5/32 inch by thirty-seconds, and has a capacity for handling a large range of work. The extreme sizes of bushings that can be handled in the jig are shown in the illustration, while a medium sized bushing is illustrated in position in the V-block. Many manufacturers who have a variety of bushings to drill could use a universal jig of this type to very good advantage.

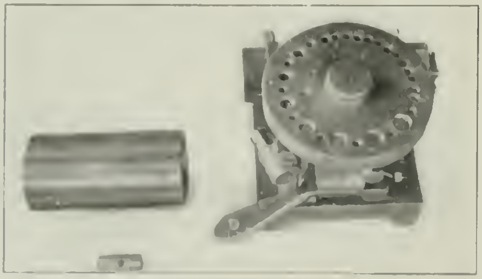


Fig. 2. Opposite Side of Universal Drill Jig showing Clamping Lever

Among the contract work handled by this company there is an automatic drill chuck, and in making the bodies of these chucks it is necessary to mill three slots at an angle of 120 degrees from each other. These slots are first drilled, after which they are finished with an end-mill. Fig. 3 shows the drill jig used for this purpose, and lying beside the jig is one of the blanks for the chuck body, and also a body after the slots have been drilled out preparatory to milling. In handling this work, the extension at the end of the chuck body fits into a socket *A*, after which the handle *B* is moved to the right to bring the opposite end of the work into contact with the rotating block *C*. This block has a jaw on it which engages the projection *D* on the work. It is necessary to drill five holes to form each slot, and this is done by moving the drilled bushing to consecutive positions by means of the handle *E*.

It will be seen that the scale *F* moves over an index point on the frame of the jig, and in this way the bushing is located for drilling each of the five holes. When located in any of the working positions, the handle *E* is pushed down to enter a stud into a hole in the frame of the jig, thus locking the bushing in place ready for the drilling operation. After the five holes for one slot have been drilled, the handle *G* is drawn back to release the index pin from the hole in the plate *H*, after which the handle is rotated to the next position in which the index pin enters the hole to locate the work for drilling out the next slot. The jaw which engages the projection *D* on the work enables the work to be rotated in this way. When the work has been indexed, the five holes for the second slot are drilled according to the preceding instructions, after which the work is indexed a third time to provide for drilling the third and final slot. The accuracy secured with this jig will be readily appreciated when it is known that the limit to which the work must be finished is 0.001 inch. E. K. H.

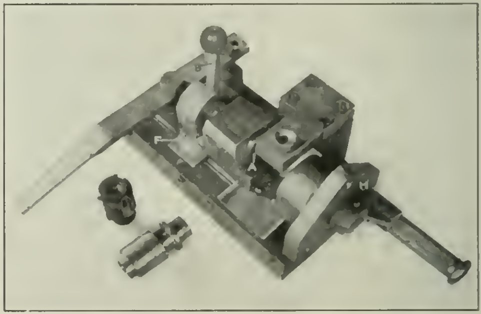


Fig. 3. Special Drill Jig used in machining Chuck Bodies

* * *

SAFETY FIRST AND MOTION PICTURES

The employes of the New York Central, Lackawanna, Santa Fé, and Burlington railroads are to be taught some of the principles of accident prevention by means of a moving picture exhibition including a love story. At first thought, says the *Railway Age Gazette*, one might think that this is a rather light and questionable treatment of a very serious subject, but love and tragedy are so skillfully combined that no one who has seen the pictures will question their effectiveness. The safety first movement is essentially one which depends on appeal to various emotions rather than to systematic commands and instructions, and arguments addressed to the emotions rather than to the intellect alone are, therefore, very successful. The men who will derive the most benefit from this method are probably the freight-train men, and it is from the everyday life of these men that the lessons shown have been taken. For general audiences the scenes are perhaps of a rather startling character, but for the men who work about trains and in freight yards, the lessons are none too vivid. Most of these men do not fully realize the percentage of their fellowmen who are killed or injured by carelessness each year.

A NEW METHOD OF POLISHING DIAMOND DIES

BY J. A. S.

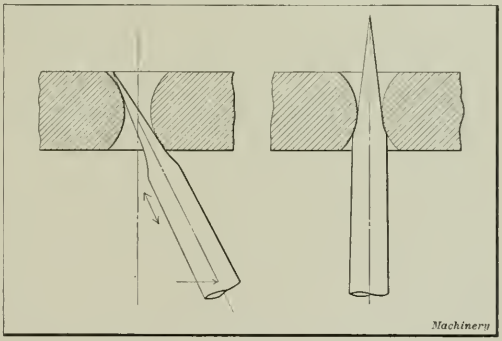
The draw-holes of diamond dies soon wear rough and non-circular and they have to be frequently reground to a polish in order to make them fit for use in wire drawing. As the drawing of fine wires has received a tremendous impetus since the introduction of the metal filament electric lamp, it may be interesting to direct attention to a new automatic machine and method for regrinding the diamond dies used for this purpose.

In the simplest machines hitherto employed for this purpose, a slim pointed steel pin or needle is rapidly pushed to and fro in the hole of the rotating draw-stone, to which an abrasive and polishing medium is applied. By placing the pin or needle at an angle to the axis of the stone, the draw-hole can be given a conical form similar to that required. It is, however, found that the correct form of the draw-hole when ground in this way, is often entirely destroyed because after each adjustment of the pin, only a small zone on one side of the draw-hole is ground. In order to improve this condition, the grinding pin is given a separate and positive movement relative to the axis of the hole by means of a more or less complicated mechanism; but even this, it is claimed, does not produce the desired result of maintaining the original conical shape of the hole in the die. The reason for this is that the guidance and rotation of the polishing pin-holder takes place about a given fixed point outside the draw-stone, and the lateral movement, for instance, is a compulsory one. The form of the draw-hole is, however, usually different in each case; sometimes it is long and sometimes it is short, and the position of the draw-stone perforation also varies because of different thicknesses of the draw-stone holders. In addition to this, it is frequently impossible to deflect the needle sufficiently from its central position because the pin would push the stone away from the disk to which it is only cemented by means of wax.

The regrinding of conical perforations in draw-stones has also been attempted by employing a wire drawn tautly through the perforation in place of the polishing pins. This wire, during the grinding operation, is moved to and fro in the perforation of the draw-stone which is caused to rotate and at the same time to make oscillations about its vertical axis. The difficulty of successfully grinding out fine perforations with even very hard fine grinding wires, from say 0.1 millimeter to 0.015 millimeter in diameter for the finest perforations, is evident, because the fine grinding wire has to sustain a certain tension and also the action of the sharp diamond dust has a tendency to cause the wire to break. Moreover, in grinding out holes which have become non-circular, it is difficult to keep such wires sufficiently taut to restore the true circle in holes which have worn out of truth. It is also claimed that the consumption of expensive diamond dust for a given amount of work is disproportionately greater when fresh grinding wires have to be constantly employed than if only a single pin point is used to do the grinding.

In order to deal with these difficulties, Messrs. Werths & Co., of London, England, have introduced a machine for grinding and polishing diamond dies by means of an improved movement which, it is claimed, overcomes the disadvantages of the preceding methods. Its fundamental feature consists of having the point of the grinding tool employed, mounted in the perforation of the draw-stone which rotates on a vertical axis, while the pin rocks to and fro in a known manner, slowly and uniformly about its vertical position or about the axis of rotation of the draw-stone, up to a given position of inclination to both sides or only to one side. The tool used is an ordinary slim pointed steel pin. This pin, moving without any compulsory guide under the action of its own weight, merely slips into the hole so far that the pin in passing its central position rests freely and without impediment on the walls of the draw-hole. Thus the pin point, in its movement toward the inclined position, may be simultaneously drawn further out of the draw-block hole commencing at a given position of inclination in rocking back the pin. By this means, as will be seen from the illustrations showing the pin upright and in its oscillating position, in the vertical position the point of the pin, which would otherwise again grind the form of the hole exactly as it was at the commencement of the grinding operations, encounters the perforation at its narrowest place where it is non-circular. This is necessary in order to make holes which are non-circular again circular. By the deflection of the pin and the simultaneous drawing out of the pin point from the perforation, the advantage is obtained, apart from an oblique position corresponding to the conical form of the perforation of the stone, of the pin point not being too sharply bent over so as to press away or break the revolving stone which is only attached by means of wax. At the same time, the pin is so bent at the entrance end in the drawing motion, that the hole is formed somewhat curved.

The novelty and essential feature of the Poppe method here described, consists more particularly of the arrangement by which the grinding pin—under all phases of its grinding operation so long as it is not withdrawn—rests against the walls of the perforation of the stone by its own weight, so that non-circular holes must be ground circular. Also, that when the pin scrapes along the walls of the hole, that is to say, when it rises and falls, the polishing material is always again conveyed to the place of grinding which allows of a very economical consumption of the expensive diamond dust. The correct form of the perforation, namely the gradual tapering of the hole by means of slightly curved walls of the hole on one side and a suitably small enlargement of the outlet of the hole on the other side, is properly ground by the special action of the polishing pin so that the draw-stone thus treated is characterized by smooth and even drawing and greater durability. No compulsory guidance of the polishing needle takes place except on the periods of its withdrawal, so that perfect grinding is assured even if the diamond is not centrally mounted exactly to a hair's breadth and the stone-holder is not pushed away from the table. By the free running guidance of the pin, its wear is retarded and the pins may be placed in and out of action in the hole without stopping the machine or impeding the operation of other pins. The machine occupies the very small space of 26 inches by 38 inches, and requires about one-sixth horsepower to drive it. The smallest and largest calibers may be mounted simultaneously side by side, the needle being chosen fine or heavier according to the size of the hole, the weights on the pin-holder being adjusted accordingly. The grinding action is automatic and hence the draw-holes are not spoiled for want of attention or experience, and it is claimed that one workman can easily attend to two or three such machines, polishing twenty to thirty stones simultaneously. The use of these machines has been adopted to a considerable extent in England, Germany, France, Austria, etc., and will probably receive favorable attention where their special features become known.



An Improved Method of polishing Diamond Dies used for Wire Drawing

* * *

Think out your work and work out your thoughts.

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MERCHANDIZING IDEAS

The value of a technical journal like MACHINERY lies chiefly in the force with which it appeals to its special class of readers. Readers of MACHINERY are practical men in the mechanical industries, from the proprietor and superintendent down. These men read the periodical to become informed on the latest developments in shop practice and the new equipment for machine shops. To effectively appeal to these men and to serve them efficiently, it is necessary to have the cooperation of the brightest minds in the field—the cooperation which means writing articles based on personal experience. It is not easy to get such cooperation.

Technical or trade journals of large circulation that are so fortunate as to have among their subscribers men willing to write out of their valuable practical experiences are in an advantageous position, and cooperation of this sort can be developed only through conducting a journal along right lines. It must be practically helpful—not helpful in a patronizing sense, but in the true sense. It must give the definite, useful, shop and technical information which such a journal is read for. The reading matter must be carefully selected and presented in a manner that is attractive, clear and forceful. That means careful, conscientious editorial work. A paper conducted on such lines has no space for puffs or write-ups offered for advertising considerations. The editorial and advertising departments must be absolutely separate and independent, serving distinct purposes as they do, but not so estranged that each has no idea of what the other is doing. An advertising department ignorant of developments in the mechanical world as recorded in the reading pages is not in the best position to serve its clients. And an editor who neglects to read the advertising in his own and other technical journals is likely to grow out of touch with the commercial side of the business, which he cannot afford to do.

It would be absurd to present general articles on economics in a trade journal devoted to tanning, but some phases of economics interest the tanner as much as the banker. Here is where a difficulty often lies in judging material offered for publication in a strictly technical or class journal. Articles in general, besides being of special interest to the class or industry represented, should be simple, straightforward and plain, but not so simple as to belong to the kindergarten class. Between the kindergarten class and the profound type of article that no one understands except perhaps the writer, is a wide range that can be worked profitably by those who aspire to reach others in their respective trades.

* * *

WASTE IN EMPLOYING LABOR

The address by Magnus W. Alexander of the General Electric Co. at the annual convention of the National Machine Tool Builders' Association was a revelation of enormous wastes in the employment of labor. The magnitude of these wastes is appalling. Mr. Alexander dealt only with the manufacturers' losses, but undoubtedly the losses of employes due to being misfits in positions are much greater. Notwithstanding the practical impossibility of obtaining exact figures on the cost of employing labor, Mr Alexander endeavored to make an investigation that would throw some light on average conditions. He divided employes into five classes and segregated the cost of employing each class. This ranged approximately from $8.50 to $65 each in the General Electric plants. These costs included the clerical cost of hiring, the estimated instruction cost, the estimated losses of production, and damage to machinery and tools.

When these losses per individual are multiplied by thousands, the aggregate is enormous. In one period the General Electric Co. hired over 42,000 persons, and out of that number secured a permanent addition to its force of only 7000. When the magnitude of these figures is considered, the extent of the losses throughout the country due to indiscriminate hiring and firing of help can be better appreciated. No doubt the losses are to some extent unavoidable, but more care on the part of those who hire would eliminate a large percentage of these.

The Norton Co., Worcester, Mass., has attacked the problem intelligently with the view of fitting the round pegs in the round holes and the square pegs in the square holes. The characteristics of each individual applying for employment are carefully studied, and if need be he is given a preliminary training of short duration before being turned over to the foreman in whose department he is to be employed. If greater care in selection were exercised and if foremen realized the cost of firing a man for some petty breach of discipline, the losses to employers and to employes could be reduced materially.

* * *

REFORM IN WORKING DRAWINGS

A mechanical drawing may or may not be an artistic piece of work, but if it conveys the right message to the men in the shop its mission is accomplished. Unfortunately, the practice of making mechanical drawings has never been standardized and there is no agreement on the so-called "conventions" used by draftsmen to save time and space. The result is that many mistakes are made in reading drawings.

Mr. Fish, whose paper was read before the recent convention of the National Machine Tool Builders' Association, pointed out some of the common mistakes made in drawings and advocated the more liberal use of the English language wherever mistakes were likely to occur. There is no agreement on the common conventions, and every draftsman is free to add conventions of his own. This is a great mistake. A drawing should tell its own story without the aid of an interpreter. If it needs an interpreter it is seriously lacking.

The situation seems to be one that in the first place demands standardization of practice in the making of mechanical drawings and uniformity in conventions, if they are to be used. The use of conventions in general, however, is to be deprecated for the reason that no matter how well they are commonly understood by the drafting fraternity, the conditions in modern shops will always lead to mistakes. Many men are employed in machine shops who have had no mechanical training and consequently have never studied mechanical drawing. A laborer put to work on a boring mill may be required to read a mechanical drawing, but to such an employe common conventions are Greek, and he must have the aid of the foreman or someone else to explain them. Legends in English are generally understandable and should therefore be employed in preference.

STRENGTH OF MATERIALS

In the design of machinery, nothing is more important than to be able to determine the stresses to which a machine member is subjected in order that it may be given adequate strength for the purpose intended. This is especially true in the case of machinery in which the failure of the component parts might cause danger to life and serious damage to property. As every student of the theory of the strength of materials knows, accurate calculations can be made for the strength of many of the parts entering into machine design. But there are also many parts for which calculations are impossible, or for which they would be so involved and uncertain that the sum of experiences is the only guide upon which the machine designer can depend.

Whenever calculations can be conveniently made, they should be carried out; but successful designs and the results of practical experience should be compared with the calculated results wherever possible, as in this way theory and practice can be made to supplement each other. There are many practical conditions, especially when such metals as cast iron are dealt with, that require consideration in addition to mere calculated strength; in all cases where a machine part is exposed to excessive wear this factor must be considered also.

Sometimes wear may be such an important factor that the designer must base his calculations for strength, not on the dimensions of the parts when new, but when they have been in use for a period of time. This applies particularly in the case of gear teeth.

There are no hard-and-fast rules to follow for many problems relating to strength of materials, but judgment and experience (and the "factor of safety," sometimes called the "factor of ignorance") will always prove valuable aids to the designer, no matter how well versed he may be in the general theory of the strength of materials.

* * *

IMPORTANCE OF ACCURATE SCREW THREADS

Hundreds of patents have been taken out on nut-locking devices, and thousands of dollars have been spent in promoting them—with more or less profitable return. Nut-locks are absolutely necessary in some places, but in many others they cannot be used because of trappiness, cost and inconvenience of application. Thousands of machinery parts are lost or ruined every day because nuts and set-screws loosen and work out. House hardware falls to pieces for the same reason, and everyone having experience can recollect cases where loose screws have caused loss, inconvenience and sometimes danger to life and limb.

This common trouble brings us to a consideration of the importance of accurate and close-fitting screw threads. As stated above, nut-locks are often positive necessities, especially on railroad tracks, motor cars and other screw-connected parts in which vibration is excessive and appreciable turning moments are developed by the vibration. The less the tolerance or space between nut and screw the less effective is vibration in loosening them, of course, but the best screw fits are not proof against rapid and long-continued vibratory action. On a great many machine parts, however, well-fitted screws and nuts once tightened will remain indefinitely locked by friction alone. The reason that so many screws needlessly work loose is because of inaccuracy of fitting. This was recognized years ago by the leading typewriter manufacturers, and action was taken to correct the evil. It is not easy to make a machine screw that will fit a tapped hole so closely as not to work loose in service, and that still can be screwed in readily when assembling. Such conditions can be reached only by refinements of tap and die making and methods of manufacture developed under the direction of highly skilled and competent men. The result, however, is well worth the cost, and too much care cannot be taken by machinery builders to secure good fitting screw threads in all machinery parts. They are the evidence of good work—work that saves customers an untold amount of worry and inconvenience, and losses of all sorts that now are common because of ill-fitting screws.

ORGANIZING FOR SAFETY

BY A. J DALY*

The wonderful change effected by the safety organizations of the large industrial corporations who were pioneers in welfare work, has been one of the bright spots in the industrial progress of the last decade. In practically all plants where safety work has been organized, there have been lower percentages of injury, lower casualty costs and wonderful improvement of the *esprit de corps* of the employes. The results obtained by their organization are now being duplicated by other companies, and the following contains some ideas on starting the work.

In starting or organizing the safety work in a plant where little or nothing has been done, the management is always confronted with the problem of deciding which one of several methods it shall use. The company has the choice of employing a safety engineer and putting him in charge of the work; of organizing safety committees from among its workmen, and being guided by their recommendations; or of placing the work under one of the existing departments and allowing it to be carried along with the usual work. Generally the choice of methods lies between the first two mentioned, namely a safety inspector or a safety committee. The practice of placing safety work under the charge of the repair, millwright or mechanical departments has several serious disadvantages. The duties of these departments are generally so varied that the foreman or master-mechanic is busy at all times with his routine work, so that safety work would be slighted or considered as a side line—a thing to be avoided. Then, again, the men in charge of these departments usually view things from a production standpoint, and therefore do not always see the necessity of safety appliances.

As stated before, the choice is usually between a safety engineer and a committee picked from workmen of the plant. In making this decision, I believe the management should be guided by the following considerations:

1. The condition of the plant; is it hazardous; is it plainly apparent that much work will have to be done?

2. The speed with which the work is to be completed; is it the intention to do a moderate amount each month, or is the work to be rushed to completion?

3. The attitude of the employes toward the safety movement and toward the company in general.

The following detailed discussion of each point will show the reasons for this belief. If a plant is in poor shape (from a safety standpoint) and it is obvious that a great deal of work must be done in the line of gear guards, railing and safety equipment, it is by far the better plan to place the work in charge of a competent safety engineer. If one man is in charge he can be in closer touch with the management and can plan the work so as to take up the more dangerous places first. This is often difficult when working with a committee taken from various parts of the work. Each man will honestly feel that the danger point or unguarded machine in his own department is the more hazardous, and will be a little disappointed if the work is sidetracked for another job.

Then, again, a committee of workmen loses interest and enthusiasm if their recommendations are not carried out quickly. They soon begin to feel that they are figure heads and that the officials in charge do not care for their suggestions. With one man in charge the case is different, as he can understand the difficulties and limitations, and can work accordingly. In every plant there are bound to be limitations as to money expended, and it very often happens that one large job, such as guarding the cranes or placing walks over lineshafts may take the entire safety appropriation for several months. In a case like that, if a workman should make a suggestion of minor importance and find that it was delayed three to six months, he would be likely to lose interest. The explaining of the plan of work does not seem to satisfy him, as he sees only his own suggestion and wishes it completed. Another point concerning recommendations made by employes and delayed because of more important work, is the fact that if an accident occurs at a point where an employe recommended a guard an excessive amount of criticism is heaped on the management, and the cry of "I told you so" is heard. Unless the management is in a position to install all worthy suggestions of employes almost immediately, I believe it is better that no suggestions be asked for.

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* Safety Inspector, American Steel Foundries, Sharon, Pa.

When the work has advanced to the point that suggestions can be given reasonably prompt attention, the value of a safety committee becomes apparent. A workman imbued with the safety spirit can uncover more dangerous conditions than any safety inspector could hope to find, and by working a committee in conjunction with a safety inspector, the dangerous points will soon be located. Probably 75 per cent of the suggestions would come from the members of the safety committee. In plants where most of the workmen are satisfied and men of long service, the committee system is particularly effective, as the men are naturally interested in their work and are quick to note the attitude of the management, and hence respond at once. The real and greatest value of the committee comes in the education of employes and prevention of unsafe practices. If a committee works faithfully along this line, it can accomplish more than a safety inspector, for the reason that the members are on the job all the time, and see everything, while one man cannot be everywhere. Hence, the following conclusions are drawn: In a case where a great deal of work is to be done over a long period of time, use a safety inspector; where the work is to be finished quickly and the attitude of the employes toward the company is good, use a committee; in case of doubt, use a safety inspector.

* * *

LOCATING THE CRITICAL RANGE WITH THE BRINELL BALL TESTER

BY J. GERRISH AYERS JR.*

The location of the upper critical points in steel calls for quite an elaborate outfit and the manipulations must be performed with extreme care. The foot of the range, however, can be determined quite readily by a single thermo-couple, as the quantities of heat dealt with are relatively large compared with the amount absorbed or evolved at the upper critical points, except in the very low carbon steels. In the higher carbon steels where the eutectic point or $Ac_{3\text{-}2\text{-}1}$ (as the case may be) is the correct hardening temperature the determination can easily be effected, but the upper points Ac_3 and $Ac_{3\text{-}2}$ of the lower carbon steels are generally determined by the use of a neutral body and a recording device such as is embodied in the Saladin outfits. In these methods the points are located by the sudden absorptions or evolutions of heat involved in the transformations taking place at the critical temperature. In the method here described the points are detected by a far more pronounced phenomenon, namely, the difference in the hardness resulting from the changes in the microstructure of the metal quenched at different temperatures within and without the critical range. In consequence this method does not require a particularly elaborate or delicate equipment and gives results which may be directly applied to commercial hardening without the interpretation of heating or cooling curves.

BRINELL HARDNESS NUMBERS AT VARIOUS QUENCHING TEMPERATURES

Specimen Number	Brinell Hardness Number	Quenching Temperature in Degrees F	Specimen Number	Brinell Hardness Number	Quenching Temperature in Degrees F
1	187	1300	18	600	1470
2	187	1310	19	600	1480
3	187	1320	20	600	1490
4	187	1330	21	600	1500
5	187	1340	22	600	1510
6	187	1350	23	600	1520
7	340	1360	24	600	1530
8	387	1370	25	600	1540
9	460	1380	26	600	1550
10	512	1390	27	600	1560
11	555	1400	28	600	1570
12	578	1410	29	600	1580
13	600	1420	30	600	1590
14	600	1430	31	600	1600
15	600	1440	32	600	1610
16	600	1450	33	600	1620
17	600	1460	..	...	

Machinery

The apparatus used was a Heraeus electric furnace equipped with a Le Chatelier pyrometer for heating the specimens to the desired temperature, and an "Alpha" Brinell ball tester for accurately determining the hardness of the quenched specimens. Thirty-three specimens about 12 millimeters by 6 millimeters by 50 millimeters in size were cut from the same piece of steel and suitably machined for the Brinell hardness test. Starting at 1300 degrees F., a piece was heated and quenched in water. The same procedure was followed with successive pieces up to 1620 degrees F., in 10-degree increments. Each piece was in the furnace a given time and all were allowed to become thoroughly saturated with heat at their respective temperatures. Every reasonable precaution was taken to keep the temperature of the quenching medium constant and to make all other conditions of the test as nearly uniform as possible, so that the hardening temperature would be the only varying factor. After the pieces were hardened they were given a final polishing to remove the scale and then subjected to the Brinell hardness test, with a standard load of 3000 kilograms and a ball 10 millimeters in diameter. The accompanying table gives the Brinell hardness numbers for the various temperatures at which the pieces were quenched. The diagram shows a curve obtained by plotting hardness as ordinates and quenching temperatures as abscissae, and depicts graphically the location of the critical range.

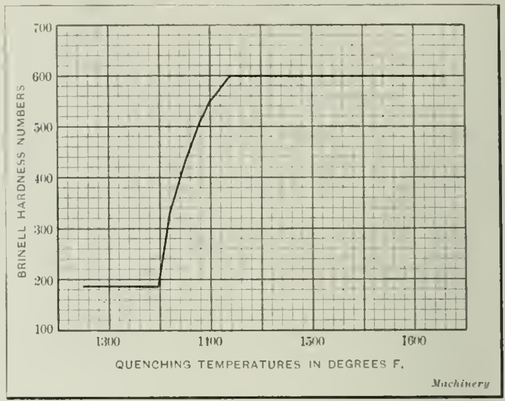

Diagram showing Location of Critical Range

From this data we conclude that no change affecting the hardness of the steel has occurred below about 1350 degrees F. but at 1360 F. we cross the foot of the critical range, i.e., the point Ac_1 where the pearlite goes into the solid solution producing a sudden increase in the hardness of the steel. At 1370 degrees F. some ferrite has entered into the solid solution and the steel becomes still harder. This change progresses until 1420 degrees F. has been reached when the balance of the ferrite is dissolved and the maximum practical hardness of the steel is obtained—600 Brinell hardness in this case. Higher temperatures up to 1620 degrees F. show no increase in the hardness of the steel, but the fractures indicate the increasing temperature by their increasing coarseness. Consequently we have ascertained that about 1420 degrees F. is the top of the critical range and the proper hardening temperature for the steel in question, although in practice it is advisable to heat a little higher to allow for any delay in manipulation that might possibly lower the temperature.

* * *

In their efforts to produce an aluminum alloy which would not be appreciably heavier than aluminum, but would possess a much greater tensile strength, German chemists have succeeded in making an alloy which has a tensile strength three times that of aluminum and which is composed of 1 per cent of tungsten and 9 per cent of cobalt or 0.8 per cent molybdenum and from 9 to 10 per cent of cobalt, the remainder being aluminum.

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* [illegible] Av., Newark, N. J.

DATA ON SURFACE AND CYLINDRICAL GRINDING*

OPERATING CONDITIONS AND RATES OF PRODUCTION FOR TYPICAL OPERATIONS

BY ROSS HOLMES†

IN connection with the detailed investigation of crankshaft grinding as summarized in the August number of MACHINERY, data were taken on the other general classes of grinding and the following detailed classes were chosen as typical. In machining the parts of an automobile engine, the grinder puts the finishing touches on nearly all the moving surfaces, although in many cases they are previously rough-turned or bored to reduce the amount of metal to be removed.

Pistons, Piston Pins and Piston Rings

For example, pistons are roughed out on a Foote-Burt piston machine which reduces them to rough size, faces off the end and machines the ring-grooves all in the same operation. Then a plate is fitted in the open end to provide a center and the work is placed in a 12 by 32 Norton grinder. The grinding wheel is a 24 L Norton, 18 by 2 inch, running at 1500 revolutions per minute or a surface speed of approximately 7000 feet per minute. The work is driven by a projection on the plate which engages a projecting bolt held in the spindle. Its speed is adjusted to about 90 feet per minute while the traverse motion covers the length of the piston and returns in 30 seconds. Three times across the piston finishes it. From 0.030 to 0.040 inch is left on for grinding, and on the first cut across, the wheel is held right up to the finished dimension. The work gives enough to leave plenty for finishing, which is accomplished by one complete traverse motion without shifting the wheel. In taking the roughing cut, the wheel is advanced by hand and this takes an average of 27 seconds. Then 20 seconds are spent in micrometer gaging and changing pieces in the machine. Combining these two times with the finishing cut time as determined by traverse, *i.e.*, 30 seconds, gives one minute and 17 seconds as the production time. However, such is the variation in the castings and the closeness of the allowable limit of 0.001 inch either way, that 215 pistons represent a good day's work.

The piston pin is ground on a 10 by 36 Norton grinder using a 24 M Norton wheel. This wheel is 2 inches wide by 18 inches in diameter, and runs at 1200 revolutions per minute or a surface speed of 5660 feet per minute. When the wheel wears down to 16 inches in diameter, the belt is shifted to the smaller pulley giving a speed of 1400 revolutions or 5870 feet per minute. Experiments made with 24 L wheels showed that they were too hard and checked the work, while 24 N wheels merely wore away rapidly without giving a good finish. The work revolved at 156 revolutions per minute or 50.5 feet per minute, at which speed a pin was finished in 2 minutes and 27 seconds, which represents the complete time inclusive of changing the work and adjusting the machine, plus an allowance for dressing the wheel. This piece is made from a 3⅝-inch length of 1¼-inch Shelby steel tubing ground to 1.235 inch. This leaves about 0.0175 inch of stock to remove, as the tubing comes a bit over size. The steel in the tubing contains from 15 to 25 points of carbon, and is carbonized to a depth of 0.03 inch and then hardened before grinding. The speed of the traverse depends entirely upon the hardness of each individual pin and cannot be determined in advance.

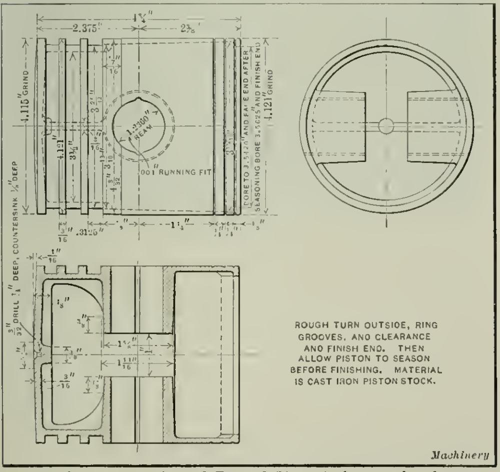
4¾"
2.375"
2⅜"
4.115" GRIND
4.121"
3¾"
7/16"
1.2300" REAM
.001" RUNNING FIT
CORE TO 3.5420" AND FACE END AFTER SEASONING BORE 3.5625" AND FINISH END
4.121" GRIND
3/16"
.3125"
1¼"
1/16"
DRILL ¼" DEEP, COUNTERSINK ⅛" DEEP
3/32"
1⅛"
1 11/16"
3/16"
ROUGH TURN OUTSIDE, RING GROOVES, AND CLEARANCE AND FINISH END. THEN ALLOW PISTON TO SEASON BEFORE FINISHING. MATERIAL IS CAST IRON PISTON STOCK.
Machinery

Fig. 1. Dimensions of Type of Piston to be ground and Instructions for Machining Operations

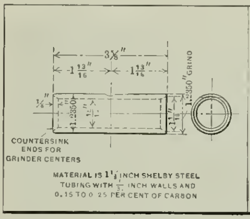
3⅝"
1 13/16"
1 13/16"
1.2350" GRIND
1.2350
⅛"
COUNTERSINK ENDS FOR GRINDER CENTERS
MATERIAL IS 1¼ INCH SHELBY STEEL TUBING WITH 1/32 INCH WALLS AND 0.15 TO 0.25 PER CENT OF CARBON

Fig. 2. Type of Piston Pin to be ground

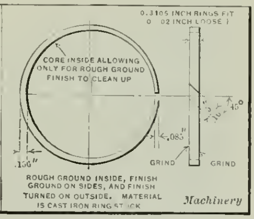
0.3105 INCH RINGS FIT 0.002 INCH LOOSE
CORE INSIDE ALLOWING ONLY FOR ROUGH GROUND FINISH TO CLEAN UP
45°
.085"
.156"
GRIND
GRIND
ROUGH GROUND INSIDE, FINISH GROUND ON SIDES, AND FINISH TURNED ON OUTSIDE. MATERIAL IS CAST IRON RING STOCK
Machinery

Fig. 3. Type of Piston Ring used in Piston shown in Fig. 1

Piston rings are ground after being rough-turned and are held to an accurate size by means of a magnetic chuck on a Heald ring grinder equipped with a 9 by ⅝ inch wheel. A 24 L Norton vitrified wheel is used to rough off 0.030 inch, leaving 0.005 inch for the finishing operation which is done with a 40 J carborundum wheel. The work is rotated to give a surface speed of 160 feet per minute and the grinder wheel runs at 2100 revolutions per minute or a surface speed of about 5000 feet per minute. At these speeds about 150 rings are the average daily run on either the roughing or finishing operations.

Grinding Operations on the Live Shaft

The live shaft has four surfaces to be finished on the grinder—the taper upon which the wheel fits, the main bearing, the oil retainer fit for the differential case and the differential bearing. The taper is ground in a 12 by 42 Landis grinder using an 18 by 3 inch 24 M wheel rotating at 1500 revolutions per minute or a surface speed of about 7000 feet per minute. This is somewhat faster than would ordinarily be recommended for this wheel, but the speed is necessary to get the required finish. The work speed is quite slow, being from 30 to 40 feet per minute, depending upon what point of the taper is measured. The tapered end is hardened to a scleroscope test of 75. This is too hard for a grade L wheel; otherwise, if it could be used, the finish could be obtained at a lower speed than 7000 feet per minute. A ring gage is used and the allowable variation is 1/64 inch sideways on the taper. This corresponds to a variation of about 0.002 inch. Taking off 0.035 inch of stock on a straight cut, the cutting time is 35 seconds and the total time 46 seconds. After grinding sixteen pieces, it is necessary to dress the wheel, which takes from one to two minutes. Considering all adjustments and variations in stock, the standard output for this operation is 350 per day of 9 hours.

The main bearing is ground on the same machine running at the same speed. Owing to variations in the width of this bearing, it is sometimes possible to feed straight in, while on other pieces the traverse must be used. Where the first type of feed is possible the time is 35 seconds, against 42 seconds with the traverse. The No. 64 work speed of this machine is used on the traverse while the actual cutting time is 21 seconds. This bearing is ground to an accuracy of 0.001 inch.

The oil retainer fit does not require such a close limit, within 0.005 inch being sufficiently accurate. The same type of machine is employed equipped with the same size of wheel and driven at the same speed, except that a 24 L wheel is used. The work speed is 40 feet per minute. About 0.05 inch of stock is removed in 46 seconds. The total time, including gaging and setting up, is 83 seconds. After grinding eleven shafts, it is necessary to dress the wheel. This takes 1½ minute or about 8 seconds per shaft, which brings the total production time to 91 seconds. However, the output of the machine averages about 180 shafts per day or one every 3 minutes. This is due to changing wheels and changing jobs.

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* For articles on rates of production on the grinding machine and allied subjects in MACHINERY, see also "Crankshaft Grinding," by Ross Holmes, published in August, 1914, and other articles there referred to.
† Address: Care of Reo Motor Car Co., Lansing, Mich.

The bearings for the differential gear have to be ground to an even closer limit, 0.005 inch being the specified limit with 0.028 inch of metal to remove. The cutting time is 30 seconds using a straight-in feed and 50 seconds covers the whole operation, including changing, gaging and grinding.

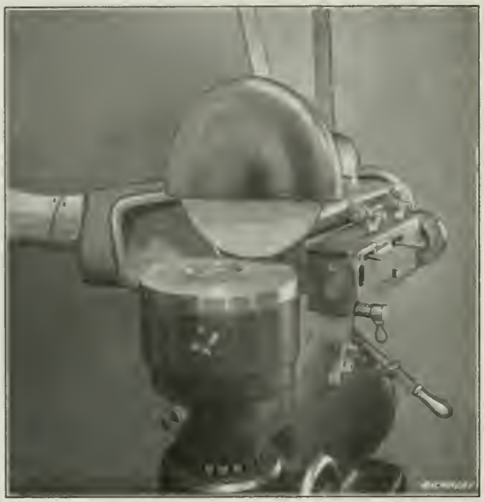


Fig. 4. Grinding one of the Piston Rings on a Heald Ring Grinder

Surface Grinding Between Two Keys

Another variety of work, where the surface to be ground lies between two keys, is represented by the sliding gear shaft. This is cut off from the bar stock and has the end bearings turned, after which the work goes to a Barber-Colman miller which uses a forming cutter and roughs out the sliding keyways, leaving the splines. The grinding is done on a Bath No. 20 multiple key shaft grinder, using a 46 M Norton 3¼ by 1 inch wheel. This wheel is hollowed out to the shape of the shaft and the work is moved longitudinally beneath it. The wheel runs at 2160 revolutions per minute or approximately 1700 feet per minute. This machine is furnished with a four-way dividing head and an index attachment which centers the sliding way with the wheel when adjusting the grinder dog. The roughing operation leaves 0.0045 inch of metal for grinding and this is usually removed in three rotations of the shaft. The wheel is advanced to 0.001 inch of the finish size and the work rotated twice or eight traverse cuts. Each traverse cut and return takes 10 seconds for the 8-inch travel. The wheel is now set up a trifle and the next two sides traversed, after which the micrometers are applied and the final two sides ground accordingly. The actual cutting time varies from 220 to 225 seconds, while the whole operation takes an average of 3¾ minutes. Dressing the wheel takes 40 seconds and causes the next shaft to take an undue length of time through resetting the stop. The diamond is held in the end of a bar which has a radial motion relative to the table, producing a perfect concave surface in the wheel. Two other diamonds face off the side bevels, and thus dressing the wheel becomes a short operation. Each wheel is good for about 300 shafts and then 30 to 40 minutes are required to change wheels and dress the new one. A production of 13 shafts per hour represents a very good average on this work.

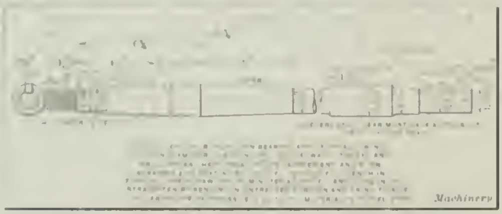
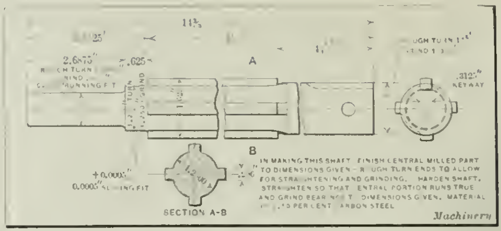


Fig 5 Rear Axle Live Shaft on which Four Grinding Operations are performed


11⅜
25'
2.6875"
.625
A
B
TURN
GRIND
RUNNING FIT
.3125"
KEYWAY
+0.0005"
0.0005"
SECTION A-B
IN MAKING THIS SHAFT FINISH CENTRAL MILLED PART TO DIMENSIONS GIVEN - ROUGH TURN ENDS TO ALLOW FOR STRAIGHTENING AND GRINDING. HARDEN SHAFT, STRAIGHTEN SO THAT CENTRAL PORTION RUNS TRUE AND GRIND BEARINGS TO DIMENSIONS GIVEN. MATERIAL PER CENT CARBON STEEL
Machinery
Fig. 6. Example of Grinding where Surface to be ground lies between two Keys

Internal Grinding

Grinding internal surfaces such as sliding gears for the transmission is done on a No. 70 Heald machine using three 46 K Norton wheels placed side by side, each wheel being 1¼ by ⅜ inch in size. These wheels run at about 8500 revolutions per minute or a surface speed of about 2800 feet per minute. At this speed they remove 0.007 inch from the inside intermediate sliding gear in a few seconds over a minute, while the whole production time is about 100 seconds. With the same set-up, 0.010 inch of stock is ground from the low speed gear in about 1½ minute, and the whole production time including gaging and changing stock is 2¼ minutes. Two plug gages are used, one being 0.0005 inch under size. This allows it to slip through the front face of the gear and test the other side and aids in making the hole the same size at both ends. These gears are held in a three-piece expanding collet chuck which is carefully cleaned each time with an air blast to be sure of the perfect centering of the gear. Owing to changing wheels and also to the necessity of adjusting the machine, inasmuch as the same man works on a variety of gears each day, 160 gears constitute a full day's work.

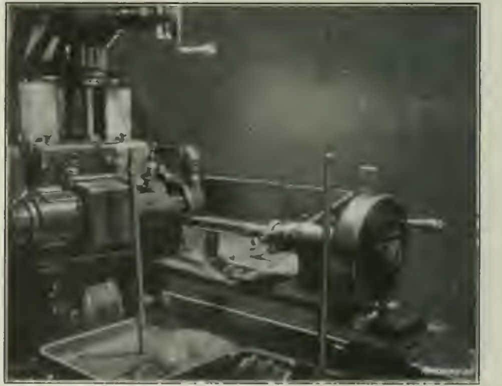


Fig. 7. Grinding the Sliding Gear Shaft shown in Fig. 6 on a No. 20 Bath Key Shaft Grinder

Sleeves are ground on a similar machine using a 36 J wheel 3 by [illegible] inch in size. This wheel running at 7500 revolutions per minute gives a surface speed of 5900 feet per minute. The traverse is set to cover the sleeve in 5 seconds each way. The amount of stock removed is 0.018 inch, with a limit of 0.001 inch either way for accuracy. On the first cut the feed is by hand to smooth up unevenness in the stock. After that the finish is produced by the traverse. The production time for this size of sleeve is 2½ minutes.

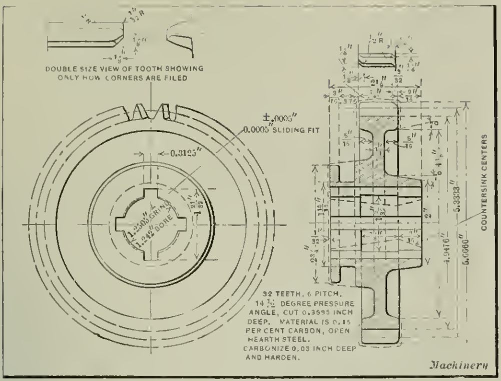

DOUBLE SIZE VIEW OF TOOTH SHOWING ONLY HOW CORNERS ARE FILED
±.0005"
0.0005" SLIDING FIT
0.3125"
1.2505" GRIND
1.242" BORE
32 TEETH, 6 PITCH, 14½ DEGREE PRESSURE ANGLE, CUT 0.3595 INCH DEEP. MATERIAL IS 0.15 PER CENT CARBON, OPEN HEARTH STEEL.
CARBONIZE 0.03 INCH DEEP AND HARDEN.
5.3333"
4.9470"
5.0060"
COUNTERSINK CENTERS
Machinery

Fig. 8. Transmission Gear in which the Bearing is to be ground

Cylinder grinding presents quite a different class of work. No. 10 Brown & Sharpe grinders are used with a 303 F carborundum wheel 3½ inches in diameter by ¾ inch wide. This wheel runs at 3900 revolutions per minute, which corresponds to a surface speed of 3580 feet per minute. The recommended speed for this wheel is from 5000 to 6000 feet per minute, but such practice ruins the bearings of the machine in a short time and causes the wheel to glaze over, heat up and ruin the work. The present speed was determined by gradually slowing down from the recommended speed to the present one which produces the greatest quantity of acceptable work with the greatest economy. The wheel is held on an eccentrically placed spindle and it is by means of this eccentricity that the depth of cut is determined. However, there is no scale or gage to show how much the spindle is off center and consequently the setting requires considerable skill, since it is only by the amount of spark and sound that the depth of cut can be judged. The spindle eccentric or head rotates at a speed of 104 revolutions per minute.

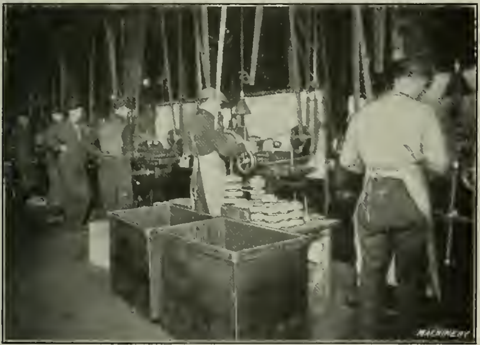


Fig. 9. Battery of No. 70 Heald Grinders for grinding Gears shown in Fig. 8

First, the cylinder is placed in the jig and lined up. This is done by allowing the wheel to touch the casting lightly, and then it can be seen which way to shift it in order to remove an equal amount of stock on all sides. This shifting is done by adjusting screws on the top, bottom and sides of the gib as explained in the detailed article by Douglas T. Hamilton entitled "Production Tools for Reo Engine Cylinders," published in the September number of MACHINERY. Once lined up the wheel is set in for the full depth of the roughing cut—usually about 0.006 inch—which is taken off in one traverse and return. The cylinder springs enough so that about two-thirds of this amount or 0.004 inch is removed on the first travel and the remaining 0.002 inch is left for the return travel. An average of 110 seconds is needed for the traverse to cover the length of the cylinder once. This is the slowest traverse on the machine. After this cut, the cylinder is micrometer gaged and the finish cut made accordingly. Reo cylinders are ground to an accuracy of 0.001 inch either way or a variation of 0.0015 inch out of round. Since these cylinders are cast in pairs, the jig must now be shifted to the other cylinder end, relined up and the grinding done on it. On these machines the best observed time was 14 minutes 56 seconds. Including making all adjustments, dressing the wheel, and allowing for bad castings, this would mean from 32 to 35 cylinders per day ground to these limits. However, in the actual method used, two machines are operated by one man, in this way utilizing his time to the best advantage. He sets up one job during cuts on the other, finishing from 45 to 50 cylinders daily with an average speed of about 23½ minutes each.

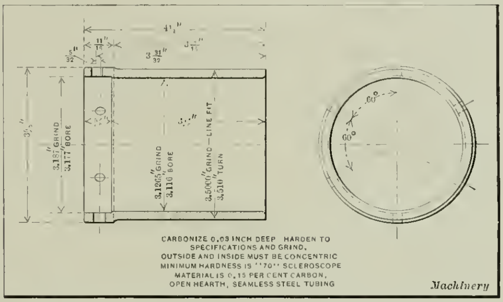

3.187" GRIND
3.177" BORE
3.1205" GRIND
3.110" BORE
3.5000" GRIND—LINE FIT
3.510" TURN
60°
60°
CARBONIZE 0.03 INCH DEEP HARDEN TO SPECIFICATIONS AND GRIND.
OUTSIDE AND INSIDE MUST BE CONCENTRIC
MINIMUM HARDNESS IS "70" SCLEROSCOPE
MATERIAL IS 0.15 PER CENT CARBON, OPEN HEARTH, SEAMLESS STEEL TUBING
Machinery

Fig. 10. The Type of Sleeve for which Grinding Data is presented

The tabular summary presented herewith gives a comparison of the times and amount of work, and these form the basis for the standards in miscellaneous grinding work. In the calculations no account is taken of minor details such as the cross-bored hole in the piston, for the piston would take as long to machine if this hole were solid metal and consequently it is so considered. The apparent variation in the grinding time per square inch or per cubic inch is caused either by a variation in the hardness of the stock or by a difference in the allowable limits of variation. The timing of the piston ring presented some difficulty, inasmuch as stock left on by the roughing machine had to be removed by the finisher. In other words, speeding up one operation resulted in adding to the time on the other operation. The most efficient work seems to result from an equal division of time between the roughing and finishing operations.

GRINDING STANDARDS ON CLASSES OF WORK UNDER CONSIDERATION

Part	Type of Grinding	Operation	Time		Area Ground, Square Inches	Volume Removed Cubic Inches	Type of Wheel
			Minutes	Seconds			
Piston	External surface		1	17	36.60	1.280	24 L Norton
Piston pin	External surface		2	27	14.08	0.246	24 M Norton
Piston ring	Sides of ring	Rough	3	36	1.571	0.047	24 L Norton vitrified for roughing
		Finish	3	36	1.571	0.0079	40 J carborundum for finishing
Live shaft	External surface	Taper	.	46	18.4	0.644	24 M Norton
		Main bearing	.	35	18.40	0.460	24 M Norton
		Oil retainer	1	31	13.75	0.688	24 L Norton
		Differential bearing	.	50	11.97	0 335	24 L Norton
Sliding gear shaft	Longitudinal		3	45	18 6	0.0836	46 M Norton
Sliding gear	Internal surface		1	40	8 35	0 0585	46 K Norton
Sleeve	Internal surface		2	30	30 65	0.552	36 J Norton
Cylinder	Internal surface		14	56	129.75	7.775	303 F carborundum

Machinery

SOLDERING AND BRAZING ALUMINUM

THE PRACTICAL PROBLEMS INVOLVED—SOLDERS AND FLUXES TO USE AND METHOD OF PROCEDURE

BY FOREMAN JOINTER

Much has been written in recent years about aluminum and its peculiar characteristics, but comparatively little has been published from the practical mechanic's point of view, although the metal is now used in a rapidly increasing number of industries, and has become an essential material in many of them. One of the cardinal arts in the manipulation of aluminum in the hands of the metal worker is the process of jointing. As the jointing of aluminum is popularly supposed to be a difficult process, the writer attempts in this article to deal with the various methods of jointing the metal, for modern requirements.

The art of jointing most commercial metals has been known and practiced for many centuries, but this is not the case with aluminum, as the metal is only in its infancy as compared with other common metals. Aluminum was obtained first in 1827, but at this period it consisted of a whitish-gray powder and it was not until 1845 that metallic pellets were obtained. In 1854 the metal was obtained in a state of almost perfect purity by St. Clair Deville. However, the jointing of aluminum was not done until 1855, and it is only within the last few years that satisfactory progress has been achieved.

COMPOSITION OF SOLDERS

Letter	Tin	Aluminum	Zinc	Copper	Bismuth	Lead	Phosphor-Tin*	Silver	Antimony	Cadmium	Magnesium	Chromium	Vanadium
A	95.00	.....	.....	.....	5.00	.....	.....	.....	.....	.....	.....	.....	.....
B	78.50	2.00	19.00	.....	.....	.....	0.50	.....	.....	.....	.....	.....	.....
C	.....	66.70	.....	.....	.....	.....	.....	33.30	.....	.....	.....	.....	.....
D	20.00	70.00	.....	.....	.....	.....	.....	10.00	.....	.....	.....	.....	.....
E	97.00	.....	.....	.....	3.00	.....	.....	.....	.....	.....	.....	.....	.....
F	.....	6.00	89.50	4.50	.....	.....	.....	.....	.....	.....	.....	.....	.....
G	71.25	2.25	26.00	.....	.....	.....	0.50	.....	.....	.....	.....	.....	.....
H	60.00	4.00	8.00	4.00	.....	12.00	.....	12.00	.....	.....	.....	.....	.....
I	37.50	.....	25.00	37.50	.....	.....	.....	.....	.....	.....	.....	.....	.....
J	.....	8.00	92.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
K	30.00	.....	20.00	.....	.....	.....	.....	.....	.....	50.00	.....	.....	.....
L	80.00	2.25	17.00	.....	.....	.....	0.75	.....	.....	.....	.....	.....	.....
M	66.00	15.50	.....	.....	9.00	.....	.....	.....	7.00	.....	2.25	.....	0.25
N	15.50	2.50	78.25	.....	.....	2.50	1.25	.....	.....	.....	.....	.....	.....
O	.....	20.00	65.00	15.00	.....	.....	.....	.....	.....	.....	.....	.....	.....
P	49.05	.....	20.31	1.15	.....	26.06	.....	.....	3.43	.....	.....	.....	.....
Q	30.00	70.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
R	.....	4.00	94.00	2.00	.....	.....	.....	.....	.....	.....	.....	.....	.....
S	85.10	10.80	.....	.....	.....	.....	.....	.....	.....	1.35	2.75	.....	.....
T	60.00	.....	15.00	.....	5.00	10.00	.....	.....	5.00	.....	.....	5.00	.....
U	86.00	.....	.....	.....	14.00	.....	.....	.....	.....	.....	.....	.....	.....
V	98.00	1.00	.....	.....	1.00	.....	.....	.....	.....	.....	.....	.....	.....
W	20.00	70.00	.....	10.00	.....	.....	.....	.....	.....	.....	.....	.....	.....
X	18.00	2.00	27.00	.....	.....	23.00	.....	.....	.....	.....	.....	.....	.....
Y	90.00	5.00	.....	.....	5.00	.....	.....	.....	.....	.....	.....	.....	.....
Z	81.95	.....	.....	.....	15.05	.....	.....	.....	.....	.....	.....	.....	.....

Machinery

* Ten per cent Phosphorus

Soft Soldering Aluminum

In the manipulation of aluminum it is essential that there should be simple and efficient methods of uniting two pieces of the metal. The process of soft soldering will, therefore, be considered first. There are, it is true, a great number of industrial applications where aluminum cannot be employed economically owing to a certain amount of difficulty encountered in soft soldering it effectively. Almost as soon as aluminum was produced commercially, it was discovered that the ordinary solders and fluxes could not be used with it, but in 1855 M. Christofle, a goldsmith of Paris, found that either pure tin or pure zinc would unite aluminum. In practice, however, the tin speedily disintegrates, while zinc by itself is brittle, and discolors badly. M. Hulot, therefore, tried an ingenious process of coating the surfaces with copper, and then soldering the coppered surfaces in the ordinary way, but after the lapse of a few months it was found that the copper stripped off very easily. Although innumerable attempts have been made to discover a satisfactory soft solder for aluminum, it would appear, that up to the present time, no practical, simple, and well tested process of soft soldering aluminum has yet been proved to be permanently successful, notwithstanding the large number of aluminum solders that are patented every year, each inventor naturally claiming superiority.

Composition of Aluminum Solders

The solders for aluminum consist chiefly of an alloy containing several metals in various proportions, *viz.*, aluminum, antimony, bismuth, cadmium, chromium, copper, lead, magnesium, phosphor-tin, silver, tin, vanadium, and zinc.

In the accompanying table various compositions of soft solders are given in tabulated form, which are but a selection from those that might have been given had space permitted.

It is frequently stated that joints made by these patent solders will stand the time test and retain their original strength after an indefinite exposure to atmosphere or other influences, but in a number of instances these guarantees have not been fulfilled. The writer has witnessed some recent demonstrations of patented solders for aluminum and has also used them and made tests for comparison, but it should be recognized that the merits of an aluminum solder cannot be judged without subjecting it to a duration test. Although remarkably strong joints were made by means of a blowpipe, the solders used melted at too high a temperature (about 608 degrees F.) to allow the ordinary soldering bit to be employed satisfactorily. These high-temperature solders greatly impede universal jointing of the metal and are, in the writer's opinion, largely responsible for many mechanics failing to obtain even a moderately good soldered joint; there are also many who still doubt the possibility of making a soldered joint in aluminum.

What is wanted is an effective and easily used solder (an alloy with the color of aluminum being preferable) which will make permanent joints in light and heavy work; a solder that can be used freely with the ordinary soldering bit, to enable the same rapidity to be maintained as when soldering tin-plate, copper or brass articles, and also a solder that will withstand indefinite exposure to the atmosphere. This would then enable intricate articles in sheet aluminum to be joined easily and manufactured, which at the present time is a tedious operation. It is for this reason that commercial articles of aluminum having soft soldered joints are rarely sold. Usually the articles are cast, spun, pressed or drawn from one piece of the metal, or, if it is necessary to join one piece to another, welding, riveting or screwing is employed.

Why Aluminum is Difficult to Solder

Perhaps it is worth while to explain some of the difficulties in soldering aluminum and finding an effective and easily used solder. The problem has been very difficult owing to the oxidizing characteristics of the metal. The chief reasons for the difficulty are as follows:

1. The formation of an almost imperceptible but very persistent film of oxide on the surface of the metal; this

film of oxide, which is always present, is intensified at soldering temperatures and, being very refractory, prevents ordinary soft solders from alloying with the metal and forming a strong joint.

2. The highly electro-positive character of the metal causes electrolytic action with low-temperature solders containing negative metals like lead, the result being automatic disintegration at the joint. Especially is this the case in damp situations favorable to galvanic action.

3. The high heat conductivity of the metal renders local heating to alloying temperature a tardy and difficult matter; this trouble increases as the size of the article worked on increases; hence the heat is conveyed from the soldering bit and solder so rapidly that they are chilled quickly, and therefore the solder does not become sufficiently liquid to flow readily.

An experience extending over the time that has elapsed since aluminum became extensively used has demonstrated that the metal can be soldered, but not so readily and effectively as other metals. When soldering aluminum, it is essential that the oxide film on the surface should be removed before cohesion with the solder can take place, and as it forms again on exposure to the air instantaneously, it is necessary that the removal of the oxide and the covering with solder should be simultaneous. In soldering other metals the oxide can be removed chemically; with aluminum this has been a very difficult problem, although Otto Nicolai, of Boppard-on-the-Rhine, has invented a flux which, it is stated, combines with the alumina and produces a compound that remains fluid during the process of soldering, thereby completely counteracting the effect of the oxide on the surface of the metal. However, in the absence of a suitable flux the oxide must be removed mechanically by abrasion.

Tinning Aluminum Preparatory to Soldering

Tinning the surfaces of aluminum preparatory to soldering is an important factor; also, when soldered joints in sheet aluminum are needed, the distance of the overlap of the pieces to be joined should be much less than that usually allowed for other sheet metals. The reason for this is that the solder will not flow into an aluminum joint, even when tinned, by capillary attraction as it does into tin, brass or copper joints. The process of tinning is accomplished by heating the surfaces to be soldered to a temperature somewhat above the fusing point of the solder used, a satisfactory tinned surface being obtained by rubbing with the point of a well tinned soldering bit so as to remove the film of oxide and allow the solder to act upon the clean surface, all in the same motion, removing any dross that may have formed. After the surfaces to be united are thus tinned, they may be soldered together by pressing the tinned surfaces in contact, again heating the metal and solder to the desired temperature, and finally by rubbing thoroughly with the hot soldering bit the surface carrying the liquid solder. In the actual operation of soft soldering aluminum, it is essential that all joints should be kept under slight pressure until the solder has thoroughly set, this method thus preventing disruption of the joint.

Effect of Dampness on Aluminum Soft Solders

The following is a case in point, with reference to the disintegration of soft solders in damp situations. During the month of March, 1910, the writer made two aluminum vessels of triangular shape 12 inches in depth, sheet aluminum 0.036 inch in thickness being used. The joints were made by using a solder composed of tin, zinc, aluminum and phosphor-tin. One of the vessels was used for filtered water and the other for dry materials; both were made at the same time and by precisely the same process. After a lapse of a few months the vessel that had been used for the water came back for repairs, the defect being that the joints were leaking; upon examination, it was found that the solder had badly disintegrated; in fact, the greater portion of the solder could easily be stripped off the aluminum, whereas with the other vessel the solder is still in good condition. The writer has several soft soldered specimens of aluminum, as well as aluminum soldered to brass, that were jointed in 1906. These are also perfect, but it must be stated that the specimens referred to are not exposed to severe conditions, such as spray of sea water (which rapidly deteriorates aluminum soft solders), or a damp atmosphere.

Fluxes for Aluminum Soft Solders

A large variety of soldering fluxes to use with aluminum soft solders have been tried with more or less success; *viz.*, ammonium chloride, borax, copper chloride, cadmium iodide, lard oil, rosin, stearin, silver chloride, stannous chloride, tallow, vaseline, zinc chloride, etc.; in fact, it would probably be more difficult to mention what has not been tried as a flux to use with aluminum soft solders. However, stearin has several properties which make it a valuable soldering flux, and it can be used successfully with a number of the solders listed in the table previously referred to. The rapidity with which a flux acts is an important factor in its usefulness. Occasionally the writer has noticed a flux advertised in the columns of various engineering periodicals as an ideal soldering flux for all metals except aluminum, thus showing the difficulty of finding a suitable flux for aluminum soft solders. An ideal soldering flux which would appear to be needed at the present time for use with aluminum soft solders, would be a flux that would rapidly dissolve the oxide film and combine with the alumina, to produce a compound that would remain fluid during the soldering operation. This would then allow the solder to penetrate the liquid compound and thoroughly alloy with the metal, although in many instances fairly good results are obtained without the assistance of a flux; especially is this the case with soft solders containing various percentages of phosphor-tin. This may possibly be explained by the fact that these solders probably owe their adhesiveness to the great affinity that phosphorus has for oxygen. For instance, if a molten alloy containing phosphorus is placed upon aluminum, there is naturally a tendency to absorb oxygen from the impure film on the surface of the aluminum as well as from the surrounding air. When making these phosphor-tin solders designated in the table by the letters *B*, *G*, *L*, and *N*, respectively, to avoid loss of the more easily volatile of these metals, it is advisable to melt the aluminum first, then add the zinc, tin, and phosphor-tin, in the order named. To obtain a soft solder that may be worked at a comparatively low temperature, to enable the soldering bit to be employed solely, the solder is mostly composed of metals that possess low melting points, such as bismuth, cadmium, tin, etc., as these metals readily combine in all proportions when fused together. In the case of solders that melt at higher temperatures, it will be necessary to use a blowpipe flame or a bunsen burner as a subsidiary; care should be taken that any flame used is free from free carbon.

Soldering Bit for Aluminum

An aluminum soldering bit will be found to be far superior to the ordinary copper bit when soldering aluminum, the point and the joint being kept much cleaner during the soldering operation. Another advantage is that the point and slopes of the soldering bit can be tinned with the same flux as that used for the joint; a soldering bit of any other metal has a tendency to discolor the aluminum and to form alloys with the metal and the solder. More care, however, must be exercised in the manipulation of the aluminum soldering bit, because its melting point is lower than that of the ordinary copper soldering bit. It should be the aim of the mechanic to so use the soldering bit that its point or "face" remains tinned; re-tinning involves loss of time and frequent filing quickly wears it away. In addition, it is essential that both the tinning and soldering should be thoroughly done, and performed quickly to get good results. The quality of the workmanship has a very great influence on the permanence of the work.

Pointers on Soldering Aluminum

1. Remember that the metal cannot be soldered as readily and successfully as other metals; if you expect that it can, you will be disappointed.

2. Never attempt to solder aluminum until the surfaces to which the solder is to be applied have been thoroughly cleaned, as aluminum solders adhere only to bright and clean surfaces.

3. Do not expect to get good results with poorly prepared tools; good tools are essential to good soldering.

4. The surfaces to which it is intended that the solder shall

adhere should be thoroughly "tinned" in order to get good results.

5. Before attempting to solder, the metal near the joint to be soldered should be raised almost to the melting temperature of the solder.

6. Remember that both the tinning and soldering must be done thoroughly to get good results.

7. Any blowpipe flame that is used for heating must be free from free carbon. A large blowpipe flame should only be employed in "heating up" the parts to be soldered—not on the solder itself. Do not overheat the metal or its strength will be impaired.

8. A soldering bit of pure aluminum is essential to the success of the operation; the ordinary copper bit tends to alloy with the metal composing the solder and to discolor the metal.

9. Do not expect the solder to flow with such rapidity as in soldering such metals as tin-plate, brass, and copper; aluminum solders generally flow sluggishly.

10. A solder should not be considered perfect until it has been subjected to a duration test.

11. Avoid wide seams when jointing sheet aluminum. The solder will not flow into the joints, even when tinned, by capillary attraction as when soldering other sheet metals.

12. Do not expect the solder to pull the joint together, but see that the joint is kept under a slight pressure until the solder is thoroughly set.

13. Aluminum solders should not be stored in a damp atmosphere. If kept for some time, the solder deteriorates; hence, when required for use the metal does not flow so readily.

14. Good results will not be obtained if the metal is soldered in a dilatory manner; smartness is the keynote to successful aluminum soldering.

Hard Soldering or Brazing Aluminum

The process of hard soldering or brazing aluminum differs from ordinary soft soldering principally because the uniting metal or solder is chiefly composed of copper and zinc; hence a much greater degree of heat is necessary, although other metals are occasionally added. Whatever may be the composition of the uniting metal or solder, it is always desirable to retain to a great extent the strength, malleability, fusibility and color of the metal to be jointed; therefore, the composition of the uniting metal should contain a certain amount of aluminum. As these hard solders have a high melting point they cannot be applied with a soldering bit, and a hearth fire or a powerful blowpipe must be used. Hard soldering is generally termed "brazing." The process is one of the oldest of the mechanical arts, and was well known to the ancient Egyptians. The uniting metal or solder is known by various names, *viz.*, spelter, spelter-solder, brazing brass, brazing solder, brazing-spelter, etc. Brazing or hard soldering is used on most metals where greater strength is required than can be given by soft solder, or where the work has to withstand a degree of heat that would cause soft solder to fuse.

The fusing point of the solder used should be as close as possible to that of the article to be brazed, as a more tenacious junction can thus be secured. In the actual operation of brazing, joints will often appear to be sound, but when the superfluous solder is removed it will be discovered that this is what held the pieces together. When the extra material is cleaned off, defects caused by the solder not having run into the joints satisfactorily can be detected. Aluminum is without doubt one of the most difficult metals to braze effectively. This is largely due to the difference in the fusibility of aluminum oxide and aluminum metal. From a mechanical point of view, to attempt to braze aluminum is evidently a mistake; the metal is far more likely to fuse than many of the brazing compounds employed.

The coefficient of expansion of aluminum is considerable and a piece of work may be rendered useless owing to the deformation it has received during the brazing process. The essentials of a brazed joint are the contact of absolutely clean surfaces free from oxide and dirt. In aluminum we have an astonishingly bright and clean metal, but the bugbear to successful brazing is the difficulty in eliminating the oxide that is so refractory at brazing temperatures, and which effectively prevents that intimate connection (which is so essential) between the brazing solder and the surfaces to be joined. It is well known that brazing or hard soldering is generally preferred to soft soldering where superior strength is required, particularly at high temperatures; but aluminum and the aluminum-zinc alloys do not lend themselves in a satisfactory manner to brazing. A number of interesting experiments were made quite recently in a large engineering works with the brazing of various sheet aluminum articles. Several types of joints, brazing solders and fluxes were employed. In the experiments referred to the results were unsatisfactory in that fusing of the aluminum took effect before a perfect joint was obtained. Until the remarkable advance made during the last few years with the development of the autogenous method of jointing various metals, brazing was considered the ideal process where strength and durability were required. Even today the question is frequently asked by many mechanics, that if aluminum cannot readily and effectively be soft soldered "why not braze it." Obviously, as will be gathered from the foregoing, the brazing of aluminum, strictly speaking, is at present far from being a satisfactory commercial proposition.

* * *

A MACHINE GREENGOODS GAME

It is not always the farmer who buys the gold brick or tempting roll of imitation greenbacks. Gullible human nature is found in the highways and the byways of the great cities as well as on the farms. The purchase of de luxe editions of Dickens and other standard authors at prices ranging up to $50,000 or $75,000 recently aired in the trial of a book agent captain of industry, proves this. But the exploitation of machines as a bunco game is not so common. Perhaps it requires too much brains of the promoter to make such games profitable—but they have been worked in some cases with success.

A few years ago an interesting and promising device for boring square and polygonal holes in metal was brought to the attention of the public. The apparatus could be attached to a lathe, milling machine or drilling machine, and would quickly and accurately drive a triangular cutting tool through a piece of steel, producing a regular square hole with smooth sides and sharp corners. However, as might have been anticipated by a mechanical expert familiar with the general demand for such tools, it never won great commercial success. The machine was interesting, if not fascinating to watch. Its work was so different from that of the ordinary machine tool that it attracted attention way out of proportion to its actual value; but interested attention did not mean sales and the necessary cash to carry on the business.

After a year or two of work the original promoters of the machine sold out to a gentleman of little or no mechanical experience but who had a persuasive tongue and manner. He did not try to interest legitimate customers but frequented offices and homes of men and women who had money to invest and no knowledge of the needs of manufacturers. It was much easier and more profitable to sell stock in the boring machine business than to sell machines.

Some of the stories told to prospective customers were weird and ludicrous. The promoter made a lawyer believe that the machine had great possibilities in bridge building plants. He asserted that no machine existed for boring square holes, and that bridge builders would welcome a machine of this type which would enable them to use bolts in bridges with square shanks of the carriage bolt variety! They would be able then to assemble bridges much more rapidly and cheaply, inasmuch as the workman could work single-handed, not requiring a helper to hold a wrench on the head of the bolt when he screwed up the nut! The possibilities in the manufacture of hardware were also pointed out, both promoter and victim being in blissful ignorance of the fact that the punch press provides a means for cutting holes of any shape in sheet metal, at a speed a hundred times greater than is possible with any geometric boring machine.

The moral of this story, if it has any, is that before investing your money in any mechanical proposition, it is well to secure the advice of a disinterested person who knows something about the conditions of manufacturing and the probable value of the device to be exploited

INDEX DRILLING AND TAPPING ATTACHMENT FOR BROWN & SHARPE AUTOMATIC SCREW MACHINE*

A RAPID AND ECONOMICAL DEVICE FOR PRODUCING ATOMIZER PARTS

BY W. F. GRADOLPH†

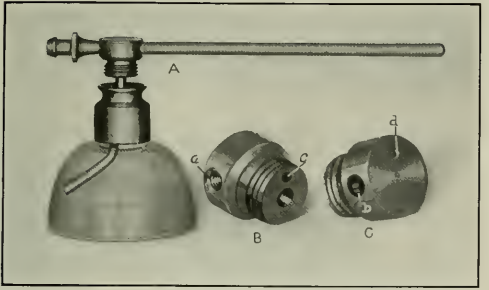


Fig. 1. Atomizer Top Cap assembled and dismantled

THE tooling equipment for making atomizer parts cheaply and rapidly on a screw machine presents many problems. The handling of small parts in different machines greatly increases the cost, and it is always the aim to reduce second operations to a minimum. The Brown & Sharpe automatic screw machine lends itself admirably to the application of many different attachments, and in the following article an attachment of the indexing type operated from the cross-slide for drilling and tapping will be described.

The part to be made is shown assembled on an atomizer at *A* in Fig. 1, and also at *B* and *C* in the same illustration, and is one of several hundred parts which are assembled into De Vilbiss atomizers manufactured by the De Vilbiss Mfg. Co., Toledo, Ohio. The part, which is an atomizer top cap, before having the cross holes drilled and tapped, is formed, drilled, center-hole tapped, threaded on the outside and cut off in the regular way in a Brown & Sharpe automatic screw machine. It is then brought to the Brown & Sharpe machine shown in Fig. 2, and is placed in the vertical magazine hopper *A*. The hopper is located at the rear end of the machine and by means of an attachment fastened to the regular stock-feeding mechanism, the parts are fed through the spindle to the special chuck *B*. For performing all the operations hereafter enumerated, the spindle of the machine is stopped, that is, it is held stationary with a brake, and the work is in no case rotated, all the tools held in the turret or on the cross-slide being power-driven.

After feeding the parts to the chuck and gripping, the first operation is to drill holes *a* and *b*, Fig. 1. To do this, the turret is indexed and the jig *C*, Fig. 2, is brought forward carrying bushings which guide the drills accurately and enable them to start without deflecting on the circular faces of the work. Drills *D* and *E* are then withdrawn, whereupon the turret is again indexed and drill *F* is brought into position. This tool then drills hole *c* in the work shown in Fig. 1. It will be noted here that hole *c* is off center; this hole is produced by means of a drill-holder held in an offset bushing located in the turret. As the work is not rotated, the offset of the bushing controls the position of the hole in the work relative to the position of the central hole. This particular hole has two diameters as shown by *c* and *d*, and consequently it is necessary to hold two different sized drills in the turret. These drills are driven in the ordinary way by means of the Brown & Sharpe standard turret drilling attachment driven by belt *H* which, through bevel gears in the turret itself, drives the drill-holders holding drills *F* and *K*.

After drilling the hole *c*, the index head *I*, Fig. 2, indexes one-half revolution and brings the tap *J* into position. This attachment is one of the most unique tools connected with the set-up and will be described separately later. Hole *a* is then tapped while drill *K*, held in the turret, drills the small hole *d* in the work; that is, it projects completely through the work guided by the hole *c* previously drilled. After hole *a* is tapped and hole *d* is drilled, both tools withdraw and the chuck releases the work, which is then ejected and a new piece is brought into position. The index head on the cross-drilling attachment then turns around half a revolution, bringing the drill *D* into position again for the next piece.

The Index Cross-slide Drilling and Tapping Attachment

The index cross-slide drilling attachment shown set up on the No. 2 Brown & Sharpe automatic screw machine in Fig. 2 is shown in detail in Fig. 3, where a better idea of its construction can be obtained. Referring to the latter illustration, it will be seen that the attachment consists primarily of a body *A* enclosing a driving and indexing mechanism. Casting *A* is fastened to the rear cross-slide in the usual manner and carries an indexing drum *B* that is indexed by means of wormwheel *C*, receiving power from the worm *D* driven by a pulley *E* belted to the overhead works. The drilling and tapping spindles *F* and *G*, respectively, are driven by a grooved pulley, which is belted to the overhead works and drives these spindles through gearing. The drilling spindle is driven direct by means of gears *I* and *J*, whereas the tapping spindle is driven in one direction by gears *K* and *L*, friction cone *O* and cup *Q*, and in the other direction through gears *I*, *J*, *M* and *N*, friction cone *O* and cup *P*. Cone *O* is made of cast iron, whereas friction cups *P* and *Q* are made from phosphor-bronze. Gear *N* is screwed onto the extended shoulder of cup *P* and gear *L* is screwed onto the extended shoulder of cup *Q*. The pulley shaft is provided with a left-hand thread, as is gear *K*. The spindles *F* and *G* rotate in phosphor-bronze bushings.

The operation of the friction device is as follows: When the cross-slide advances, the pressure of the tap against the work forces friction cone *O* back into contact with cup *Q*, power being obtained for the tap through gears *K* and *L*. This continues until the cross-slide has reached the extreme forward movement, whereupon it drops back, and in dropping

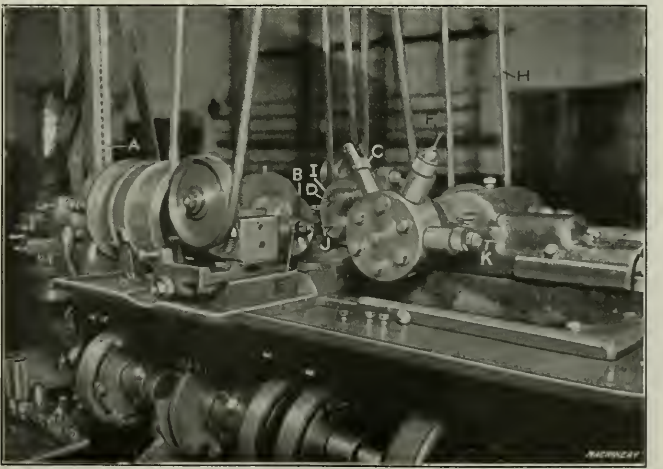


Fig. 2. No. 2 B & S Automatic Screw Machine used for machining Atomizer Top Cap

back the tap still being in the work, draws friction cone *O* into contact with friction cup *P*. The drive is then through gears *I*, *J*, *M* and *N*, driving the tap in the opposite or left-hand direction, and consequently withdrawing it from the hole in the work.

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* For further material on Brown & Sharpe automatic screw machine work, see "Magazine Attachments" in MACHINERY, February and March, 1912; and "Milling, Cross Drilling and Burring Attachments" in September, October, November and December, 1911.

† Address: The De Vilbiss Mfg. Co., Toledo, Ohio

The Indexing Device

Another very interesting feature of this cross-drilling and tapping attachment is the indexing device for bringing the drill and tap consecutively into operation. As was previously mentioned, the drum carrying the entire mechanism is enclosed and carries a wormwheel meshing with a worm, which is driven by a tight pulley *E*. The shaft carrying tight pulley *E* also carries a loose pulley *W* so that when no motion of the drum is required the belt is shifted over onto the loose pulley. Just as soon as the drill or tap is released from the work, the roll *Y* held on fulcrum arm *S* comes in contact with a cam A_1 fastened to the side of the machine. This forces in arm *S* which is fulcrumed in the bracket *T*, withdrawing the locating plunger *U* from the indexing bushing *V*, and at the same time shifting the belt from the loose pulley *W* onto the tight pulley *E*, the details of this mechanism being illustrated much more clearly in Fig. 4. When the belt is shifted onto tight pulley *E*, the cylinder *B* makes one-half revolution, but before this is completed the cross-slide is advanced and thus withdraws the locking plunger from the action of cam A_1. The indexing plunger rides on the cylinder holding the belt shifter over against the tension of the coil spring B_1 until the half revolution is completed, whereupon the index pin drops back into the bushing, allowing the spring B_1 to push the shifter outward, shifting the belt onto loose pulley *W*. The commendable feature of this attachment is its compactness and reliability. We have been using it for a considerable time and the tap breakage has been practically nil. Its simplicity commends it to those interested in screw machine work and screw machine tools and equipment.

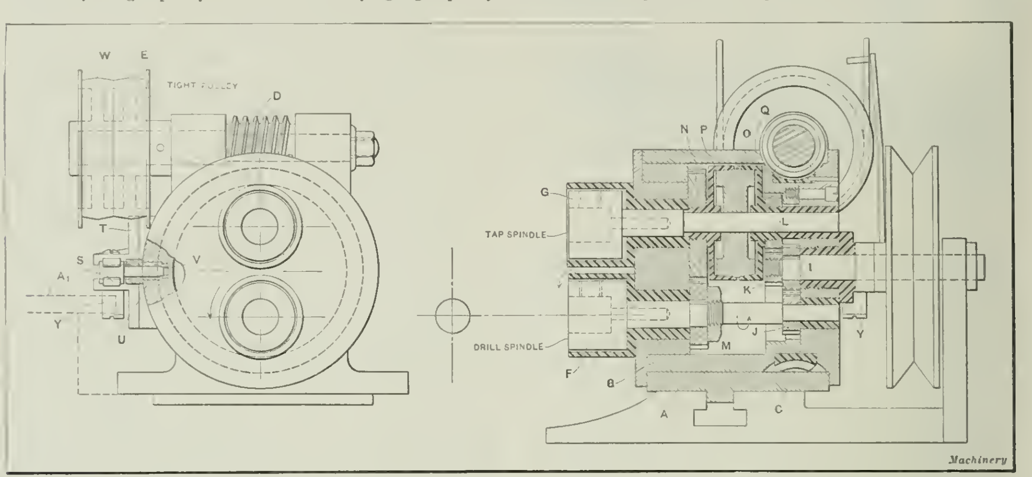

Fig. 3. Details of Cross-slide Index Drilling and Tapping Attachment shown on the Machine in Fig. 2

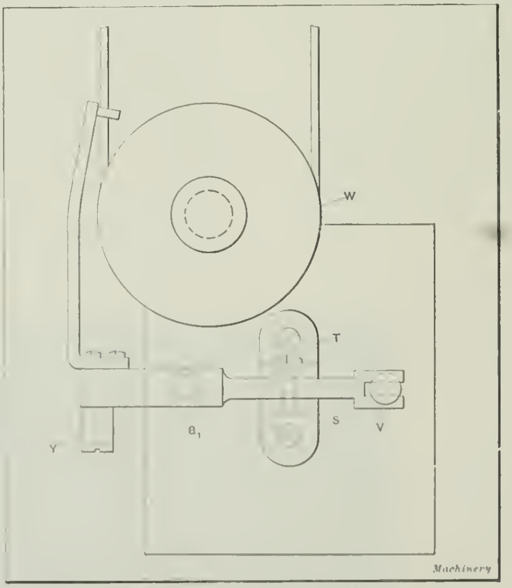

Fig. 4. Detail showing Indexing and Belt Shifting Device

INTERNATIONAL ENGINEERING CONGRESS NOT ABANDONED

A report was current to the effect that the International Engineering Congress to be held in San Francisco, Cal., September 20-25, 1915, was to be abandoned because of the European war. The committee of management has issued a statement correcting the erroneous impression, and stating that the five governing bodies of the five national societies under whose auspices the congress is to be held, recently gave the matter careful consideration and unanimously confirmed their original pledges to support it. Communications have been received from various foreign countries throughout the world including those located within the war zone, indicating that a large majority of the papers originally solicited for the congress will be turned in on time, and that the congress will be truly international in character. The total number of papers contemplated was about 290 and of this number about 220 are definitely promised.

The meetings will be held in the new auditorium building in the civic center of San Francisco in which the Panama-Pacific International Exposition authorities have reserved assembly, section and committee rooms for the week of the congress, sufficient to fully meet all requirements.

The committee appeals for the strong and immediate support of American engineers; in view of the conditions brought about by the war, it is imperative that they subscribe promptly. Subscriptions should be sent to W. A. Cattell, secretary, or W. F. Durand, chairman, Foxcroft Bldg., San Francisco, Cal.

* * *

As a producer of raw materials, the United States stands in the first place among the nations; its production of iron ore is 44 per cent of the world's production; of copper, 55 per cent; of petroleum, 63 per cent; of coal, 40 per cent; of cotton, 56 per cent; and of wheat, 20 per cent.

DESIGNING CONE PULLEYS*

A NEW GRAPHICAL METHOD OF FINDING THE RADII, WITH EXAMPLES

BY ROBERT C. H. HECK†

THE dotted outline in Fig. 1 represents a pair of equal pulleys having a diameter D_o and placed at a distance S between the centers or axes. The full lines shows a pair of unequal pulleys on the same axes, with radii R and MR, respectively. If absence of slip is assumed, M is also the ratio of the turning speed of the small pulley to that of the large one. In order that the length of belt shall be the same in these two cases, the mean diameter D_m of the unlike pulleys, which equals $R + MR$ or $R\ (1 + M)$, must be a little less than D_o. The method now offered consists in expressing the relation as a formula:

$$D_m = D_o \times (1 - Q) \qquad (1)$$

The exact value of the small fraction Q is then calculated for a wide range of conditions, and these values are plotted in a large-scale diagram. From this diagram, the factor Q can be read with an accuracy far greater than is attainable in any of the graphical constructions commonly used for finding the diameters of cone-pulley steps. The corrective factor Q increases with the pulley ratio M and also increases as the distance S gets relatively smaller. By introducing another proportionality factor, we have:

$$S = ND_o \qquad (2)$$

Then by having Q depend upon M and N, the diagram is made general; it is independent of, but applicable to, any particular dimensions. In the main diagram, Fig. 3, the base (for both sections) represents M, *i.e.*, the diameter ratio and ideal speed ratio of the steps. It is laid out on a logarithmic scale, beginning with equal pulleys at the left-hand edge, for which $M = 1$ and $\log M = 0$; and running to $M = 10$, which is beyond the limit of practice. The ordinate represents Q to a uniform scale, measured downward from the top of the diagram because it it is a subtractive quantity. In the lower left-hand section, the scale of Q is two and one-half times as great as in the main diagram. Each curve is drawn for the particular value of shaft-distance factor N with which it is numbered. The use and full meaning of the diagram can best be made clear by means of numerical examples.

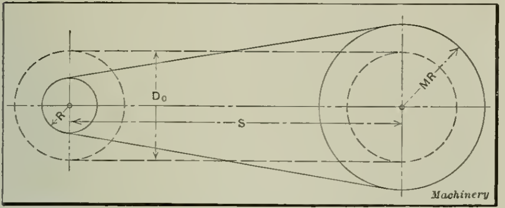

Fig. 1. Diagram showing Equal Sized Pulleys and Unequal Pulleys for Same Length of Belt

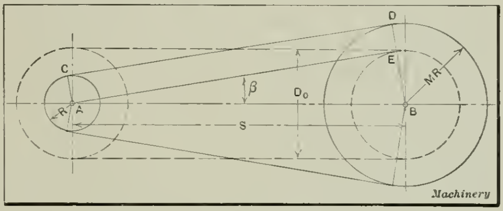

Fig. 2. Diagram illustrating Method of Procedure in calculating Values for plotting Diagram shown in Fig. 3

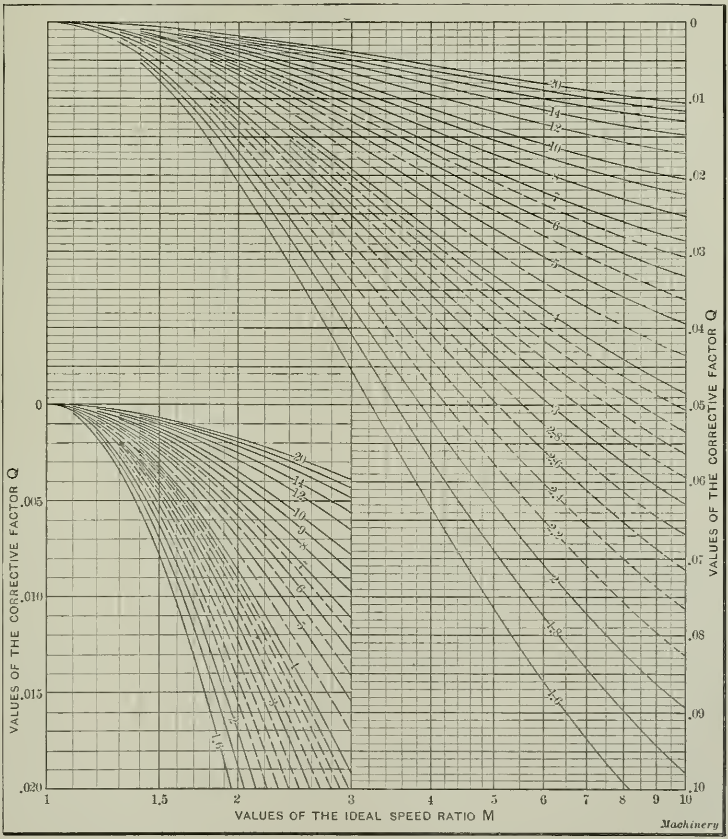

Fig. 3. Diagram for determining Values of Corrective Factor Q from Corresponding Values of Speed Ratio M and Distance Factor N

Example 1: In Fig. 1 let $D_o = 12$ inches and $S = 48$ inches, so that the value of N is 4. Find the diameters for a pair of pulleys which will fit the same belt and have a speed ratio of 3 to 1. The vertical line for $M = 3$ is crossed by the curve for $N = 4$ at $Q = 0.0192$, and 1.92 per cent of 12 inches is 0.230 inch, so that D_m is 11.77 inches. Since $D_m = R\ (M + 1)$ and M is 3, the radius R of the small pulley is $11.77 \div 4 = 2.9425$; and either by subtraction as $(D_m - R)$ or by multiplication as MR, the other radius is found to be 8.8275 inches. The diameters are then $D_1 = 5.885$ inches and $D_2 = 17.655$ inches. This is the simplest problem that arises; and even when interpolation must be made in the diagram for both M

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* For information on the design of cone pulleys previously published in MACHINERY, see "Cone Pulley Radii," September, 1905.

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and N, it is easily possible to get D_m accurate to the nearest 0.01 inch. On the question of considering or disregarding the belt thickness, it may be remarked that this is of much more importance as affecting belt length and velocity ratio than in its influence upon the design for constant length around different steps. As between $D_m = (1 - Q) D_o$ and $D_m + T = (1 - Q)\ (D_o + T)$ the difference in D_m is only QT; and unless Q is unusually large this is practically negligible.

Example 2: Design a pair of five-step equal cones with a middle diameter of 10 inches, to be placed 54 inches apart and to give speeds in a geometric progression having the term ratio 1.4. The middle step being fixed and the two sides alike, it is necessary to design only two steps. For these M will be 1.4 and 1.4^2 or 1.96. Since $N = 5.4$, by referring to the diagram and reading from the enlarged section, we get $Q = 0.0016$ and $Q = 0.0062$. For the step nearest the middle $D_m = 9.98$ inches; $R_1 = 9.98 \div 2.4 = 4.16$ inches; $R_2 = 5.82$ inches. For the end step $D_m = 9.94$ inches; $R_1 = 9.94 \div 2.96 = 3.37$ inches; $R_2 = 6.57$ inches. The five diameters will therefore be 6.74, 8.32, 10, 11.64 and 13.14 inches, respectively.

Example 3: With no allowance for sag, find the length of belt around a 12- and 60-inch pulley pair with 20 feet between shaft axes. This problem must be worked by trial solution. First get N as for the known value of D_m, which is 3 feet; with $S = 20$ feet the value of N becomes 6.67. Referring to the diagram with this value and with $M = 5$, Q is found to be 0.0205. Then $D_o = D_m \div (1 - Q) = 36 \div 0.9795 = 36.755$ inches = 3 feet ¾ inch. Comparing this result with $S = 20$, the more exact value of N is found to be 6.53 and the corresponding value of Q is 0.0208, which makes $D_o = 36.765$ inches. Obviously, the first approximation is, in this case, good enough for all practical purposes. From Fig. 1, it is evident that the dotted belt length is the circumference of the circle of diameter D_o plus $2S$. To be exact, add one belt thickness (say 0.22 inch) to D_o, getting 36.99 inches. The circumference of a circle of this diameter is 116.21 inches, or approximately 9 feet 8.25 inches, and the whole length of the belt is 49 feet 8.25 inches. When working from a given value of D_m to an unknown value of D_o, as in the present case, it is necessary to divide by $(1 - Q)$ which means a troublesome calculation. Changing to an operation for which the slide rule is amply accurate is effected by calculating and tabulating a second corrective factor from the relation:

$$\frac{1}{1 - Q} = 1 + Q_1 \qquad (3)$$

Then instead of dividing 36 by $(1 - Q)$ or 0.9795 as in the last example, it is a much simpler numerical operation to look up $Q_1 = 0.0210$ and add to 36 the Q_1 fraction of itself or 0.755 inch. Values of the factor Q_1 are given in the table.

VALUES OF FACTOR Q_1

Q	0.000	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.009
0.00	0.0000	0.0010	0.0020	0.0030	0.0040	0.0050	0.0060	0.0071	0.0081	0.0091
0.01	0.0101	0.0111	0.0121	0.0132	0.0142	0.0152	0.0163	0.0173	0.0183	0.0194
0.02	0.0204	0.0215	0.0225	0.0235	0.0246	0.0257	0.0267	0.0278	0.0288	0.0299
0.03	0.0309	0.0320	0.0330	0.0341	0.0352	0.0363	0.0373	0.0384	0.0395	0.0406
0.04	0.0416	0.0427	0.0438	0.0449	0.0460	0.0471	0.0482	0.0493	0.0504	0.0515
0.05	0.0526	0.0537	0.0549	0.0560	0.0571	0.0582	0.0593	0.0604	0.0616	0.0627
0.06	0.0638	0.0650	0.0661	0.0672	0.0684	0.0695	0.0707	0.0718	0.0730	0.0741
0.07	0.0753	0.0764	0.0776	0.0788	0.0799	0.0811	0.0823	0.0834	0.0846	0.0858
0.08	0.0870	0.0881	0.0893	0.0905	0.0917	0.0929	0.0941	0.0953	0.0965	0.0977
0.09	0.0989	0.1001	0.1013	0.1025	0.1038	0.1050	0.1062	0.1074	0.1086	0.1099

Machinery

Example 4: Design a pair of four-step equal cones, to give speeds in a geometric series with the ratio 1.2, the largest diameter being 16 inches and the distance between centers 10 feet. Let X stand for the ratio between successive speeds or values of M. There is here no middle pair of equal steps, with $M = 1$, as in Example 2, but the two steps near the middle are each distant by half of interval X from the state $M = 1$. In a geometric series half an interval is measured by the square root of the term factor $X = 1.2$. Then the series of values of the speed ratio M will be $X^{-\frac{3}{2}}$, $X^{-\frac{1}{2}}$, $X^{\frac{1}{2}}$, $X^{\frac{3}{2}}$, each being multiplied by X to get the next, and the product of the two middle terms being unity. With like cones, only steps Nos. 3 and 4, in which M is greater than 1, need be considered. Let $M_1 = X^{\frac{1}{2}}$ or $\sqrt{X}$. $M_2 = X^{\frac{3}{2}}$. For $X = 1.2$, $\log X = 0.07918$; whence $\log M_1 = 0.03959$, $\log M_2 = 0.11877$; $M_1 = 1.095$, $M_2 = 1.315$. With $M = 1.315$ and the largest diameter $D_4 = 16$ inches, the smallest diameter D_1 is $16 \div 1.315 = 12.17$ inches. Then $D_m = 14.09$ inches and $N = 120 \div 14.09 = 8.53$. For $M = 1.32$ and $N = 8.5$, $Q = 0.0007$ and there is no occasion for a second trial. The effect is to make D_o only 0.01 inch larger than D_m for the end steps, while for the middle steps D_m will be indistinguishable from this value of D_o. Using $2\,D_m = 28.20$ inches, we get $D_2 = 28.20 \div 2.095 = 13.46$ and $D_3 = 28.20 - 13.46 = 14.74$. The four diameters are now found to be 12.17, 13.46, 14.74, and 16 inches, respectively. The data for this problem lie in the region where it is commonly considered proper to keep the sum of diameters constant, and the solution shows how insignificant is the error involved in so doing. It appears that for ordinary countershaft conditions, especially under the modern plan of a small speed range on the belt cones, the error due to a constant sum of diameters is very small. But where cones are put close together and have a large speed range, as in countershafts for grinding machines, the correction by Q must, of course, be made. There is nothing novel about these statements. The point is the advantage of the present method as a means of securing accurate results, without the uncertainty due to graphical error which is multiplied if the layout is too big to be drawn full size. A final example at the opposite extreme of conditions will complete the exposition of this method.

Example 5: A foot-power lathe has steps 3, 4 and 5 inches in diameter on the headstock cone, while the diameter of the largest step on the driving cone is 20 inches and the distance between axes is 30 inches. Find the other two diameters on the large cone. The trial method of Example 3 must surely be used here, with perhaps several trials. For the step given, $M = 20 \div 3 = 6.67$ and $D_m = 23 \div 2 = 11.5$. If this were D_o, N would be $30 \div 11.5 = 2.61$. Knowing that D_o will be larger, try $N = 2.4$ and get $Q = 0.064$. This will make $D_o = 11.5 \div 0.936 = 12.29$ inches and $N = 30 \div 12.29 = 2.44$, which shows that the guess was a good one. A closer value of Q is now 0.0633, for which $Q_1 = 0.0676$ and $D_o = 11.5 + 0.78 = 12.28$ inches. This gives $N = 2.443$ exactly. Having thus established the value of D_o, the procedure for the unknown steps will be to assume a trial value of Q, get D_m and M and check back to Q. Take the step for which $R = 2$ inches. Try $Q = 0.058$, $D_m = 12.28 - 0.71 = 11.57$ inches, $MR = 9.57$ inches and $M = 9.57 \div 2 = 4.79$. For $N = 2.44$ and $M = 4.79$ the diagram gives $Q = 0.0497$. Try again with $Q = 0.050$; then $D_m = 12.28 - 0.61 = 11.67$ inches, $M = 9.67 \div 2 = 4.84$ and $Q = 0.0502$ from the diagram. This is close enough; then $D_m = 12.28 - 0.62 = 11.66$ inches and the diameters are 4 and 19.32 inches, respectively. From end step to second step the value of Q changes from 0.0633 to 0.0502 or by 0.0131. The next change will be smaller, perhaps about 0.010. Try $Q = 0.040$ and $D_m = 12.28 - 0.49 = 11.79$ inches. With $R = 2.50$ inches, $MR = 9.29$, $M = 3.72$ and Q is found to be 0.0395, which is near enough because a variation of 0.0005 in the value of Q means but 0.0006 inch in D_m. The diameter for this step is then 18.58 inches, and for the two cones the whole set of values is 3, 4 and 5 inches; and 20, 19.32 and 18.58 inches. The step differences are 0.68 and 0.74 inch for the large cone, as against 1 inch for the small one. In a problem of this sort it would be better to use a graphical method for approximate solution and then check to assure accuracy by means of the diagram here given.

Appendix

The method of determining the location of points for the curves in Fig. 3 is derived as follows: In Fig. 2 the dotted belt length is:

$$L = (\pi + 2N)\ D_o. \qquad (4)$$

The length around the unequal pulleys is:

$$L = (\pi - 2\beta)\ R + (\pi + 2\beta)\ MR + 2\,S\ \cos\beta.$$

$$= \pi\ (M + 1)\ R + 2\beta\ (M - 1)\ R + 2\,ND_o\ \cos\beta \qquad (5)$$

Letting $D_m = (M + 1)\ R = (1 - Q) D_o$, (6)

$$R = \frac{1 - Q}{M + 1} D_o.$$

$$(M-1)\,R=(1-Q)\,\frac{M-1}{M+1}\,D_o.$$

Substituting these values in Formula (5) and equating it with Formula (4) gives:

$$L=\pi(1-Q)D_o+2\beta\,(1-Q)\,\frac{M-1}{M+1}\,D_o+2N\cos\beta\,D_o$$
$$=(\pi+2N)D_o.$$

From the preceding we find:

$$Q=\left[\,2\beta\frac{M-1}{M+1}-2N\,(1-\cos\beta)\right]\div\left(\pi+2\beta\frac{M-1}{M+1}\right)\qquad(7)$$

From Fig. 2 we find:

$$\text{Sin}\ \beta=\frac{M-1}{S}R=\frac{1-Q}{N}\times\frac{M-1}{M+1}.\qquad(8)$$

Having Formulas (7) and (8), the problem is to find by trial solution the value of Q for given values of M and N. The steps are as follows: (*a*) Assuming a trial value of Q get sin β from Formula (8), taking it to correspond with the nearest minute of angle. (*b*) Look up cos β and compute the value of β in angular measure or expressed as a fraction of a radian. For this operation it is convenient to have made out an auxiliary table giving β for each degree up to say 30 and for each minute from 1 to 59. (*c*) Work out Formula (7), getting a computed value of Q. (*d*) With this value of Q recompute sin β by Formula (8) and compare it with the value taken at the start. In making the calculations represented by the diagram, Fig. 3, this was repeated until the two values of sin β agreed within 0.00005. The check is on sin β rather than on Q because the first value of Q is rough and merely guides the selection of sin β, whereas this sin β is definitely and precisely related to cos β and β as used in Formula (7). The calculation is rather laborious, although not so involved as might be inferred from a glance at Formula (7); but there is no practical reason why anyone should repeat it, nor would any usable requirement as to precision call for the printing of a numerical table of values of Q. The diagram is based on 295 calculated points and a good many more obtained by careful numerical interpolation.

* * *

EXPERIENCES OF AN APPRENTICE

BY APPRENTICE

Whenever a new man comes to work in our tool-room, he and I soon become acquainted, as it falls to my lot to show him where various tools are kept and to run errands for him, etc. I have several ways of sizing a new man up, one being to appear very much interested in his kit of tools. If his "mikes" are thrown into the tool-chest on top of other tools, his stock drops quite a few points in my estimation; if he owns no "mikes" at all, his stock goes down still farther; and lastly, if he singles me out in order to blow about the wonderful jobs he has done and the big money he always received before coming here, I put him down as a "bluff." That is part of the experience gained in three years' apprenticeship.

We had a world-beater of a toolmaker in our tool-room lately—until the boss decided otherwise. I will call his name Al because it was something else. The boss gave Al a dandy little die for piercing round holes and punching a number of oblong slots as his first job. Being in the business to absorb all the knowledge I can acquire, I naturally watched Al pretty closely in hopes he would use some kink new to me that he had gathered in his travels. He sprung no surprises until he had completed the die, when he started to make the oblong slotting punches. I wondered and watched until he had the oblong punches all screwed to the punch-plate and began to scribe the outline of the dies on the punches. Then I sauntered over to his bench and asked him if he were going to fit his blanking punches before he put holes in the punch-plate for the round punches.

He said, "Sure."

"Well, how are you going to transfer your round holes from the die to the punch-plate after you have the blanking or slotting punches fitted?"

"Are you looking for information?"

"I sure am."

"Well, I'll tell you kid; after I get those blanking punches fitted and screwed to the punch-plate, I'll take the die to the drill press and then put a piece of drill rod in the chuck just large enough to fit the holes in the die. Then, I will move the die until the drill rod enters it and then clamp the die to the table, raise the spindle, enter the blanking punches, resting the punch-plate on parallels, and substitute a drill for the piece of drill rod. Then I will drill the hole in the punch-plate and next shift the die to the following hole and so on. Do you follow me?"

"Yes, I follow you, but I'm a son-of-a-gun if I get you! How do you know that the center of the drill is in the same place as the center of the drill rod was? Those chucks run out something fierce."

"Ain't I just told you that I line up the chuck so that the drill rod just enters the die?"

"Yes, that is clear enough, but suppose you turn the chuck or the spindle one-half revolution; the drill rod will be pointing to one side of the hole. And when you drill down through the punch-plate, even though the punch-plate is perfectly parallel with the die, the drill is likely to run, even if the spindle happens to be at right angles to the table. When the drill breaks through the punch-plate, its center won't be directly over the center of the hole in the die. I don't see how it's possible for your round punches to line up with the die within a row of apple trees."

I knew by the expression on Al's face that he had followed me and saw the chance of errors in his method, but he is one of those fellows who won't admit he is wrong when it is clearly proved, especially if it happens to be a kid who is arguing. As is usual with a certain class when they recognize they have the wrong end of an argument, he instantly became abusive and attempted to silence me by offering to bet $10 that the punches would line up.

Ten dollars is quite a bet when it represents a week's pay, but Tom, who is an old toolmaker and who had been listening to the argument, slipped me a ten-spot and said: "Call his bluff kid." This brought Tom into the argument and Tom said, "The kid is right, Al. You have gone about the job backward. What you should have done was to bore your holes in the punch-plate at the time the die was bored and then make your round punches, leaving them a trifle longer than the blanking punches. Then you should have inserted your round punches in the punch-plate and fastened the blanks for the blanking punches to the plate, entering the round punches in the die far enough so that the blanking punches rested on the face of the die. Then the outline of the dies could be scribed on the face of the blanking punches. After milling the blanking punches to the scribed lines, the round punches should again be used as pilots to guide the blanking punches in the dies when shearing the punches. That is the easiest way and you will find it will do away with the practice of bending the punches or peening the punch-plate around the punches in order to crowd them this way or that and make them line up with the die."

Al replied that each man had his own way of making a die and added, "You probably have secured the best results with your way, while I have had the best results by mine."

Tom turned to his work, disgust plainly written on his face and indicated to me to get away from Al and let the matter drop. The next day, Tom sidled up to me and whispered, "Go over and ask Al what he is doing."

I looked over at Al, and sure enough he was busy pounding over the punches, then trying them in the die and then pounding them back a little. I tried to look unconcerned as I stepped to Al's bench, and after I stood watching the operation of punch bending a minute or two without either of us speaking, Al volunteered the information that the confounded parallels were "out."

What I cannot understand is why in the face of the arguments in favor of time-tried methods and the trouble that Al experienced, such men will start their next job exactly as they did the last. Tom says those fellows have missed their vocation; if they took an interest in their work, they would never make the same mistake twice, and furthermore, when a man is cut out for a toolmaker, he will instantly recognize the value of a principle and will quickly adopt a better way of doing any job at hand.

FORMING A WIRE IN THE AUTOMATIC SCREW MACHINE

BY E. WHITNEY

The threaded wire shown in Fig. 1 is finished completely in a No. 2 Brown & Sharpe automatic screw machine. As the automatic machining of this piece involves some unusual practice the writer will offer a few suggestions in regard to certain conditions which, for economical production, should either exist or be put into effect. First, the stock for work of this kind should be of soft metal and of small diameter, not to exceed ⅛ inch in any case. Second, the bend or part to be formed should be of a simple nature and not interfere with or supersede any regular screw machine operation. Third, the work should be placed on a heavy machine, such as the ⅞-inch Cleveland, or the No. 2 Brown & Sharpe. If the preceding suggestions are followed, work of this nature may be performed not only automatically but simultaneously with the other operations, and with but one setting of the machine. Although the screw machine production alone would be greater if the piece were made on a smaller machine, the combination of all operations will greatly reduce the total cost of machining the piece and justify the work being performed on the larger machine.

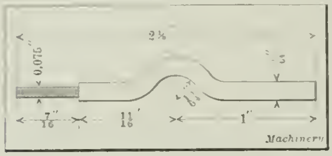


Fig. 1. Form and Dimensions of Work to be produced

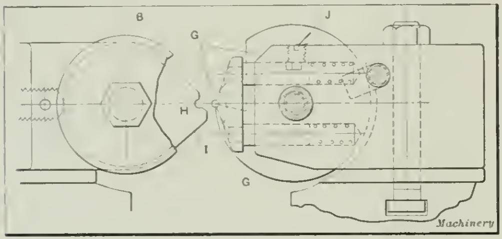


Fig. 2. Front View of Arrangement of Forming Tools on Cross-slide

The cam-shaft driving belt on the machine for handling this work should be somewhat heavier and tighter than usual, although it will be found by experimenting that the pressure required to form the wire does not equal that often used in heavy cutting with cross-slide tools. Fig. 2 shows a front view of the cross-slide tool arrangement, looking from the turret, and Fig. 3 shows a plan view. In Fig. 3, the forming tool is shown at *A* and the die at *B*; and in Fig. 2 the die is shown at *B*, the forming tool being omitted. These special tools are made circular in shape and the material is tool steel, hardened and ground, while the toolposts are made of machine steel, and casehardened; if desired, the forming tool, as well as the die, could be made a unit with the toolpost. The special tools are clamped in position in the same way as the circular cutting tools, except that they are mounted outside the toolposts, which are made up for this purpose and are heavier than usual. In Fig. 3 the extra clamp *C* is shown and also the jack screw *D* which backs up the die. The same bolt that carries the forming tool also clamps the circular cut-off tool. A turret support for the work is shown at *F*. Figs. 2 and 3 show the spring plunger *G* which holds the work securely against the carrier *H*. This carrier has a lower extension (shown at *I*, Fig. 2) which, together with the turret support *F*, carries the work after it has been separated from the bar. It should be noticed that the face of the spring plunger *G* has a circular cut to receive the lower extension *I* on the carrier, the retaining screw being shown at *J*.

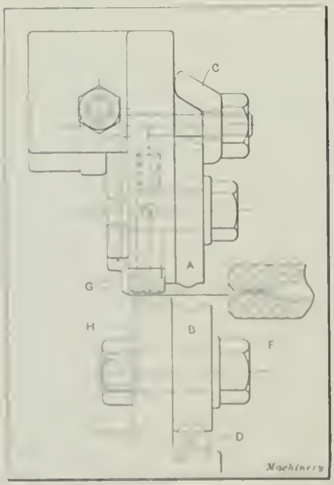


Fig. 3. Plan View of Arrangement of Cross-slide Tools shown in Fig. 2

To obtain the best results, the front and rear tools should be mounted on the same center as shown in Fig. 2. This does not affect the cut-off tool (which is usually mounted ¼ inch below center) because the diameter of the work is small. In operation, the piece is hollow-milled and threaded close to the chuck and then fed to the stop. The cut-off tool now operates, and at the same time the support *H* passes under the work and dwells there, and a little later the support *F* in the turret also supports the work, the hole in the support being chamfered for this purpose. Fig. 3 shows the support *F* as it advances; but when the wire is formed the support is in a forward position as close as clearance will allow. Just as the cut-off tool has separated the work from the bar, an additional forward movement compresses the springs which operate the plunger *G*, thus holding the work firmly against the carrier *H* so that when the bend occurs it is located 1 inch from the cutting-off end, all the draw being taken from the threaded end of the wire. Thus it is seen that the rear cross-slide has three distinct forward movements, *i. e.*, to cut off, clamp the work and form the bend. All the tools now withdraw simultaneously and the wire drops into the pan as usual. The order of operations is shown in the table and the arrangement of the turret tools in Fig. 4.

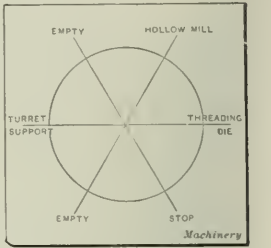


Fig. 4. Diagram showing Arrangement of Turret Tools

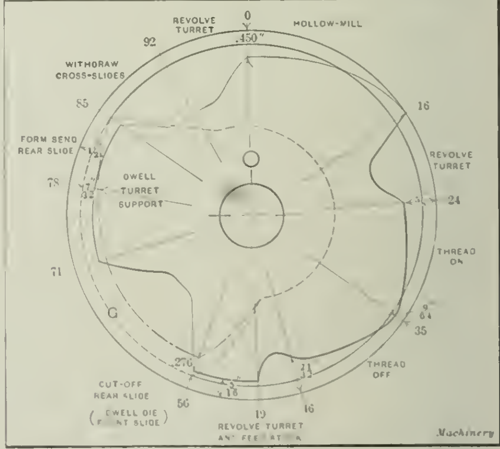


Fig. 5. Cams used on Machine for making Pieces shown in Fig. 1

The set of cams for this operation is shown in Fig. 5. The lead cam is illustrated by the full line, the front cross-slide cam by the dotted line, and the rear cross-slide cam by the dot and dash line. Attention should be called to the layout of the lead cam. It will be noted that, in this case, as the feeding of the stock follows directly after the revolving of the turret, 1 or 2 per cent of the cam surface is added to the usual amount given in the table. The front cross-slide cam from 56 to 85 on the cam circle is ground to be the same

TABLE GIVING ORDER OF OPERATIONS

	Revolutions at 1200 per Minute	Percentage of Cam Surface
Hollow mill 0.450 inch at 0.001 inch feed..	45	16
Revolve turret..........................	22	8
Thread on thirty threads................	31	11
Thread off..............................	31	11
Revolve turret and feed stock to stop......	28	10
Cut off 0.058 inch at 0.0009 inch feed......	62	22
Revolve turret twice while cutting off....	(42)	15
Form bend..............................	20	7
Withdraw cross-slides to clear...........	19	7
Revolve turret..........................	(20)	8
Revolve turret..........................	22	8
Total number of revolutions to make one piece..........................	280	100

Machinery

radial distance from the center and thus give a steady dwell for the die. The turret support *F* takes hold of the wire at 71 on the cam circle and the wire is formed from 78 to 85. The space from 85 to 92 provides clearance so that the hollow-mill does not strike the other tools when the turret is revolved.

In conclusion it should be mentioned that the heavy No. 2 Brown & Sharpe die-holder was not used for cutting these fine threads; the much smaller No. 00 die-holder was used and was carried in a ⅝-inch drill extension which had a 1-inch shank. In comparing the expense and efficiency of the tool equipment just described the reader should take into consideration that the special tools would cost little more than the regular equipment and also that the regular punch-press operation would require a special operator, whereas more than one automatic may be operated by one man. Besides, it is always an advantage to have the least number of machines in operation on a piece of work and also to have the work completed in one department without extra cleaning, counting, and trucking.

* * *

PERKINS AUTOMATIC SCREW MACHINE

The automatic screw machine shown in Fig. 1 was designed by J. E. Perkins for the Winsted Hardware Mfg. Co. of Winsted, Conn., and this concern keeps several of these machines running on its work. The machine is intended for doing work that can be performed complete in three operations, namely: drilling or end-working, forming with the cross-slide, and forming and cutting off with the rear slide. The machine is extremely simple in construction and operation, and for work within its scope its first cost and operation are extremely low. The operation is entirely automatic, after the stock has been started. Fig. 2 is a close-range view of the tools at the point of action. It should be understood that the machine is not highly refined in its design, as only a few were to be built.

The stock bar is fed through the hollow spindle, as is usual in screw machine operations, and the bar and spindle are rotated by means of a belt on the spindle pulley. The working functions of the machine are all derived from a cam-shaft *A* which runs longitudinally beneath the bed. This cam-shaft is operated by a driving wheel *B* located on a shaft *C* at right angles to this cam-shaft, motion being transmitted by means of a worm and worm-wheel *D*. From this cam-shaft are actuated the operations of the turret slide *E* with the end-working tool, the front forming slide *F*, the rear forming slide *G*, and the stock-feeding mechanism. The turret slide is operated from a cam drum *H* on the extreme right end of the cam-shaft, which in conjunction with the post *I*, projecting downward from the turret slide, operates the drill, counterbore or end-forming tool, as the case may be. The front forming slide and the rear forming slide are both operated from opposite sides of a plate cam *J* on the cam-shaft near the center. These tools may be adjusted by set-screws at the ends of the operating levers. It should be especially noticed that the two forming slides are operated independently of each other; that is, the front forming slide operates on the rear forming slide, but is in no way governed by its movement. This means that there is a minimum of idle movements, and the space on the cam is not wasted. This slide construction may be best seen by referring to Fig. 2. Here the front forming slide may be seen at *F* carrying the tool *L*, and the rear slide at *G* carrying the tool *M*. The front slide is dovetailed into the rear slide, but retains its independent action. Thus, the front slide can be advanced at the same time as the rear slide if desired, or in fact any combination of the two movements may be secured and at varying speeds.

The operation of the stock-feeding mechanism is effected from the left-hand end of the cam-shaft. Here is a cam-drum and cam-lever that operates a plunger shaft parallel to the main spindle, and by means of yokes from this shaft the chuck is opened, the stock advanced and the chuck closed, using the Brown & Sharpe type of collet, in which the chuck is closed by a taper sleeve being forced on the outside of the taper on the collet, thus insuring positive operation. The gripping fingers for feeding the stock are within the pulley that operates the spindle.

The machine will handle bar stock up to ½ inch diameter, and the production is at the rate of from six to eight pieces per minute according to the nature of the work.

C. L. L.

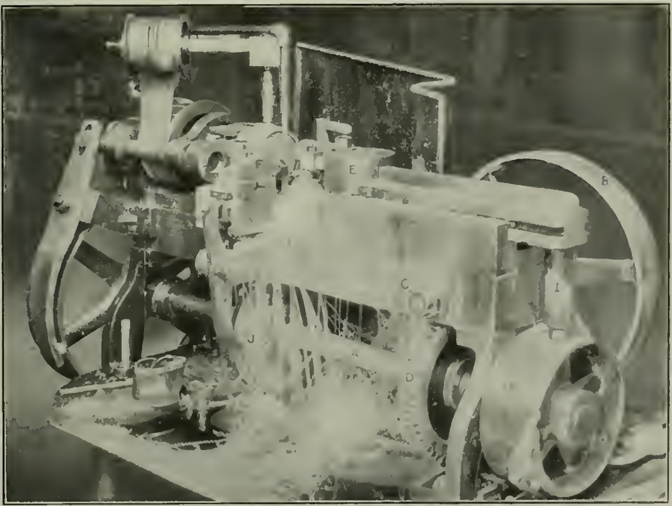


Fig. 1. Screw Machine built for Work requiring no Turret Indexing

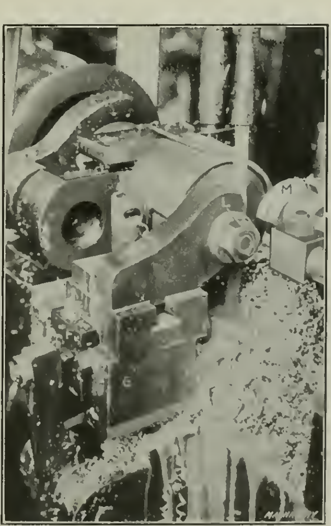
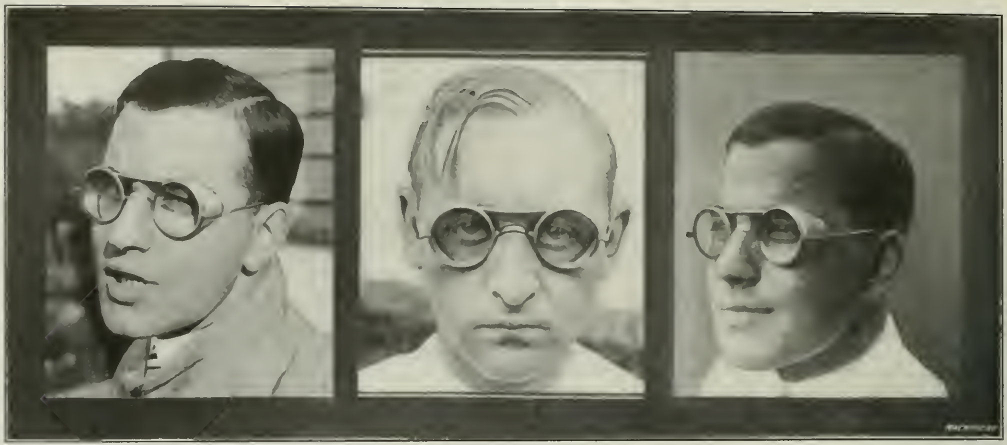


Fig. 2. Close Range View of Cutting Tools



Note Complete Protection afforded the Eyes and Orbits from the Front and Sides, also the Wide Unobstructed Vision

PROPER EYE PROTECTION

BY W. B. MC KIBBIN*

The inadequate protection or absolute non-protection of the eyes of grinding machine operators, blacksmiths, machinists, and the ladle men and chippers in foundries, is a form of criminal negligence that is entirely inexcusable. Authentic statistics are not obtainable but information from reliable sources shows that many thousands of avoidable eye accidents occur every year. The workman in many cases is as much to blame as his employer, or more, because he is willing to take a chance rather than insist upon having proper eye safeguards, which the employer would not dare to refuse him even if he wanted to.

Many workmen do not seem to realize that the full responsibility for the maintenance of their families rests directly upon their own shoulders. Such men are even unnecessarily careless at times and will risk antagonizing their employers by failing to use eye protectors that are provided for them. It is true that the wearing of special eye protectors is compulsory in some shops, but considering the numerous "Safety First" crusades, and the various "Employers Liability" and "Workmen's Compensation" laws, it is amazing how many thousands of workmen risk their eyesight every day when they could so easily secure the proper protection.

Infection

In the plants of one steel company, 250 men lost their eyes in one year by permitting fellow workmen to remove foreign substances from them. In some cases, the particle actually penetrates the coat of the eye-ball, and unless it is properly removed—especially if it is a particle of metal—the sight of both eyes is in danger through sympathetic inflammation, which is likely to cause permanent blindness. Sometimes infection results, causing dangerous ulcers which partially or wholly destroy the eyesight, and at times the entire eyeball. In this connection it should be mentioned that where more than one man uses the same eye-protectors, the danger of infection is serious.

Dangerous Workmen

A workman with defective eyesight or one using unsuitable goggles which impair his vision, is not only a menace to himself but to his fellow workmen, as a slight miscalculation on his part may affect the management of the machinery to such an extent that a serious accident may happen to him or to those working in his vicinity. The vision is often affected so slowly that the person is not aware of the fact until his eyesight is seriously impaired. This is particularly true in the case of operators of dry grinding machines. In operating such machines, small particles of metal become lodged in the cornea, and upon examination with a magnifying glass numerous scars will be found which dull the cornea and are very apt to seriously diminish the power of vision.

Improper Eye Protectors

The use of improper eye protectors is probably worse than no protection at all, for in the event of an accident which results in breaking the glass, an injury suffered by the workman is likely to be increased rather than prevented through the so-called protectors. Eye protectors provided with glasses which are off color are likely to weaken the eyes of the wearer and should not be used. Glass combined with celluloid or gellatin is never clear and imperfections in the glass cannot be eliminated. As a result, distant objects seen through such goggles are distorted, and for this reason they should never be used. The use of goggles covered with wire gauze is also undesirable as it shuts out from 15 to 35 per cent of the illumination. If the mesh is woven from dark colored wire, the light is absorbed while a bright wire causes distracting reflections. Mica is very unsatisfactory for goggles, as it is not clear, it scratches easily and becomes opaque when bruised. Celluloid has the same faults as mica with the added objection that it is dangerous, owing to its low ignition point and its highly combustible character.

Practical Eye Protectors

Clear vision and the benefit of all the illumination provided in the shop is an absolute essential of an efficient eye protector. The lenses should be large and have the highest possible transparency; they should be absolutely clear and colorless. The lenses should be free from "waves"; perfectly ground on both sides and made of a tough, strong and perfectly annealed glass that is thick enough to withstand a heavy blow. At the same time, the frames should be so designed that if the glass is broken, the pieces will be held in the frame. If the wearer needs glasses to bring his vision up to normal efficiency, the lenses of the eye protector should be ground to comply with the oculist's prescription.

The protector should also be provided with substantial screens to shield the sides of the eyes. Another important point is to have the frames made of a non-rusting, non-tarnishing metal without any leather, velvet or similar material in the construction. When such materials are used, sterilizing cannot be easily done, and sterilizing is an absolute necessity if the same eye protectors have to be used by more than one man. In one factory, the use of proper eye protectors reduced the eye injuries from 6.5 per cent of the men employed in the year 1910 when protectors were not used, to 1.6 per cent of the men similarly employed in the year 1912 when eye protectors were in general use. These figures show a decrease in eye accidents of 75 per cent, and present an undeniable argument in favor of the universal use of effective eye protectors.

* * *

It is predicted by Dr. C. P. Steinmetz of the General Electric Co. that within ten years there will be one million moderate priced electric vehicles in operation. These cars will be sold at a cost not exceeding $500 to average a speed of 20 miles per hour.

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* Address: Laurelton, Long Island, N. Y.

CARE AND USE OF HOISTING ACCESSORIES*

WIRE ROPE, MANILA ROPE, HOOKS, CHAINS, ACCESSORIES, LUBRICATION OF WIRE ROPE, STRENGTH OF SLINGS

RELIABILITY is a requisite in the use of chain slings, rope slings and other hoisting accessories employed for attaching loads to cranes and hoists. Chain slings are in common use. They are flexible and lend themselves readily to most of the hitching operations met with in industrial work. Care must be taken, however, in the use of these slings, inasmuch as frequent strains slowly weaken the chain by crystallization, a condition which, though serious, is not readily visible. Weakness caused by surface wear or the slight opening of a single link is also likely to escape notice. Breakage of single links occurs often in cheap chains made of common iron or steel, insecurely welded; a flaw in any one link may drop the load. It is therefore obvious that a cheap common chain is entirely unsuited to overhead transportation of materials. Only the very best hand-made and tested wrought-iron chain should be used for this purpose. The extra cost is negligible when compared with the liability of accident through breakage.

Wire Rope

There is a growing tendency to use wire rope for slings. Undue wear is promptly shown by broken or worn wires on the surface, which gives warning that the rope is in an unsafe condition. A wire rope sling is also stronger than a chain sling of equal size and weight. Wire rope, however, should be of the best material. Crucible steel wire rope has greater strength than iron wire rope; plow steel rope is still stronger. By substituting the better grades of steel rope, much smaller, lighter, and more easily handled slings can be employed. Wire rope for general service is usually composed of six strands of wires wound about a hemp core to make the rope pliable and to provide a cushion to reduce internal friction of the wires. When used in proximity to heat, however, as when handling molten metal, wire rope slings provided with a soft iron core, even though the slings are less flexible, should be used. In such service a hemp center may be destroyed and the rope deformed.

Spliced ends are more dependable than clamped ends. Load strains which stretch the rope slightly reduce its diameter to a certain extent, and the ends are likely to slip through the clamps. Splices should always be made by experts. Small plants may not be properly equipped for splicing wire rope, in which case it is desirable to have this work done at wire rope factories, where it can be done well, and at small cost. It is often advisable to wrap the splice closely with soft wire, not to increase its strength, but to protect the hands of the workmen from protruding wire ends. Instead of splicing the ends, forged steel sockets with hooks, eyes or other fittings are frequently secured to the rope by spreading the wires in the socket and pouring zinc into it, between and around the wires. Sockets should also be attached by experts to insure secure connections. Wire rope manufacturers are equipped with special facilities for doing this work economically.

Manila Rope

Manila rope slings are desirable to wrap the load snugly or to avoid marring it. Manila rope, however, is much weaker than wire rope, wears easily, and cannot be utilized where it would be exposed to flame or to charring temperatures. It weakens if allowed to remain wet, and should therefore be promptly dried. Although the strands are easily cut if the rope is used for handling sharp-cornered loads, the frayed condition of the rope gives prompt warning of undue wear and weakness. If manila rope slings are to be employed, it will pay to buy the best long-fibered rope obtainable. The splices must be carefully made. Manila rope should never be looped with wire rope, as the smaller wire rope will cut through the strands of the soft manila rope.

Accessories

Hooks, eyebolts, clamping devices and similar parts attached to slings deserve equal attention in respect to their safety. Forged hooks of approved design and material can readily be purchased from reliable manufacturers who specialize on this class of work. This is also true in regard to rings for slings, eyebolts, turnbuckles, shackles and other important hoisting accessories. If cast steel hooks are used they should be well annealed and of larger proportions; but in any case, cast steel hooks are not so dependable as forged hooks. For severe service, hooks made of laminated steel plate, securely riveted, have proved satisfactory. Chain hooks and similar parts should bend slowly if overloaded, and thus give warning of their unsafe condition. They should therefore be well annealed, and never tempered or hardened. A brittle part will snap outright and drop the load.

It is clear that hoisting appliances should be suitably designed and well made, but it is fully as important that their use be carefully and intelligently supervised and their original strength maintained. There is evidently not so much danger when handling unusually heavy loads, for such operations are, as a rule, under the care of the most capable men, who anticipate the extra risk by careful preparation. Hoisting accidents more frequently occur when ordinary loads are being handled by ordinary men, and when the usual facilities are either too light, wrongly employed, or weakened by wear or use.

Information Relating to Strength of Hoisting Appliances

It is of first importance that men using hoisting accessories should know the strength of them. It is not sufficient to know the size, unless the grade is also known. While 1500 pounds may be a safe load for a single sling made of 3/8-inch *plow steel* wire rope, such a load would be excessive for an *iron* wire rope sling of the same diameter. This wide range of strength also occurs in different grades of chains and other accessories, but the difference is not readily apparent. It is therefore dangerous to provide several grades of slings and hooks in the same shop. Furthermore, a new workman, fresh from a shop in which only the strongest slings and hooks are employed, is likely to assume that the appliances in the new shop are equally strong. The safety of workmen therefore requires that all slings of equal size should be of equal strength, and of *maximum* strength, and that other details are proportionately strong.

While workmen who are accustomed to the use of slings acquire, by long experience, a valuable knowledge of the strength of chains and ropes under varying conditions, this should not be left to guess-work. It is advisable to post in conspicuous places in the shop, especially at the chain racks, and, where possible, at the point of operation of each crane, a chart showing the loads which can be safely supported by slings of various sizes, whether used normally or in a manner that decreases their lifting capacity. From a study of satisfactory crane practice in various large plants, a chart of safe loads has been compiled, which is published herewith. The loads recommended in this chart are more conservative than those usually specified, because it is intended to recognize the possible existence of slight, unobserved weaknesses in slings and the liability of excessive strains which may be applied to slings through misjudgment or accident.

It will be noted that the safe loads shown upon this chart are based upon the use of 6 by 19 or 6 by 37 plow steel wire rope; the best grade of wrought-iron, hand-made chain; and four strand long fiber manila rope. Here again the advantage of standardizing the grades of materials used for hoisting purposes is apparent; otherwise the chart would be misleading. The chart is based on the supposition that the original strength of hoisting appliances is practically maintained. The extraordinary hazards of overhead transportation of materials demand this. Hence it is becoming more and more the practice to follow a plan that provides for regular inspection and care of all hoisting accessories in the plant, to guard against deterioration.

Inspection

First of all, each sling should be stamped or tagged with an identification number that tallies with an office list, which should describe the slings and state their grade, size, date of purchase, and other useful information. At regular intervals, the person delegated to inspect slings should locate each one, inspect its condition, lay defective ones aside for repairs or for the scrap heap, and note upon his list a short report of his findings. The frequency of inspection must be governed by frequency of use. In shops where slings are seldom used, monthly inspection may be adequate, but it is more usual to inspect all hoisting accessories once a week. It is important, too, that the inspection work should be regularly done, at stated intervals, else it may drift into a condition of neglect. Such inspections require only a short time, but they bring to light dangerous weakening of the strands of manila and wire ropes, worn or broken links in chains, and similar injuries to hooks, rings, eyebolts and other parts.

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* From Bulletin No. 13 of the National Founders' Association Committee on Safety and Sanitation.

TABLE OF SAFE LOADS IN POUNDS FOR ROPES AND CHAINS

Prepared by National Founders' Association. When handling molten metal, wire ropes and chains should be 25 per cent stronger than indicated in table below.

NOTE. The safe loads in table are for each *single* rope or chain. When used double or in other multiples the loads may be increased proportionately.			When used Straight	When used at 60-degree Angle	When used at 45-degree Angle	When used at 30-degree Angle
	Diameter of Rope Inch					
PLOW STEEL WIRE ROPE (6 strands of 19 or 37 wires) If crucible steel rope is used reduce loads one-fifth.	⅜		1,500	1,275	1,050	750
	½		2,400	2,050	1,700	1,200
	⅝		4,000	3,400	2,800	2,000
	¾		6,000	5,100	4,200	3,000
	⅞		8,000	6,800	5,600	4,000
	1		10,000	8,500	7,000	5,000
	1⅛		13,000	11,000	9,000	6,500
	1¼		16,000	13,500	11,000	8,000
	1⅜		19,000	16,000	13,000	9,500
	1½		22,000	19,000	16,000	11,000
	Diameter of Iron Inch					
CRANE CHAIN (Best Grade of Wrought Iron, Hand-made, Tested, Short Link Chain.)	¼		600	500	425	300
	⅜		1,200	1,025	850	600
	½		2,400	2,050	1,700	1,200
	⅝		4,000	3,400	2,800	2,000
	¾		5,500	4,700	3,900	2,750
	⅞		7,500	6,400	5,200	3,700
	1		9,500	8,000	6,600	4,700
	1⅛		12,000	10,200	8,400	6,000
	1¼		15,000	12,750	10,500	7,500
	1⅜		22,000	19,000	16,000	11,000
	Diameter of Rope Inches	Circum. of Rope Inches				
MANILA ROPE (Best Long Fiber Grade.)	⅜	1	120	100	85	60
	½	1½	250	210	175	125
	⅝	2	360	300	250	180
	¾	2¼	520	440	360	260
	⅞	2¾	620	520	420	300
	1	3	750	625	525	375
	1⅛	3½	1,000	850	700	500
	1¼	3¾	1,200	1,025	850	600
	1½	4½	1,600	1,350	1,100	800
	1¾	5½	2,100	1,800	1,500	1,050
	2	6	2,800	2,400	2,000	1,400
	2½	7½	4,000	3,400	2,800	2,000
	3	9	6,000	5,100	4,200	3,000

Machinery

Annealing Chains and Hooks

When crane chains, hooks and similar parts are weakened by crystallization, their original strength can be practically restored by giving them a heat-treatment usually termed annealing. As a crystallized condition, however, is not readily apparent, the only reliable way to maintain their strength is to treat such parts frequently enough to forestall the risk of hidden weakness. Slings and hooks that are frequently used may require such treatment every two months; in rare cases one treatment per year is sufficient. It is the usual practice to heat these accessories to a temperature of about 525 degrees C. (980 degrees F.), dull red, or about the temperature of an open wood fire, and cool them in the ashes or in the open air. Actual annealing is not accomplished at this temperature, neither is it the purpose to anneal the parts, but rather to heat them sufficiently to remove structural strains without softening the metal. An unduly slow process of cooling tends to make the metal too soft to insure good wearing surfaces.

Lubrication of Wire Ropes

Wire rope suffers from rust, stiffness, and from excessive friction of the wires, internally and externally, if not properly and regularly lubricated. The lubricating agent should be of such a nature that it will penetrate through the rope, as well as cling to its outside surface. This is especially important on ropes exposed to moisture. A mixture of petrolatum, graphite, and crude oil has proved useful. The right lubricant can also be secured from wire rope manufacturers or their agents.

General Safeguards

Defective hoisting accessories, if allowed to remain in the shop, are likely to be used by mistake for perfect ones, with serious results. Such parts should immediately be removed from the shop; if permanently discarded, they should be so damaged as to prevent workmen from using them by mistake. It is advisable to provide extra sets of slings and other accessories; otherwise there may be considerable hesitation in sending out much needed parts for repairs until they become too weak and cause injury to workmen or material.

Workmen sometimes strike heavy blows upon hooks or chains to force them into position on the load. Workmen should be carefully cautioned against such practice. It is also common to insert nails and slivers between the links in multipart slings to equalize the length of each part; cast-iron pieces should never be used for this purpose, as they will break when the load is applied, and cause a sudden jar which may break or injure the chain.

It is important to avoid kinks in slings. Kinks permanently injure a rope sling by acutely bending the wires. Kinks in a chain sling often straighten out suddenly when the load is applied, and an excessive stress is imparted to the sling and the chain is broken.

Employes and supervisors, by following these suggestions, will make hoisting operations quite safe; yet remember: Personal caution is the greatest safeguard, after all.

* * *

GERMAN PATENTS IN GREAT BRITAIN

The confusion into which the war has thrown the patent system in Great Britain is being cleared up by the working of an act of Parliament which extends power to the Board of Trade to suspend any patent, license or registered trademark granted to any subject of a state at war with Great Britain. Permission to manufacture such articles is granted upon application, and upon the payment of a fee fixed by the Board of Trade, after a hearing at the patent office. This fee or royalty is devoted to a fund, the disposition of which depends upon the treatment British holders of patents will receive in hostile countries.

Taking into consideration both patents and trademarks, Germany and England are about on an equal footing in this matter, there being about as many German holders of patents and trademarks in England as there are British holders in Germany. The patent office in London has, at the present time, as many applications for suspensions of German patents as its machinery for fixing royalties can take care of.

* * *

Bulletin 66 recently issued by the Bureau of Railway Economics, Washington, D. C., gives some valuable statistics of railways for the years 1900-1912, inclusive. The statistics show the increase of railway mileage, equipment and number of employes and the rising rates of wages and other operating expenses. In 1900, the total number of machinists employed on the railways of the United States was 32,831; the number of carpenters was 46,666; and other shop men, 114,773. In 1912, the figures were 57,507, 70,817 and 249,429 for the respective classes. In 1900, the average daily wage paid to machinists was $2.30; carpenters, $2.04 and other shop men, $1.73. In 1912 the rates had risen to $3.20 for machinists, $2.55 for carpenters and $2.24 for other shop men.

TOOLS FOR MAKING A DOUBLE-PRONGED RIVET

To make double-pronged rivets such as shown in Fig. 1 automatically in a punch-press at the rate of over one hundred per minute without requiring the attention of an operator is a job that requires an exceptionally good set of press tools. The rivet is made from German silver wire 0.060 inch diameter. The prongs are each one-eighth inch long and it will be noticed that the bridge that connects them is upset or flattened out, but the prongs are left round. The line illustration Fig. 1 shows the steps taken in producing the rivet; this is represented four times actual size. First, the blank is cut off ⅜ inch long, then it is bent U-shaped, and finally, with the prongs confined, the bridge is flattened and the piece ejected. While these operations might be performed upon a four-slide wire forming machine, it is doubtful if, in so doing, any advantage would be secured over the method of press-working illustrated below.

Figs. 2 and 3 show the tools in action in a small press; Fig. 2 illustrates the tools from the front and right, and Fig. 3 shows them from the front and left. Moreover, in Fig. 2 the punch is in the upper position, while in Fig. 3 the punch is nearing the downward end of its stroke, illustrating another phase of the operations. In connection with the line illustration Fig. 4, the operation of the tools may be followed.

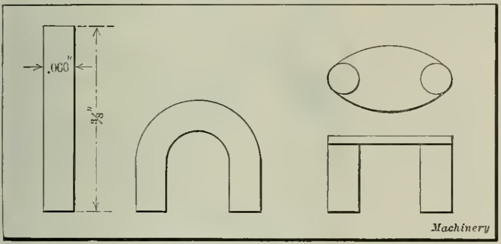

Fig. 1. Double-pronged Rivet enlarged Four Times

The wire enters the tools from the front through a bushing-block *A* whose purpose it is to free the wire of kinks and leave it relatively straight for the feed rolls *B*. These feed rolls are kept in spring tension and are geared together and operated from an eccentric *C* and rod *D*, actuated from the crankshaft of the press. The movement of the rod is permanently set to give the feed the exact amount of wire that is required. After the wire enters the tools, the operations are cutting off, carrying over, flattening and ejecting.

The cutting off is accomplished by a shear blade located on lever *E* that is fulcrumed on stud *F*. This lever is pulled up by bar *G* that is attached to the ram of the press. As the wire passes through a cut-off bushing (see Fig. 4) it is confined while the shear comes up against it and severs it. An aligning block *X*, on lever *E*, acts as a back-stop for the cutting-off bushing while the work is being sheared. Immediately ahead of the cutting-off shear comes the bending tool that forms the wire by forcing it up through the die. These tools are concealed in Figs. 2 and 3, but may be seen in Fig. 4. Continued raising of lever *E* causes the bending tool to raise the wire above the die and force it between two spring fingers whose back ends are shown at *H* and *I* in Fig. 2. Here also the loop of wire shows at *J*. The fingers are kept at the right tension by spring *K*.

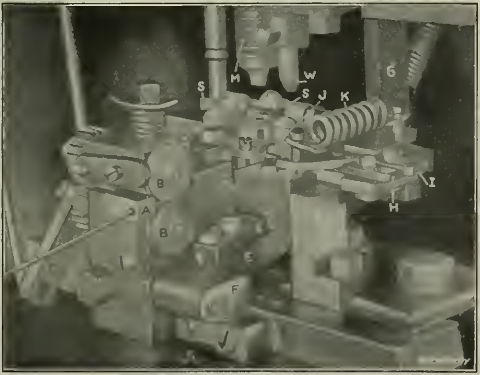

Fig. 2. Tools viewed from Front and Right

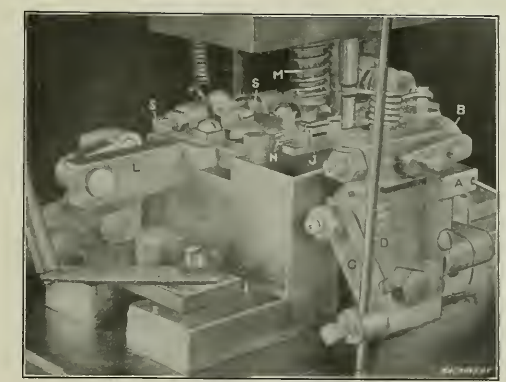

Fig. 3. Tools viewed from Front and Left

The mechanism of which these spring fingers are a part is for transferring the wire loop to the die where the bridge is flattened. This mechanism is mounted on a slide that can best be seen in Fig. 3 at *L* in the rear of the die. Through a set of toggles worked from the left end of the crankshaft, the slide is reciprocated and the work is thus transferred to the heading position. It is essential that the travel of the transfer slide be within close limits and these limits are arbitrarily determined by adjusting set-screws *S* which act as stops.

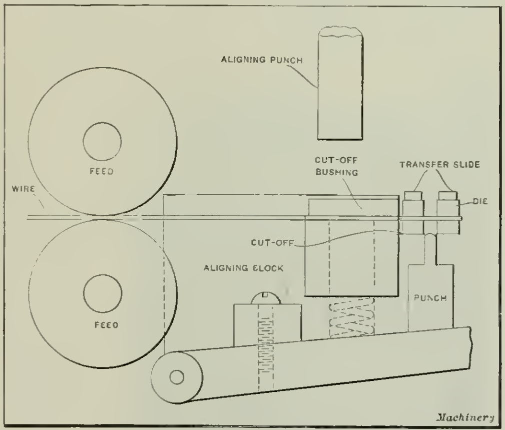

Fig. 4. Diagram illustrating Operation of Tools

The heading punch is made in two parts, kept separated by a spiral spring *M* and thus permits the descending punch to push the prongs into the holes in the die before the heading takes place. As soon as the tip of the punch "bottoms" on the base, the bridge of the rivet is flattened. A wedge on the punch *W* separates the spring fingers *H* and *I* after the rivet has reached the heading position. This gives the flattening punch room to work.

The rivet is now completed except for ejection. This is accomplished by a knock-out plate operated also from the crankshaft. Two pins on the knock-out work upward through the two holes in the flattening die and push out the rivet. As soon as it is clear of the die, a spring wire finger *N* "kicks" the rivet to one side.

These tools were made by J. H. Pilkington, manufacturer of wire and sheet metal work, of Waterbury, Conn., through whose courtesy the photographs and description are reproduced.

C. L. L.

MAKING AERO MOTOR PISTONS*

TOOL EQUIPMENT USED ON CLEVELAND AUTOMATICS FOR COMPLETELY MACHINING GNOME AERO MOTOR PISTONS

BY DOUGLAS T. HAMILTON†

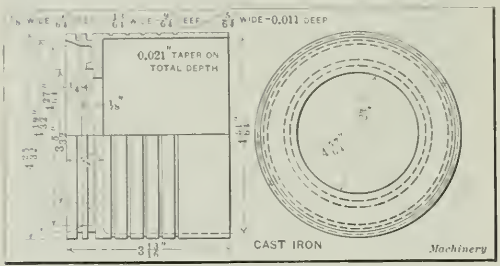

Fig. 1. Piston used in the Gnome Aero Motor which is machined complete on a Cleveland 2¼-inch Semi-automatic Machine

THE pistons used in an aero motor are made from iron castings, and as they must be very light, the walls are made extremely thin. The particular piston used in the Gnome aero motor is shown in Fig. 1 and it will be seen that the wall at the minimum thickness is only 0.0625 inch thick. The interior diameter of the piston is turned taper about 0.010 inch to the inch, which makes machining still more difficult, but this piston is finished complete in three operations, the first series being illustrated in Fig. 2 and the set-up for the second series in Fig. 3.

Tooling Equipment for the First Series of Operations

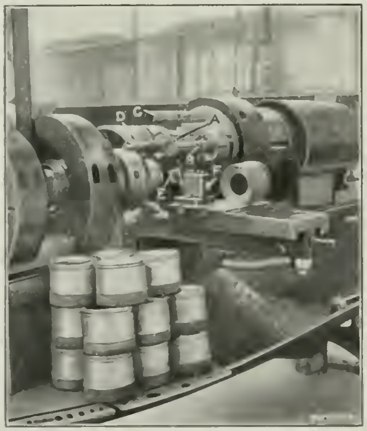

Fig. 2. Set-up on the Cleveland Automatic for performing the First Series of Machining Operations on the Gnome Aero Motor Piston

The machining operations on the aero motor piston are accomplished in a Cleveland 2¼-inch semi-automatic machine equipped with double cross-slides, which, for the first series of operations, is fitted up with a special three-jaw chuck. Fig. 4 shows how the work is held for the first series of operations and also illustrates the first two tools which are held in the turret at work. The first tool to come into operation is a rough-turning tool A, which is an overhanging tool and carries two cutters *a* and *b*. Cutter *a* rough-turns the external diameter and tool *b* reduces the end of the work for the next roughing cut. While these tools are at work, another tool-holder *B* held in the turret brings boring, facing and chamfering tools *c*, *d* and *e* into action. Tool *c* rough-bores the smallest internal diameter, tool *d* roughs out a small seat in the head of the piston and tool *e* rough-recesses and faces the head of the piston.

Upon the completion of these operations, the turret is indexed and boring tool *C* comes into action; this carries two tools *f* and *g*, which take rough- and finish-boring cuts from the smallest internal diameter of the piston. The leaders of rough-boring tools *B* and *C* are guided by a bushing *h* fitted into the nose of the spindle.

The turret is again indexed, and finish-recessing and chamfering tool-holder *D*, shown in Fig. 5, comes into action. This holder carries a tool *i* which finish-recesses the head of the piston casting, and is guided by the bushing *h* in the nose of the spindle. While tool *i* is at work, the other cutter *a* held in the tool *A* shown in Fig. 4, takes a second roughing cut from the outside diameter. The turret is again indexed, and reamer *k* comes into action. This reamer is held in the floating holder *E* as illustrated in Fig. 5, and finishes the smallest internal diameter to the correct size. While the reamer is at work, the roughing piston-ring grooving tools *l* held in holder *F* on the front cross-slide are also in action, roughing out the two piston-ring grooves in the head of the piston casting. This finishes the first series of operations on the piston.

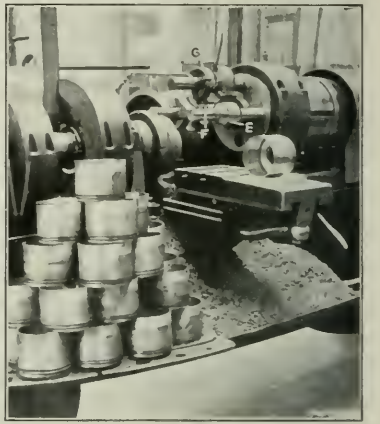

Fig. 3. Set-up for the Second Series of Operations on the Cleveland Automatic

Tooling Equipment for the Second Series of Operations

The machine is shown tooled up for the second series of operations in Fig. 3. For these operations a special work-holding chuck, as shown in Fig. 6, is used. This chuck comprises a special nose *A* screwed onto the nose of the work-spindle. Carried on this nose and free to slide on it, but prevented from turning by a set-screw, is a cap *B* which is acted upon by a nut *C*, the latter being threaded to the nose *A* and the cap *B*. The work is held in a special tapered chuck, comprising six segments, taper-turned on their external diameter, and located in their correct relative positions by pins that are held together by a flat spring retainer not shown. The action of this tapered chuck is to come down evenly on the work when the cap *B* is drawn in by collar nut *C*.

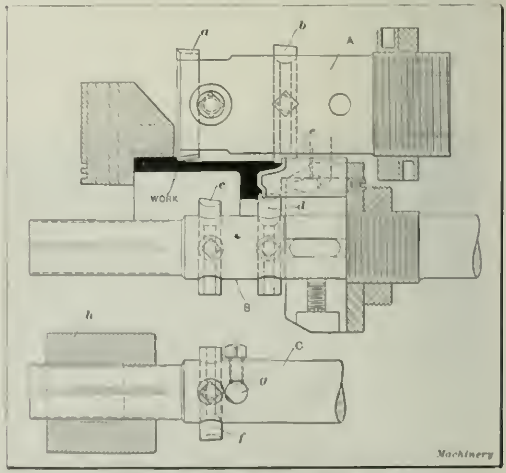

Fig. 4. Diagram showing Rough Turning, Boring, Facing and Counterboring Tools used for performing First Series of Operations

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* For articles on screw machine work previously published, see MACHINERY, November, 1914, "Examples of Screw Machine Set-ups," and articles there referred to.

† Associate Editor of MACHINERY.

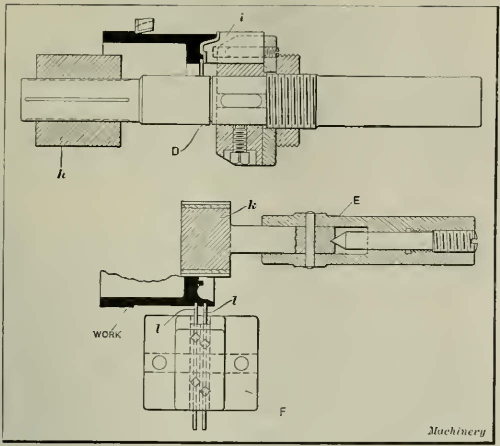

Fig. 5. Diagram showing Finish Counterboring and Facing, Finish Reaming and Rough Piston Groove Turning Tools held in the Turret and on the Cross-slide for the First Series of Operations

The first cut in the second series of operations is performed by tool-holder *E* (Fig. 6) held in the turret and carrying a single cutting tool *a*, which takes a rough-boring cut from the internal diameter. The tool-holder is provided with a pilot which fits in the bushing *b* in the nose of the spindle. This bushing serves the additional function of locating the work from the previously reamed hole in the piston. At the same time that the rough-boring tool *a* is working, an overhanging attachment *F*, screwed into the central shaft hole in the turret, carries a cutting tool *c* that finishes roughing the external diameter that was held in the chuck in the first operation. After these tools have completed their cuts, the turret is again indexed, bringing the combination rough-bottoming and end-facing tool-holder *G*, shown in the upper part of Fig. 7 into operation. This tool-holder which is held in the turret carries two cutter-heads *d* and *e*. Cutter-head *d* carries a rough-bottoming cutter *f* which is serrated on its face to break up the chips and reduce the cutting pressure. The end of the casting is faced by means of a cutter *g* held in head *e*.

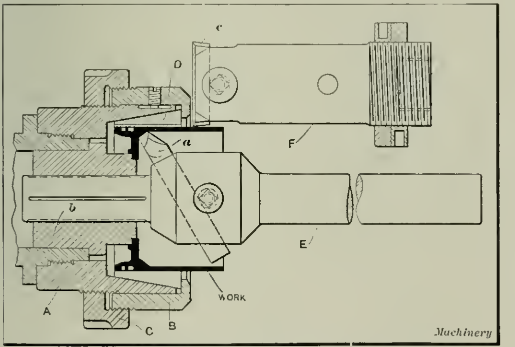

Fig. 6. Diagram showing Rough Turning Tool and Rough Boring Tool for the First Series of Operations in the Second-operation Set-up. This View also shows an Interesting Type of Chuck used for holding the Work

Upon the completion of the rough-bottoming and end-facing operations the turret is again indexed and the finish-bottoming and end-facing tool-holder *H* comes into operation. This tool-holder also carries two cutter-heads *h* and *i* holding cutters *j* and *k*. Cutter *j* is a finish-bottom facing tool and is held in the head *h* by means of a tapered wedge as illustrated. Cutter *k* is a finish end-facing tool and is also held in place by a tapered wedge. While these two cutters are at work, a cutter held in the overhanging attachment shown in Fig. 6 takes a final cut from the external diameter of the piston—finishing that portion of the piston that was held in the chuck in the first operation. The size of the outside diameter after the second-operation turning tools have done their work is 4.9607 inches; the inside diameter after the first roughing cut is 4.7245 inches; and the inside diameter after the second cut is 4.7639 inches.

Tooling Equipment for the Third Series of Operations

For the third series of operations, the machine is equipped with an entirely different type of work-holding device, as shown in Fig. 8. This comprises a hood *A* which is screwed onto the nose of the spindle, and which is bored out to fit a clamping rod *B*. The clamping rod goes completely through the work-spindle and has on its rear end a handwheel *C* which is used for clamping the work. In order to hold the work tight and rigid, an interesting clamping nut is used which forms a sort of differential screw. The external diameter of the hub of the handwheel *C* is threaded with a fine pitch thread which fits in a similarly shaped thread in the special nut *D*. The clamping bolt *B* is provided with a coarser pitch thread, and is made to travel with the nut *D* by means of a key, so that in tightening up the work both the threads on the clamping bolt and the thread in the nut *D* work in unison, and comparatively slight twisting action on the handwheel holds the work extremely rigid.

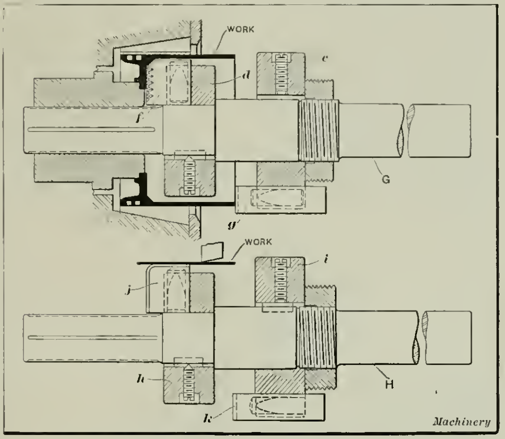

Fig. 7. Diagram showing the Rough Facing and Finish Facing Tools held in the Turret for bottoming and facing the End of the Piston

The clamping nut *D* is prevented from turning in the spindle by means of a set-screw as illustrated. The front end or head of the clamping bolt is "slabbed" and the clamping washer *E* is provided with a slot to facilitate the re-

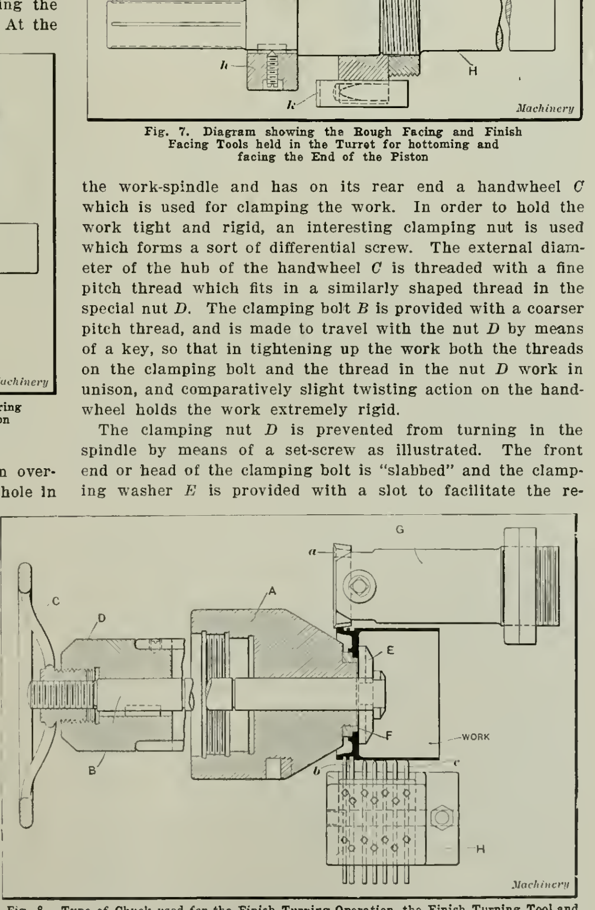

Fig. 8. Type of Chuck used for the Finish Turning Operation, the Finish Turning Tool and the Finish Piston Ring and Oil Grooving Tools, the Latter being held on the Cross-slide

moval of the work. The work is held on a machine steel seat *F*, fitted to the nose of hood *A* which fits into the two previously reamed and bored internal diameters of the piston.

The first operation is to finish-turn the external diameter to the required dimension—4$\frac{3}{4}$ inches, which is done with an overhanging turning attachment *G*, Fig. 8, held in the same manner as holder *F*, Fig. 6, and carrying a single point cutting tool *a*. While this tool is working, a gang of tools held in holder *H* is brought in from the front cross-slide. These tools comprise two finishing tools *b* for the piston ring grooves, and five tools *c* for cutting the oil grooves in the external diameter of the piston. Upon the completion of these operations, the turret is indexed and the final cut is taken from the internal diameter.

The taper-turning attachment is illustrated separately in Fig. 9, and comprises a tool-holder *A* and a cross-slide guide holder *B* fastened to the rear cross-slide. The taper-turning tool acts in the following manner: As the turret advances carrying the taper-turning tool-holder *A*, the rear cross-slide also advances to the required point and then remains stationary while the turret continues in its forward movement. Upon the advance of the turret, pin *a* comes in contact with the guide *b*. This has the action of forcing in the tool-holder *c*, which is held outward against the stop-pin *d* by means of a coil spring *e*. This spring, of course, has a constant action and keeps the pin *a* always in contact with the guide *b*.

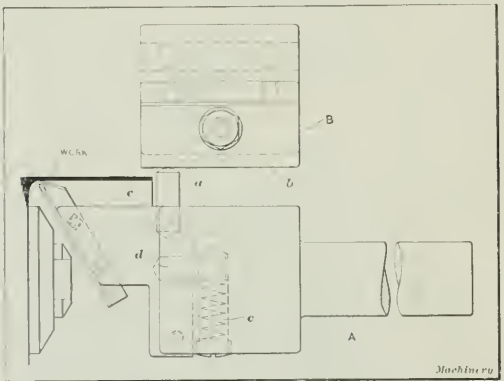

Fig. 9. Taper Boring Tool which is held in the Turret and operated from the Cross-slide for machining the Inside of the Piston. This is accomplished in the Third Operation. The Tools in Figs. 8 and 9 operate simultaneously

The tool-holder *c* slides in a dovetailed groove in the front face of the main body of the holder and is provided with an adjustable gib to take care of any slack or wear in the slide. The taper turning of the inside diameter completes the series of operations on the Gnome aero motor piston, and produces it complete at the rate of seventeen pistons per day of ten hours, the machining time being thirty-five minutes.

* * *

An interesting itemized statement of the cost of operating taxicabs in Stockholm, Sweden, is given in *Teknisk Tidskrift*. While some of the items will differ in this country on account of the lower cost of gasoline and the higher cost of wages here, the information is of considerable value. It is assumed that the cab is in actual use for three hundred and ten days and that it covers a hundred miles a day.

Gasoline........2450 gallons at 26 cents per gallon,	$637.00
Tires	540.00
Wages	800.00
Garage	100.00
Repairs	230.00
Insurance	80.00
Taxes and Miscellaneous Expenses	27.00
Interest and Sinking Fund, 23.6 per cent on the original investment of $2850	672.60
Six per cent additional interest on investment for general expenses	171.00
	$3257.60

This gives the cost of operating a taxicab, including overhead charges, as equal to 10.5 cents per mile.

ADJUSTABLE AND MULTI-CUTTING TURNING TOOLS

BY FRANK H. MAYOH*

By way of comment on the article "Adjustable and Multi-cutting Turning Tools" by Albert A. Dowd, published in the February number of MACHINERY, I am inclined to ask if turning the outside of plain bushings is a practical turret lathe job. From Mr. Dowd's illustration Fig. 4, and the description presented in this connection, it appears that plain bushings of various sizes are mounted on expanding arbors held in a collet in the turret lathe spindle, while they are turned by a tool carried by a slide mounted on the turret. This slide looks somewhat like an engine lathe cross-slide set up in an unusual position. From a practical point of view—and according to what the writer believes to be commercial practice in the manufacture of bushings—the method illustrated in Fig. 1 of this article is far superior. An engine lathe is used and does not require any special rigging up except for the arbor.

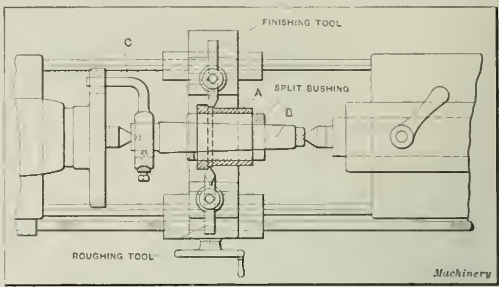

Fig. 1. Method of machining Bushings on an Engine Lathe

The work to be machined is shown at *A*, and the arbor *B* on which it is mounted may be bought in standard sizes at a relatively small cost. A suitable driving dog *C* will usually be found in any shop, and the same statement applies to an engine lathe with two centers. A further advantage of this method is that an engine lathe is a cheaper machine than a turret lathe. To machine the bushings, we take the arbor with the dog on it out of the lathe, put the work on the arbor and drive up the expanding bushing to hold the work in place. Now, placing the arbor in the lathe, we turn the work with the tools on the cross-slide, the front tool doing the roughing, and the rear tool the finishing at the same time by being set slightly behind the roughing tool in the manner shown.

Summing up the two methods of machining, we find, on one hand, a special arbor, a collet for holding it, and a special slide to go on the turret for turning, all of which would probably cost about $100. For machining the bushings on the engine lathe, all we have to provide is a special arbor costing about $10. This method will certainly produce as good work as could be turned out on the turret lathe, if not better, as the work is rigidly supported between centers, while the unique equipment described by Mr. Dowd has the end where the turning is being done unsupported. Taken on the whole, the turret lathe outfit would be a poor bargain if placed side by side with an engine lathe as described.

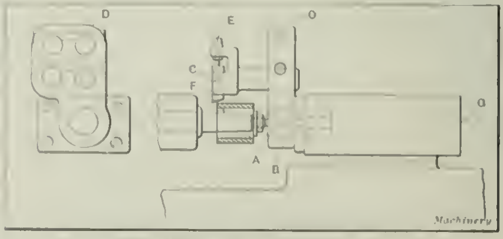

Fig. 2. Turning Bushings on a Turret Lathe using a Piloted Work Arbor

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* Address: 700 Weeden St., Pawtucket, R. I.

Now while it is not practical to use a turret lathe for this class of work, I believe a much more satisfactory method of machining this bushing on the turret lathe would be as illustrated in Fig. 2, where the arbor is of similar construction to the previous one and is held in a collet, but has, in addition, a pilot *A* on the end, which is a running fit in the bushing *B* held in the turret hole and ties the turret and arbor rigidly together for bracing. The turning is done by a bar and cutter *C* held in a tool-holder *D* which has four holes in it to take the bars while turning different diameters. The construction is a standard one by some makers and is capable of being adapted to a much larger range of work than the slide shown by Mr. Dowd, besides being cheaper. Adjustment of the blade in this bar is obtained by the screw *E*, while the cutters are bound by the screws *F*. Another set of similar tools may be placed on the turret face No. 3 at *G* if two cuts are required, and the tool-holders connected for bracing.

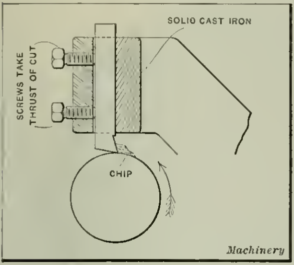

Fig. 3. Bad Position for Binding Screws

Another condition worth mentioning is shown by Fig. 3 in the February number. The screws which are shown binding on the back side of the cutters opposite the cutting surface must take the thrust of the cut as indicated by the arrow in Fig. 3 of this article; this condition is also shown in Mr. Dowd's illustration Fig. 7. A better construction would be to place the screws and plate for holding them on the opposite side and have the solid cast-iron tool-holder behind the tools for bracing, which would be much more substantial.

Having tooled up a machine for handling work similar to that shown in Fig. 6 of Mr. Dowd's article, it appears to me that while the method of piloting shown is all right with the combination of tools illustrated, were this job carried out and an attempt made to use similar tools throughout, the work produced would not be very accurate, because the pilot comes above the work and offers no support for the boring tools. To eliminate this I would tool this job up as shown in Fig. 4, where the operations would be: spot the hole with the tool *A* on the first turret face; drill and turn with the combination tool *B* on the second turret face, allowing the drill to follow in the hole spotted; as the drill is part way into the hole as shown by *X* before the turning tools commence to cut, it will help to steady them. Next, on the third turret face, place a boring-bar *C* and turning tools similar to those used with the drill. These are piloted into a bushing in the center of the chuck, thus tying all of the tools in this combination to the spindle, which insures the best possible degree of accuracy and cheapens the tool equipment by eliminating a pilot bracket and pilot bar, as these can be incorporated in the boring-bar and chuck.

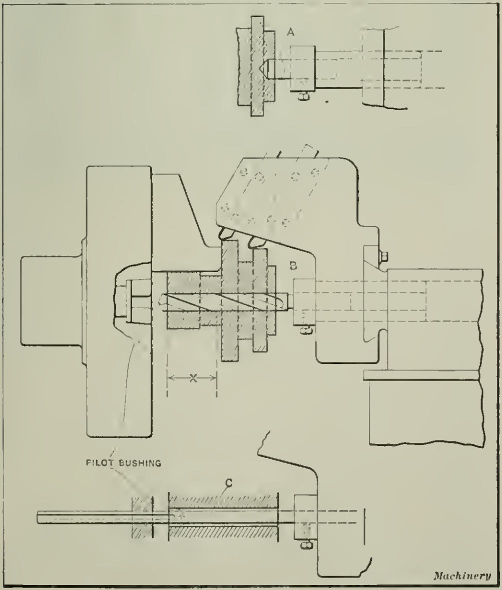

Fig. 4. Accurate Tool Set-up for machining Jack-shaft Gear Blanks

A comparison between my illustration Fig. 5 and Mr. Dowd's Fig. 9, will bring out an interesting point, as it shows a condition which is purely a matter of saving in manufacture. By mounting the pilot bar in the bracket on the headstock, I eliminate the necessity for cutting out the pilot bar at *K*, as referred to in the previous article, and I save one bar, as the bar can now pilot into a bushing in the roller back-rest on both roughing and finishing cuts; this also eliminates having a long bar extending way out when the turret swings. Mr. Dowd's Fig. 10 is another case where one pilot would do the work of two. I might add that were pilot brackets placed in the same position on the headstock in all cases, which does not appear to have been the case, they would be interchangeable and the same pilot bars could be used for almost all combinations of tools. Another point which suggests itself on this tool is that if the slide which carries the cutter were placed on the opposite side of the bracket, the thrust of the cut would come against the seat of the slide and not against the dovetail and gib, which would be a more substantial design.

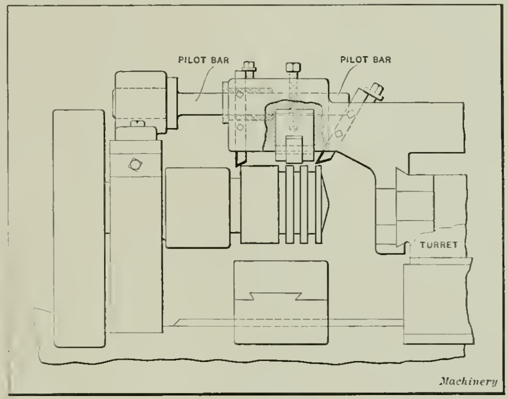

Fig. 5. Pilot held in Headstock Bracket and piloted into Back-rest

Another point which does not make itself quite clear to the writer is the method of using the adjusting tool block (Fig. 8 in Mr. Dowd's article) and why it is necessary to have the thrust of the cut come against the screws instead of placing the block on the opposite side and having the cut come against the solid metal. This would require the pilot to come on the opposite side, to which I can see no objection, as it has been done on the equipments shown in other illustrations. As regards the adjusting features shown in Fig. 8, it appears that when the screws in the slots for adjusting the block *D* are loosened, the screws which hold the blade will also become loose, thereby permitting the blade to fall out, thus losing its value as an adjusting feature in the true sense of the word. Although I have taken the article in question and discussed it at some length, I can offer no apologies, having merely done as a tool designer would do while checking with the intention of bettering the design without going too much into detail. Lack of completeness in the drawings of tool set-ups shown would make this impossible, as where one unit in a tool set-up is shown without regard to the manner in which it matches up with the other tools in the combination, it is impossible to see just how the whole will work together for the best operation.

AUTOMATIC HEAT CONTROL

BY E. P. REICHHELM*

Every practical mechanic realizes the importance of heating steel work so that when quenched it has the exact temperature required for perfect hardening. Excellent work in hardening has been done for centuries, but it depended for quality upon individual skill, trained eyesight and intuition, and even the best hardener could rarely repeat the same results until the pyrometer enabled him to make a record of the exact heat required to harden a given steel properly. Since pyrometers have come into common use, the hardener's principal care has been to maintain the correct furnace temperature by watching his pyrometer and regulating his gas and air valves so as to maintain it. Any experienced hardener will grant that before he used a pyrometer he was unable to judge his heat nearly as correctly, and that a decided advance in the art of hardening was made when the pyrometer replaced eyesight and intuition and enabled him to record his experience in figures instead of relying upon his own judgment.

The next step in securing uniformity and high quality of hardening was to find a means of supplying gas and air to a gas furnace in exact proportion to the required temperature. The automatic heat controller of the American Gas Furnace Co. is such an instrument. In daily use for over three years in shops and laboratories, both here and in Europe, it has demonstrated conclusively that essential differences in temperature affecting the results of heating processes are practically unavoidable unless the furnace is automatically controlled, because even the most skillful and careful operator is unable to check or increase furnace heats promptly enough to avoid variations from the desired temperature, which, no matter how closely his pyrometer is observed, may easily vary from 50 to 100 degrees.

The detrimental effect of such heat variations in hardening are shown in the following microscopic photographs of two fractures of the same file magnified 160 times. This file is one of the highest grade produced in Europe, and Fig. 1 shows the fracture of this file as imported, while Fig. 2 shows a fracture of the same file, a section of which was rehardened, after the exact degree of heat required for this particular steel had been experimentally determined. Fig. 1 therefore shows the result of the best hardening practice in Europe, aided by the pyrometer, while Fig. 2 shows the hardening of this identical file by the correct heat automatically maintained. That any number of files, or tools of any kind, can be hardened so as to show uniformly the excellent fracture exhibited in Fig. 2 is due to automatic heat control, as has been demonstrated conclusively in daily practice for over three years.

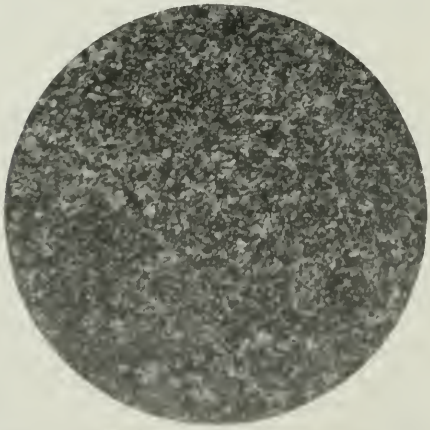

Fig. 1. Fracture Microphotograph of High-grade Foreign File
Magnification 160

Both of the photographs of fractures have been pronounced excellent by competent judges, but the decidedly finer grain and more even diffusion of the carbon shown in Fig. 2 produced a difference in the durability of the file teeth of nearly 50 per cent, as compared with the section of the file as originally hardened and shown in Fig. 1.

When the hardener is released from the constant observation of his pyrometer and the frequent handling of the gas and air valves, his whole attention can be given to his product, and the output of the man and his furnace is greatly increased, to say nothing of the uniformity and superior quality of the work, which makes the installation of the automatic heat controller only a question of how soon it can be made to pay for itself; and this depends entirely upon the amount of hardening to be done. The same instrument can be used for the equally important process of annealing by simply switching it off to an annealing oven.

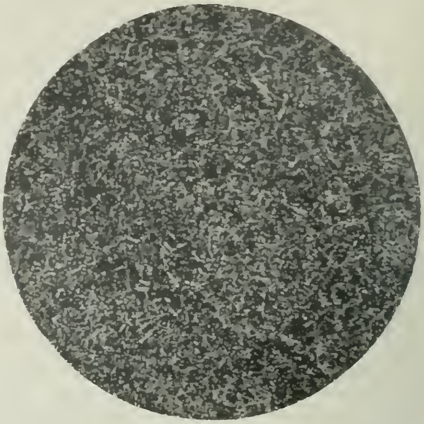

Fig. 2. Fracture Microphotograph of Same File Rehardened
Magnification 160

It might be doubted whether the file from which these fractures are shown was hardened as perfectly as the makers could do it, but there can be no doubt that this file was improved by more correct hardening, and that any number of files made of the same steel can be hardened exactly as shown in the fracture Fig. 2. The result shown is entirely due to the automatic heat controller and deserves the attention of progressive manufacturers, who desire to produce the best possible work, to stimulate the demand for things "made in the U. S. A."

* * *

HANDLING OFFICE VISITORS

The problem of treating factory visitors in a courteous manner is often a difficult one. Good business principles demand that any caller at the office, no matter what his errand, shall be given a courteous hearing, even though brief. One large concern in the machine tool building field has an efficient method of handling callers which is very effective in operation and which saves the valuable time of the management. It fulfills the requirements of courtesy, giving every visitor the opportunity to present his case. The visitor, whether he be book agent or prospective customer, is received courteously, his card taken and he is shown to a seat. The telephone operator announces him to the official whom he desires to see, and he is then invited to step into a well-appointed telephone booth where there is good light, chair, pencil and paper. The person with whom the interview is requested directs the visitor to state his mission over the telephone, and if it is one deserving more personal attention he is invited into the office, but if the preliminary talk indicates that the visitor has nothing of interest, he is told firmly but courteously that such is the case, and the receiver is hung up. There can be no hanging on by the persistent salesman, no idle talk about the weather, the political situation or any of the many time-consuming and irritating matters broached when the visitor is received in the office.

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* President and general manager American Gas Furnace Co., 21 John St., New York City.

A SPEED RECORD IN DRILLING

During the recent Foundry & Machine Exhibition in Chicago, the Colburn Machine Tool Co., of Franklin, Pa., had one of its D-4 drill presses in operation. In drilling iron and steel, this machine established records which are of such an exceptional character that a more extended account than that given in the October number will doubtless prove of interest to readers of MACHINERY. The machine was taken from the manufacturer's regular stock and ordinary commercial drills made by three different firms were used. Consequently, these results are nothing which a manufacturer cannot hope to obtain under actual shop conditions. The drill press was driven by a 25 horsepower constant speed motor and the small amount of power consumed, considering the heavy drilling which was done, was quite remarkable. The reason for this low power consumption is in a large measure due to the fact that the machine is provided with ball bearings throughout the driving train, in addition to ball thrust bearings for the drill spindle.

Among the numerous interesting examples of high-speed drilling done on this machine there was one which is believed to stand as the record for drilling in steel. A 1½ inch twist drill was driven through a piece of 0.35 to 0.40 per cent carbon steel, 4 inches in thickness, at a speed of 343 revolutions per minute and a feed of 0.061 inch per revolution. This means that the drill was advanced at a rate of 20.92 inches per minute. Three holes were drilled at this rate, and after the third hole was finished the drill was still in good condition and could have drilled several more holes at the same rate without the necessity of sharpening. After conducting this exhibition, another make of drill of the same size was put in the machine and two holes were drilled at the same speed and feed. After drilling two holes, this drill was still in fair condition and would easily have drilled another hole under the same conditions without the necessity of sharpening.

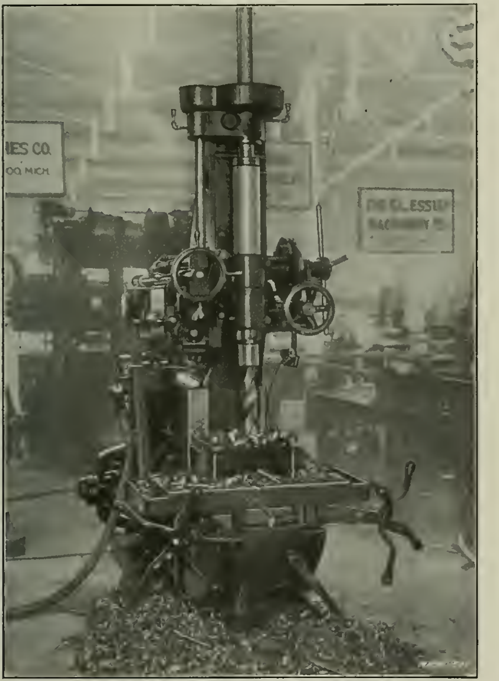
Fig. 1. Colburn D-4 Drilling Machine on which Record was made

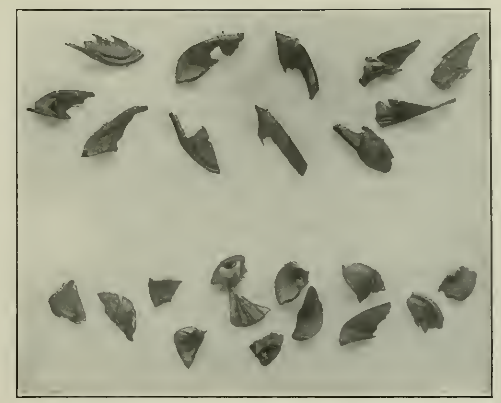
Fig. 2. Chips made while Drill was quite Sharp

Attention is called to the interesting character of the chips made with drills running under these extremely heavy feeds. All the chips shown in Figs. 2 and 3 were made with the same 1½ inch drill, running at the speed and feed referred to in the preceding paragraph, *i.e.*, 343 revolutions per minute and 0.061 inch per revolution. The great difference in the appearance of the chips is due to the relative change in the sharpness of the cutting edges of the drill. The chips shown in the lower part of Fig. 2 were made when the drill was quite sharp, and as the drill became dull the chips assumed the shape of those shown in the upper part of the illustration. Finally, as the cutting edges of the drill became ragged, the chips assumed the grotesque and rather ornamental shapes shown in Fig. 3. It would hardly seem possible that all these chips were made with the same drill working under the same speed and feed, and that the factor entirely responsible for their changed appearance was the degree of sharpness of the cutting edges. Another interesting fact brought out by these chips is that the drill is much more likely to break when it is dull than when kept sharp. This is fairly evident from the fact that the long, irregular chips made when the drill is dull, have a tendency to clog up the hole and wedge the drill, thus causing it to break. On the other hand, the short chips made with the drill when it is sharp clear themselves freely without any disposition to clog.

A further idea of the exceptionally high rate at which the preceding exhibitions were conducted will be gained from the fact that at this rate, 621 pounds of chips would have been made per hour, which is equivalent to over three tons of chips in a ten-hour day. However, as a machine for converting metal into chips, the following record which this machine established in drilling cast iron is even more remarkable. A 3-inch twist drill running at 343 R. P. M. with a feed of 0.061 inch per revolution, was driven through a cast-iron block 4½ inches in thickness twelve times without the necessity of re-grinding. After drilling twelve holes at this rate, the supply of material was exhausted so that the test could not be continued, but the drill was still in good condition, showing no necessity for re-sharpening. The amount of chips made under these conditions seems almost unbelievable, as it would amount to 2310 pounds per hour, or over 11½ tons in a ten-hour day.

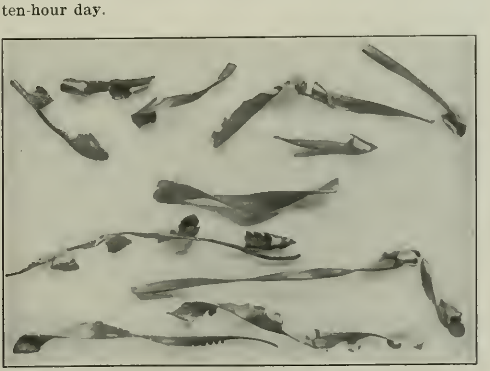
Fig. 3. Form assumed by Chips as Drill became Dull

In conducting these exhibitions, none of the drills were broken and this fact naturally leads one to inquire how this was possible under such severe operating conditions. It could only be done on a machine combining great rigidity of construction with an abundance of power. The factor of prime importance in the elimination of broken drills is to have the machine absolutely rigid. If there is any spring between the upper part of the machine and the table, the drill will not start cutting until the pressure is sufficient to overcome this strain, after which the feed is practically constant until the point of the drill breaks through. The resistance to the penetration of the drill is then removed and if there is any spring in the parts, it causes the drill to "hog in." The sudden increase in torsional strain produced in this way frequently causes the drill to break. Another condition that results in broken drills, which is also brought about by the same spring in the parts referred to, is that any movement of the table in relation to the upper part of the machine causes the spindle to be thrown out of alignment, with the result that the drill tends to bend and cramp in the hole. If the hole is deep, this is frequently the cause of breaking the drill, even though its cutting edges are perfectly sharp. It will be evident from Fig. 1 that the construction of the Colburn drill press is exceptionally massive, so that strain is effectually eliminated. The provision of ball bearing journals, helical driving gears on the spindle, and feed gears running in oil, affords the greatest possible smoothness of operation.

* * *

RECENT LEGAL DECISIONS INVOLVING MACHINERY

A careful analysis of recent court decisions has been made, and the result is given herewith for the benefit of the readers of MACHINERY. All necessary references to court records are given in each case.

Sales of Machinery on Open Account

(Federal) Where certain goods were sold by the claimant to the bankrupt on open account, the title vested in the bankrupt at once, and the relation of debtor and creditor created, so that on bankruptcy intervening the seller could not rescind the sale and recover the goods.—*In Re Caldwell Machinery Co. 215 Fed. 428.*

Injury Caused by Salesman in Demonstrating Machine

(Federal) Defendant sold certain paper cutting machines to be erected by it in a printing office in another city, and sent an agent to install the same. Almost as soon as the last machine had been set up the agent started to return, but before his train had left was sent for by the purchaser because plaintiff, who was to operate one of the machines, could not make it work properly. He returned, and the evidence as to what was done was in some conflict, but in explaining the operation of the machine to the foreman, the agent moved the lever, which caused the cutter to fall, and plaintiff's hand was caught and cut off. There was evidence for plaintiff that the machine had not been tested to its capacity, and was not in complete running order; that plaintiff was directed to do certain things, and that the agent himself made further adjustments. Held, that it was not error to submit to the jury the question whether the agent, when he moved the lever, was acting for defendant, and not for the purchaser, and within his authority as defendant's agent. The jury found for plaintiff.—*Seybold Machine Co. v. Feehan. 214 Fed. 915.*

Misstatements in Specifications

(Federal) That the specification makes exaggerated or unwarranted statements as to the capabilities of the invention, even conceding that an infringer can interpose that as a defense, does not render the patent invalid, unless the statements were made fradulently, and the patentee was a party thereto.—*Universal Tobacco Machine Co. v. Borgfeldt & M. Co. 215 Fed. 715.*

Hoisting Apparatus Held Infringed

(Federal) In a suit charging the infringement of an invention having relation to an improvement in hoisting apparatus which includes a pair of superimposed engines, the defense was made that no infringement existed for the reason that the apparatus in question was a combination of features which had in the past existed in other apparatus. The evidence established the fact that the combination was nothing more than the placing of two engines one on top of the other, each operating independently, and that such engines individually were covered by previous patents. The Court held that to constitute a combination it is essential that there should be some joint operation, performed by the elements producing a result due to their joint and cooperating action, while in an "aggregation" there is a mere adding together of separate contributions, each operating independently of the others. The apparatus in question must be considered to be an "aggregation" rather than a combination, simply for the reason that the engines contained in it operate separately and independently to each other. The plaintiff's engine must be held infringed by defendant's hoisting apparatus. Decree for plaintiff.—*Mead Morrison Mfg. Co. v. Exeter Machine Works. 215 Fed. 731.*

Indivisible Contract of Sale

(Ohio) A written contract for the sale of several articles of machinery for a sum in gross is indivisible except by subsequent agreement of the parties, and the seller cannot recover the contract price or any part thereof unless he substantially performs, or tenders performance of, all the terms of the contract on his part to be performed.

Where a contract for the sale of machinery specifically provides for the manner and method of delivery, the seller has no right or authority to impose other or further conditions precedent to delivery than those named in the contract.—*Petersburg Fire Brick & Tile Co. v. American Clay Machinery Co. 106 N. E. 33.*

May Enjoin Infringement

(New York) A manufacturer who produces a machine of recognized excellence in the market, and stamps the same with his trade name or mark, acquires a property right in it which the law will protect from infringement.—*Poyn's Sons Co. v. Payette. 149 N. Y. S. 184.*

Belt Shifters must be Provided

(Kansas) The State Factory Act of Kansas (Gen. Stat. 1909, sec. 4679) provides that belt shifters shall be provided in all manufacturing establishments in which machinery is used and that machines shall be operated with loose pulleys when practicable. In construing this act the Kansas courts have held that the law must be strictly complied with, and substitutes, no matter how safe and convenient, will not be considered a compliance with the law.—*Rank v. Kansas City Packing Box Co. 142 Pac. 942.*

Subject of Protection

(Federal) To entitle a complainant manufacturer to protection against the use of its unpatented machines and methods by others, it must appear that they are in fact secret, and it is not entitled to an injunction to restrain the use of machines copied from its own by another manufacturer, which obtained its information respecting the same from former employes of complainant, who were not informed and had no knowledge that the same were secret.—*Hamilton Mfg. Co. v. Tubbs Mfg. Co. 216 Fed. 401.*

Duty of Foreman Having Charge of Machinery

(Federal) A foreman, having charge of and controlling workmen, is presumed to observe the presence or absence of proper safety appliances and to know the danger of working at rapidly revolving machinery without such appliances, and it is his duty to warn those working under his direction and control of dangers not obvious to them.—*Russell v. Champion Fiber Co. 214 Fed. 963.*

Implied Warranty in Sale of Machinery

(Kentucky) Where plaintiff purchased a certain piece of machinery, and it proved inadequate, plaintiff's retention of the machine for about sixty days during which time he thoroughly tried it, and it was repaired and adjusted by experts from the seller, was not such a delay as to preclude him from rescinding the contract of purchase. Where a seller contracts to supply a piece of machinery to be applied to a particular purpose, and the buyer necessarily trusts to his skill or judgment, there is an implied warranty that the machine will reasonably perform the duty for which it is to be applied.—*International Harvester Co. v. Bean. 169 S. W. 549.*

OPERATION OF GRINDING WHEELS IN MACHINE GRINDING[*][†]

APPLICATION OF MATHEMATICAL ANALYSIS TO THE PROBLEMS OF WHEEL AND WORK SPEEDS IN GRINDING

LONG experience in the use of grinding wheels has established facts regarding the action of such wheels when used on modern grinding machines. These facts, however, have been stated only as empirical rules. Such rules are easily forgotten or confused by operators because they are not related in any obvious way to any known principles by which results may be predicted. For example, what is the effect upon a wheel of increasing the speed of work, or of increasing the diameter of the work, or of diminishing the diameter of the wheel? The following analysis of the action of the grinding wheel when operating upon cylindrical or plane surface work, reveals a principle which leads at once to the answers to questions like those in the preceding sentence. In all cases the term "speed," whether referring to work or to wheel, means peripheral speed.

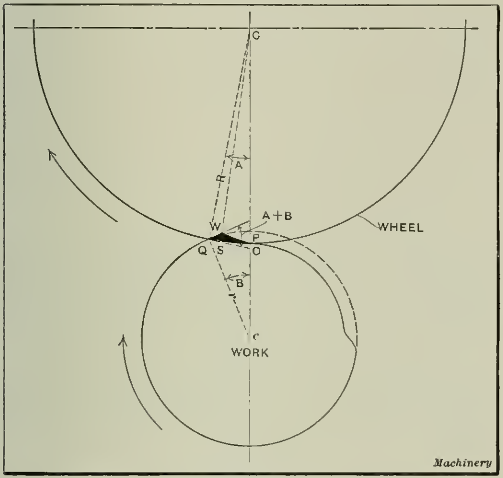

Fig. 1. Action of Grinding Wheel when operating on Cylindrical Work

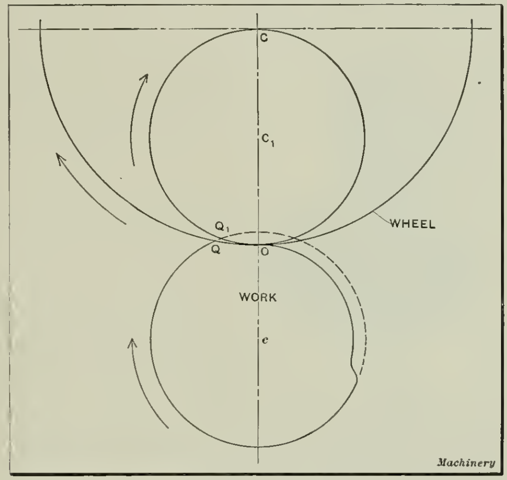

Fig. 2. Diagram illustrating Effect of Changes in Diameter of Wheel or Work

In Fig. 1 let

$C =$ the center of the wheel;

$c =$ the center of the work;

$OP =$ the radial depth of cut;

$OQ =$ the arc of contact of wheel and work.

Each of these dimensions is much exaggerated in the figure, the real dimensions in actual work being exceedingly small. The arrows indicate the direction of motion of wheel and work, respectively. Assume for a moment that there is but one abrasive grain or cutting point in the surface of the wheel, and that this one grain is at O. On account of the revolution of the wheel, the point O will move to Q in a certain time, but on account of the revolution of the work, the point Q on the work will move toward P, to the point W. As the speed of the work is usually very much less than the speed of the wheel, this distance QW will be much less than OQ. The cutting point will remove from the work a chip represented by OQW. From the outline or shape of the chip it appears at once that when the cutting point begins to act at O, its depth of cut is nothing, but that the depth of cut of the grain increases gradually to its maximum WS. As the abrasive grain in a grinding wheel is set or fixed in the bond of the wheel, it is clear that the deeper the grain cuts into the work, the more the bond will be disturbed, or worn away. The distance WS will be called the maximum grain depth of cut, or, for brevity, the grain depth of cut. Of course, there are actually a number of cutting particles between O and Q, but each acts in the same manner as the single grain we have considered. The grain depth of cut of each particle, however, will be the distance WS divided by the number of cutting grains or particles in action at once, or the number between O and Q. When a grinding wheel is working properly, we may consider the abrasive grain in the wheel as cutting small chips from the work, and the surface of the work as cutting or wearing away the bond of the wheel. Now, it is quite evident that the greater the grain depth of cut, the more effective will be the action of the work upon the bond of the wheel. So long as the bond is being worn away just as fast as the abrasive grains of the wheel are being worn down, the wheel will continue to work well. If the bond is cut away too rapidly, the wheel will appear too soft, and will wear away too rapidly. If the cutting grains wear down faster than the bond is cut or worn away, the face of the wheel will become glossy, and the wheel will not cut freely. These considerations lead directly to the conclusion that the action of a given wheel on a given kind of work is almost entirely dependent upon the grain depth of cut. If the grain depth is too great, the wheel wears away too rapidly. If the grain depth is too small, the wheel may glaze. It is therefore important to know how the grain depth of cut may be regulated.

Referring again to Fig. 1, it appears that WS will increase if QW increases and *vice versa;* but QW depends upon the speed of the work. Therefore if the speed of the wheel remains constant, and the speed of the work increases, WS will increase. The correct working of the wheel therefore depends upon the relation of QW to OQ, or upon the relation of work speed to wheel speed. If the wheel speed and all other conditions except work speed remain constant, the grain depth will increase as the work speed increases, and diminish as the work speed diminishes. Also the work speed and all other conditions except wheel speed remaining constant, the grain depth of cut will increase as the wheel speed diminishes and *vice versa.*

Effect of Changes in Diameter of Wheel or Work

In Fig. 2, let

$C =$ the center of a grinding wheel;

$C_1 =$ center of a smaller grinding wheel;

$c =$ the center of work.

Suppose the wheel the center of which is at C, to have worn down until its center is at C_1, the work diameter remaining the same. Let the radial depth and work speed also remain constant. This insures the same rate of production in each case. Let the wheel speed also be the same in each case. It will be seen from Fig. 2 that the smaller wheel will have a shorter arc of contact with the work than has the larger wheel, or that OQ_1 is less than OQ. Since the wheel speed in both cases is assumed to be the same, the number of chips cut from the work each minute will be the same; but as the chips cut by the smaller wheel are shorter, and as the volume of all the chips cut each minute is the same, it follows that the thickness of the chips cut by the smaller wheel is greater than the thickness of the chips cut by the larger wheel. In other words, the grain depth of cut increases as the wheel diameter diminishes. Therefore the bond should wear away faster as the wheel gets smaller, and the smaller wheel should appear softer.

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[*] Paper to be read by George I. Alden before the American Society of Mechanical Engineers, New York City, December, 1-4, 1914.

[†] For additional information on grinding see "Selection of Wheels for Cylindrical Grinding," October, 1914; "Efficient Production of Cylindrical Work," December, 1912, and other articles there referred to.

In many cases as the wheel wears down, the speed of the wheel is allowed to diminish, and when this is the case the grain depth of cut will be increased on account of the diminished wheel speed, as well as because of the smaller wheel. Following the same line of reasoning, it is easily shown that if the work diameter is increased (all other factors remaining the same) a longer chip will be cut from the work, and as the number and volume of chips remain constant for each unit of time, the thickness of the chips must diminish, or the grain depth must be less. Therefore a wheel, other conditions being the same, should appear harder as the diameter of the work increases. A proper increase of work speed on the larger work will bring up the grain depth of cut to what it was on the smaller work.

Summarizing these conclusions, to which we are led by purely theoretical considerations, we can say:

1. Other factors remaining constant, increase of work speed increases grain depth of cut, and makes a wheel appear softer.
2. Similarly, a decrease of wheel speed increases grain depth of cut.
3. Similarly, diminishing the diameter of the grinding wheel increases grain depth of cut, and increasing the diameter of the wheel decreases grain depth of cut.
4. Similarly, making the diameter of work smaller increases grain depth of cut. Conversely, making the diameter of work larger makes grain depth of cut smaller.

In the above analysis no account has been taken of certain factors that no doubt modify, to a degree, the results arrived at. For example, chips cut from the work by the abrasive particles of the grinding wheel are not entirely free to escape. Referring to Fig. 1, the arc OQ will, in practice, contain several cutting points, so that several chips are in the process of being cut off at once. Before these chips all escape, some of them may be forced into spaces between the cutting particles in the face of the wheel, causing the wheel to "load." This loading may at times be such as greatly to reduce or even practically to destroy the cutting quality of the wheel. Even though the wheel does not "load," the presence of loose chips of metal between the wheel and the work may impair the cutting action of the wheel or the quality of the ground surface produced; but the four conclusions given in the preceding paragraph are recommended as giving correct relative results.

In applying the principle that grain depth of cut is the main factor in all the phenomena of a good grinding wheel, it must be remembered that the correct relative speeds of work and of wheel must be found by trial for each wheel and each kind of work. When this has been done, the principle of grain depth of cut will enable one to know the direction in which to make the changes of work speed or wheel speed, to adapt the wheel to changes in its own diameter, or to other sizes of the same kind of work.

Finishing

Thus far it has been assumed that the object of grinding is to remove stock rapidly or, in other words, to get a high rate of production. Often, however, the character or finish of a ground surface is of primary importance. From the point of view of grain depth of cut, we should reason that to get a very smooth surface by grinding, the grain depth of cut should be very small, and, therefore, that the work speed should be relatively slower for finishing than for roughing. That the bond may be worn away by a very small grain depth of cut, we should expect that generally a softer wheel would be used for fine finishing than for roughing. A very hard glazed wheel may sometimes produce a mirror-like surface on the work, the action in this case being a sort of burnishing process.

Mathematical Analysis

A general equation for grain depth of cut may be obtained as follows: Referring again to Fig. 1, let

$OQ = l =$ arc of contact of wheel and work;
$n =$ number of cutting particles per unit length of circumference of wheel;
$V =$ surface velocity of the wheel;
$v =$ surface velocity of the work;
$T =$ time it takes point on *wheel* to go from O to Q and also time it takes point on *work* to go from Q to W;
$d =$ grain depth of cut.

Then

$$l = VT \text{ or } T = \frac{l}{V} \tag{1}$$

$$QW = vT \tag{2}$$

and

$$WS = vT \sin (A + B) \tag{3}$$

$$d = \frac{WS}{nl} = \frac{vT}{nl} \sin (A + B) \tag{4}$$

Substituting T from (1)

$$d = \frac{v}{Vn} \sin (A + B) \tag{5}$$

Equation (5) shows that the radial depth of cut varies directly as work speed; inversely as wheel speed; and directly as $\sin (A + B)$. To give the reader an idea of the dimensions of some of the quantities entering into Equation (5) and also a means of determining from (5) the change in grain depth of cut due to changes in radial depth, Table I giving lengths of arcs of contact of wheel and work for three different diameters of wheels, and Table II giving the values of $\sin (A + B)$ for the dimensions of wheel and arcs of contact given in Table I, are appended.

TABLE I. ARCS OF CONTACT

	Rad. Depth of Cut, Inches	0.0005	0.001	0.0015	0.002	0.0025	0.003
	Work Diam., Inches	Arcs of Contact					
12-inch Wheel	½	0.0158	0.0210	0.0270	0.0307	0.0346	0.0378
	1	0.0212	0.0318	0.0373	0.0429	0.0482	0.0526
	2	0.0291	0.0413	0.0507	0.0584	0.0654	0.0711
	3	0.0346	0.0490	0.0600	0.0692	0.0775	0.0848
	4	0.0386	0.0547	0.0689	0.0775	0.0866	0.0949
	6	0.0448	0.0634	0.0774	0.0894	0.1001	0.1095
	8						
	12						
	24						
	∞	0.0775	0.1095	0.1342	0.1519	0.1732	0.1898
18-inch Wheel	½						
	1	0.0220	0.0311	0.0377	0.0436	0.0485	0.0533
	2	0.0299	0.0428	0.0521	0.0598	0.0669	0.0735
	3	0.0362	0.0501	0.0620	0.0717	0.0801	0.0878
	4	0.0401	0.0574	0.0699	0.0810	0.0900	0.0990
	6	0.0477	0.0672	0.0824	0.0950	0.1061	0.1162
	8						
	12						
	24						
	∞	0.0948	0.1341	0.1638	0.1897	0.2121	0.2324
24-inch Wheel	½						
	1						
	2	0.0294	0.0423	0.0521	0.0601	0.0676	0.0742
	3	0.0364	0.0515	0.0631	0.0728	0.0814	0.0892
	4	0.0407	0.0582	0.0714	0.0827	0.0925	0.1013
	6	0.0489	0.0691	0.0846	0.0977	0.1095	0.1189
	8	0.0546	0.0773	0.0947	0.1095	0.1224	0.1340
	12	0.0631	0.0895	0.1093	0.1264	0.1413	0.1549
	24	0.0777	0.1095	0.1342	0.1549	0.1731	0.1896
	∞	0.1097	0.1548	0.1896	0.2189	0.2448	0.2682

Machinery

Values of sin (A + B). To show how grain depth varies by the changes of radial depth in special cases, three examples are computed with the following results.

Example 1. $R = 9$ inches; $r = 4$ inches.

Radial depth 0.0015; $\sin (A + B) = 0.03285$.

Radial depth 0.003; $\sin (A + B) = 0.04650$.

In this case double radial depth gives an increase of only about 40 per cent in grain depth.

Example 2. $R = 9$ inches; $r = 2$ inches.

Radial depth 0.0015; $\sin (A + B) = 0.04271$.

Radial depth 0.003; $\sin (A + B) = 0.06051$.

Increase of about 40 per cent.

Example 3. $R = 9$ inches; $r = 1$ inch.

Radial depth 0.0015; $\sin (A + B) = 0.05793$.

Radial depth 0.003; $\sin (A + B) = 0.08167$.

Increase of about 41 per cent.

Examples might be multiplied, but those cited are sufficient to show that increase of radial depth does not increase grain depth in the same proportion as the radial depth increases. In the first example, doubling the radial depth gives only about 40 per cent increase in grain depth.

Resuming the equation $d = \frac{v}{Vn} \sin (A + B)$ which is Equation (5), we see that if $\sin (A + B)$ is increased say 40 per cent by doubling the radial depth, we might diminish $\frac{v}{V}$ by about 30 per cent without changing the grain depth; but these changes, which have not varied the theoretical value of grain depth d have increased the rate of production 40 per cent. This indicates that production may be increased without increasing grain depth of cut, by increasing the radial depth of cut, and at the same time diminishing the work speed a less per cent than the radial depth is increased. In practicing this method of increasing production it is assumed that the work and the machine are reasonably rigid.

Summary

All the above results, which have been obtained from purely theoretical considerations, are based on the principle that the successful working of a grinding wheel depends upon securing in its operation the correct grain depth of cut for that particular wheel on a specified kind of work. It remains for expert users of wheels to decide from practice the correctness of these theoretical results. While the matter of clearance and of the unequal diameters and irregular arrangement of the abrasive grains may modify to some degree the theoretical results, it is confidently believed that the theory based on the idea of grain depth of cut will always lead in the right direction, and that it gives to empirical rules for changes of work and wheel speeds, a rational basis, and affords the operator an opportunity to do by thought and reason what heretofore he has done by memory alone.

This brief paper may suggest a line of investigation which, with the aid of sufficient data from practical experience, will lead to some definite directions for the use of standard grinding wheels on cylindrical and plane surface work.

TABLE II. SIN $(A + B)$

	Rad. Depth of Cut, Inches	0.0005	0.001	0.0015	0.002	0.0025	0.003
	Work Diam., Inches	Sin $(A + B)$					
12-inch Wheel	½	0.06581	0.09678	0.10999	0.12807	0.14379	0.15724
	1	0.04686	0.06888	0.08084	0.09287	0.10439	0.11396
	2	0.03394	0.04822	0.05914	0.06816	0.07626	0.08294
	3	0.02879	0.04075	0.04997	0.05768	0.06453	0.07066
	4	0.02573	0.03649	0.04589	0.05163	0.05769	0.06323
	6	0.02238	0.03167	0.03868	0.04469	0.05002	0.05475
	8						
	12						
	24						
	∞	0.01291	0.01826	0.02236	0.02582	0.02886	0.03162
18-inch Wheel	½						
	1	0.06394	0.06596	0.07948	0.09210	0.10231	0.11224
	2	0.03321	0.04751	0.05793	0.06645	0.07430	0.08167
	3	0.02813	0.03916	0.04842	0.05578	0.06229	0.06830
	4	0.02448	0.03501	0.04271	0.04951	0.05497	0.06051
	6	0.02119	0.02981	0.03661	0.04221	0.04715	0.05163
	8						
	12						
	24						
	∞	0.01053	0.01490	0.01826	0.02108	0.02356	0.02582
24-inch Wheel	½						
	1						
	2	0.03246	0.04582	0.05647	0.06541	0.07322	0.08903
	3	0.02731	0.03861	0.04730	0.05462	0.05817	0.06687
	4	0.02375	0.03394	0.04167	0.04822	0.05395	0.05910
	6	0.02036	0.02877	0.03535	0.04069	0.04564	0.04997
	8	0.01821	0.02575	0.03155	0.03651	0.04080	0.04467
	12	0.01576	0.02238	0.02731	0.03160	0.03531	0.03872
	24	0.01294	0.01826	0.02238	0.02582	0.02885	0.03160
	∞	0.00914	0.01290	0.01580	0.01824	0.02045	0.02235

Machinery

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THE MICROMETER CALIPER AS A MACHINE SHOP GAGE

SOME REMINISCENCES AND IDEAS OF A WELL-KNOWN MANUFACTURER OF MEASURING TOOLS

BY J. T. SLOCOMB*†

J. T. Slocomb

My first experience in a machine shop was in 1881 at Bangor, Maine. It was in a shop devoted to general saw mill work and to all sorts of jobbing. We had a great variety of fits to make, often having to bore a hub for a driving fit on a shaft that was miles away from the shop. We were not provided with hydraulic presses, screw presses or much of anything else in the line of convenience. The only way of forcing fits was with sledge hammer, driving on a wooden block. If a hub was forced part way on and stopped, it was likely to make a lot of trouble. These things led me to a strong belief that something better than the calipers we were using would be a godsend to shops of our kind. In 1885 I went to work for the Brainard Milling Machine Co. in Hyde Park, Mass., and it was there I saw the first micrometer caliper. In a conversation one day with Mr. M—— he asked if I had ever seen a micrometer, and then produced one from his kit where he had it carefully nested in some clean cotton waste. He told me it was a good tool to find odd sizes of wire with. This started me to thinking and, as my experience had not included wire work, I naturally began to associate this new magnifying gage with general machine shop work.

About a year later, I went to work for the Brown & Sharpe Mfg. Co. at Providence, R. I. Although the B. & S. Co. had been making these calipers in small sizes for fifteen years or more, it seemed that for general machine work they had not fully appreciated their value. One of the foremen had a two-inch micrometer that he had made himself, and said he graduated it with a monkey wrench. This caliper was the most borrowed tool I ever saw, which, of course, went to show the demand for such a tool in that shop. Several years later through one of the queer turns of fate, I found myself associated with a small manufacturing business. In the summer of 1892 or 1893 we were struggling along under a panicky business condition, a time which will be remembered by a great many. The lack of regular work at that time gave me plenty of opportunity to make plans, and then the old idea of an improved machine shop gage began to take form which resulted in the Slocomb micrometer. It seemed that there was a field for these instruments in the larger sizes. The first micrometers undertaken were the sizes between 3 inches and 8 inches. We found, however, that the market was not ready for large sizes and for this reason were forced to make the smaller ones as well.

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* General manager, J. T. Slocomb Co., Providence, R. I.

† J. T. Slocomb was born at Four Falls, New Brunswick, Canada, in 1864. His parents moved to Maine when he was an infant and he lived in Fort Fairfield, Maine, until he was sixteen years old, when he went to Bangor and entered the employ of the Bangor Foundry & Machine Co. as a machinists' apprentice. He worked there four years and then went to the Brainard Milling Machine Co. at Hyde Park, Mass., afterward working for short periods for H. B. Smith Machine Co., Smithville, N. J., Holyoke Machine Co., Holyoke, Mass., Brown & Sharpe Mfg. Co., Providence, R. I., and the Rhode Island Locomotive Works, Providence, R. I. He began the manufacture of the Slocomb micrometer in 1893.

One of our first orders came from a Cleveland dealer for four of the 1-inch size. These tools were returned about as promptly as the mail could bring them, with a long friendly letter of advice. The advice was for us to quit the manufacture of such an instrument of precision with the "horseshoe" part finished in black enamel "where it was necessary to be nicely polished." This advice was mainly valuable in showing how micrometers were regarded and what we had to contend with. First came the fellow who stated that the micrometer was too expensive, then the other fellow who stated that it led to mistakes and was not to be trusted, and lastly the party who thought it was jewelry. In designing a micrometer especially for the machine shop, the matter of durability as well as accuracy came in for a large share of attention. Then again, as these tools were intended for everyday service, a matter of finish that was not essential and added to the cost was omitted. These experiences were all gained over twenty years ago, and I view with considerable satisfaction the developments in this time. I have a whole lot of faith in a thing that is *right* winning out if it is persisted in. The importance of making work to interchangeable sizes and the wonderful growth of automobile manufacture has been responsible in a large way for the extended use of micrometers.

There was an idea common twenty years ago that if a lot of snap gages running by even sixteenths of an inch were provided, in some mysterious way all of the variations would adjust themselves naturally. What really happened was that the variations, which were the rule, were taken care of by the fit-together method, and the resulting work was not interchangeable. Looking at this subject squarely, there are a great variety of fits required, calling for a great many measurements. A running fit in a long bearing or hub usually has to have more allowances than where the bearing or hub is short, and the same applies to tight or force fits. Soft or hard materials, thick or thin walls of hubs, rough or smooth surfaces (whether ground or lapped or rough-turned) and the general grade of work all have a bearing on the measurements. In my opinion to meet all of these conditions, the micrometer is the most satisfactory tool known when it is used as it should be. Where approximate measurements are necessary we use a steel scale and read it directly off the work. This not only shows that the work is the desired size, but it shows *how much* larger or smaller it is, which is useful information. In making a nice fit, the micrometer will do the same thing as the steel scale but with the necessary refinement. Do not lock the micrometer to some size and then use it like a snap gage. If you do, you lose three-quarters of its value.

I have not furnished a locking device for the reason that I believe it detrimental to the best use of the micrometer and that it would tend to hinder the general adoption of micrometers in the machine shop. I make a distinction between gaging and measuring. If you are inspecting—only finding out if some size is or is not correct this gaging might answer, but in the making, where if a size is not correct (which is likely) you want to know how much stock remains, then you want to measure and not gage.

A single micrometer with one inch range will cover the range of about four thousand snap gages besides being valuable in many other ways. Some practice with micrometers is, of course, needed to get the best results, but this is easily attained, and when attained there is no more liability of making mistakes in the reading than there is in the use of the ordinary steel scale. A great help to the use of micrometer calipers is to have graduated dials on all machine adjusting screws for lathes, planers, milling machines, grinders and where fine adjustments are made. These dials should be graduated to read in thousandths inch so that cuts can be adjusted to conform with measurements as found by the micrometer. To be sure, all of these screws are not accurate to pitch, but for the small adjustments necessary the error is not enough to be troublesome. Milling machines and grinding machines have been provided with such dials almost from the first, but they are just as necessary on lathes and planers.

In making interchangeable work, one way that has been in favor for a good many years is to make a sample or model machine, then disassemble the parts and use these as models for duplicating parts. This was the only reasonable way until the advent of micrometer calipers. Today it is perfectly feasible to put all necessary dimensions on a set of drawings so that a machine can be duplicated at any time and make good fits. Besides, this plan will produce better results, because measurements are stated on the drawings, but in the case of the model, measurements of the model have to be made repeatedly with the consequent chances for making errors.

As I stated before, it was difficult to sell micrometers above the two-inch size, but now there is a demand for the large sizes running as high as 36 inches, and even larger. One reason for the demand for these large calipers is that a large shaft costs a good deal of money, and it is important that the greatest care be taken in making the fits, as it costs a great deal more to spoil a large piece than a small one. In the handling of these large micrometers, it has been found a help to use a pulley, cord and weight over the machine to act as a counterweight. This arrangement effects a convenience in having the micrometer always at hand, for the weight can be adjusted slightly in excess so that the caliper stays suspended over the machine but within reach.

On first thought it might appear that micrometers should be made with more than one-inch range each. There are several objections to this plan and there is not much in favor of it. As micrometers are usually made, the spindle or screw when way down overhangs about 1 1/16 inch. A greater overhang than this causes some spring when "feeling" the caliper over the work. This, of course, could be provided for by making the parts larger, but this would necessitate making them heavier which would be an objection. The shorter screw is more easily made accurate and the accuracy is more easily maintained than in a long one. In shops where a good many men are employed, a large number of calipers must be furnished, and they may as well be of different sizes. Some of the devices I have seen for making a micrometer with a two-inch range cost as much to make as two separate micrometers. Sliding anvils and attachments are a source of inaccuracy through maladjustments. In a place where extreme reliability is desired, as in micrometer calipers, it is best to have them simple without attachments and with the least possible chance for mistakes.

* * *

STEEL PUNCHINGS FOR BALL BURNISHING

A use for small, round punchings that are ordinarily a scrap by-product when holes have been punched in machine steel has been found by a concern that does a great deal of ball burnishing on its goods. The punchings are used in the tumbling barrels instead of steel balls. They are first tumbled with no work in place and then, after the corners have been well rounded, the work is put in with the soap-suds solution. The claim is made that the burnishing effect is nearly as good as that obtained when using hardened steel balls, which cost a hundred times as much. Aside from the preliminary tumbling, no preparation of the scrap punchings is required and it is only necessary to replace them as they wear away. The metal dust is carried away with the soap-suds solution in which the work is tumbled. C. L. L.

* * *

RELATION BETWEEN WAGES, LABOR SUPPLY AND LAND

In a recent *Consular and Trade Report*, we find the following statement relating to the conditions in the Marquesas Islands: "The average wage now prevailing in the Marquesas is about 77 cents a day, but in times of competition for a limited supply, as when several vessels happen to be in port at the same time, it often goes as high as $1. The labor problem here, as in Tahiti, is a serious one. Almost all Marquesans own land; there are no poor, as food is obtained with little effort."

THE TOLFORD BALL GRINDING MACHINE*

A MACHINE FOR GRINDING STEEL BALLS WORKING ON A DIFFERENT PRINCIPLE FROM THOSE NOW IN USE

BY CHESTER L. LUCAS†

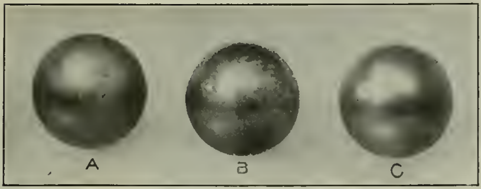

Fig. 1. Steel Balls ground by Tolford Process

THE blanks for steel balls are formed into an approximately spherical shape from steel wire or rods, by dies in either a forging hammer or heading machine. The steel is worked hot or cold, depending upon its composition, the size of the balls, and the practice in the particular shop where the balls are being made. After forming, they are hardened and sent to the rough-grinding machines. These form them very nearly spherical in shape; then they go through a finish-grinding operation that completes them.

The grinding of steel balls is an operation to which much attention has been paid. At present, balls for bearings are ground by rotating them between two disks, one of which is usually of cast iron, having concentric rings or grooves cut for seating the balls, and the other a cup-shaped emery wheel. The spindles of the emery wheel and the cast-iron disk are not in line; hence the paths traveled by the disks are eccentric to each other, giving the balls a radial as well as a curvilinear motion. Fig. 2 illustrates this general principle. The ball is ground to shape and size by removing the metal by a series of flat abrasions, and the rate of grinding, which is governed by the relative velocity between the balls and the disks, is comparatively low. The resulting surface is composed of a succession of minute flat faces, but these are so very small that the ball is acceptable as to shape and size.

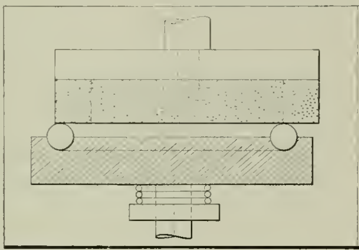

Fig. 2. Diagram illustrating General Principle of Present-day Ball Grinding Operations

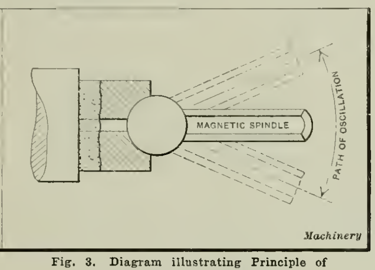

Fig. 3. Diagram illustrating Principle of Tolford Ball Grinding Machine

The Tolford Ball Grinding Machine

The Tolford Co. of Hartford, Conn., recently designed and built a ball grinding machine that operates on an entirely different principle. The balls are held individually on spindles and rotated in contact with a grinding wheel that rotates in the opposite direction and at a much higher rate of speed. The grinding surface of the wheel is concaved to fit the size ball being ground. In addition to being rotated, the ball is oscillated on its axis while turning. The three movements of the wheel and ball are illustrated by the diagram Fig. 3 which shows the grinding wheel that revolves in one direction, and the ball spindle that oscillates and revolves in the opposite direction. One of the advantages claimed for the machine is that the balls and grinding wheels have a high relative velocity and consequently the grinding operations are much more quickly performed.

Fig. 1 shows at *A* a ball ground by the Tolford process; at *B* a partly ground ball to illustrate the grinding principle, and at *C* a finished polished ball. The Tolford ball grinding machine is illustrated from the front in Fig. 4 and from the rear in Fig. 5; a view of the driving mechanism for revolving and indexing is shown in Fig. 6; a close view of the oscillating chuck is shown in Fig. 7; a diagram to illustrate the chuck and spindle mechanism is shown in Fig. 8; and in Fig. 9 is a diagram to illustrate the method by which the positions of the balls in the chucks are changed. In general, the machine somewhat resembles a multiple-spindle automatic screw machine in that it has four work-holding spindles that automatically turn and index. In accordance with the description of the principle illustrated in Fig. 3, its functions are to provide for the carrying and rotating of the grinding wheels, the magnetic holding of the balls in oscillating, the rotating of the chucks and the oscillating of each chuck through a path of sixty degrees. In addition, the indexing of the ball-holding spindles must be provided for and the changing of the poles of the grinding operations must be accomplished.

Arrangement of Ball Carrying and Grinding Spindles

Referring now to Figs. 4 and 5 which show the machine from front and rear respectively, it will be seen that there are four spindles for holding the balls during the grinding. These spindles may best be traced from their rear ends,

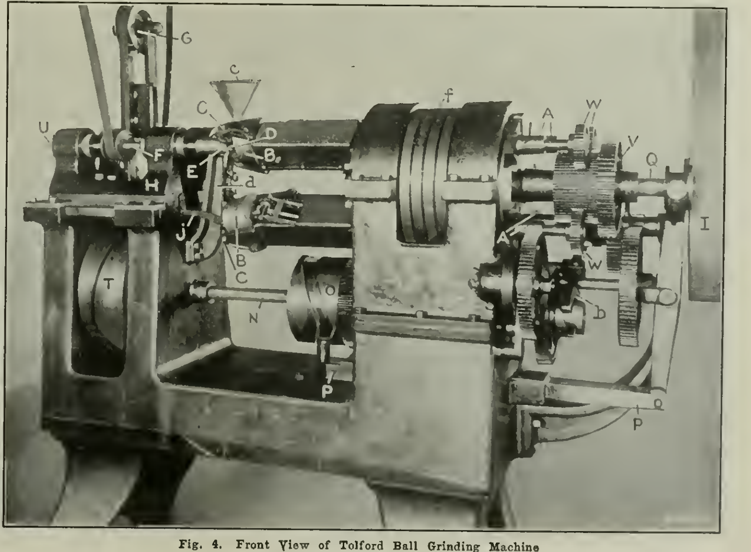

Fig. 4. Front View of Tolford Ball Grinding Machine

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* For information relating to the manufacture of steel balls, refer to the following articles previously published in MACHINERY: "The Manufacture of Steel Balls," February, March and April, 1912; "Some Tools Used in the Manufacture of Small Steel Balls," August, 1912.

† Associate Editor of MACHINERY.

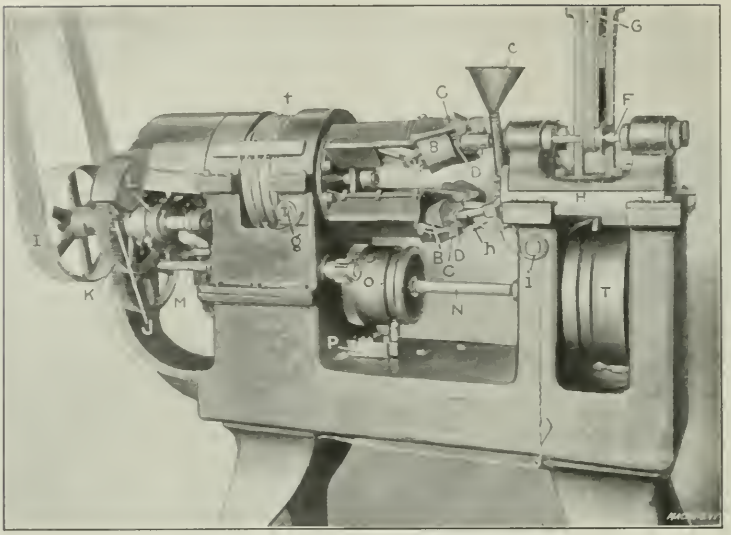


Fig. 5. Rear View of Tolford Ball Grinding Machine

which are indicated at *A*. At the forward end of the machine on each of these spindles are the oscillating chucks *B*. The spindles rotate at the same time that the oscillating chucks are swinging about fulcrums *C*, and the balls which are held in the magnetic chucks on the ends of the spindles are rotated as well as oscillated, and a part of the surface of the ball practically equal to a hemisphere is worked upon by the grinding wheel. By looking carefully at Figs. 4 and 5, some of the balls may be seen at *D*. Although there are four work-holding spindles carrying balls, grinding is only performed on the two upper spindles. The third spindle location is used for loading and the fourth spindle is in the ejecting position. One of the two grinding wheels is illustrated at *E*, and in shape it resembles a hollow hemisphere, as can be seen in Fig. 3. These are carried by the two upper spindles *F*. In both Figs. 4 and 5 one of the spindles partly hides the other. By means of an overhead driving belt that passes around the two grinding wheel spindles and an intermediate idler *G*, whose position may be relatively adjusted by a sliding standard on which it is mounted, the spindles are revolved. These two driving spindles *F* are mounted upon a carriage *H*, and this carriage advances and recedes at proper intervals to provide a clear path for the work spindles while indexing. The method of reciprocating the carriage will be touched upon later.

How the Various Movements are Secured

Turning now to the driving end of the machine, best illustrated by Fig. 6, in which the gear guards are shown removed, it will be seen that the main drive is received from the single pulley *I*. From this one drive, by means of the mechanism about to be described, all of the rotating, reciprocating, indexing and oscillating movements are secured except for the rotating of the grinding wheel spindles. Referring back to Fig. 5, it will be seen that the shaft upon which driving pulley *I* is mounted carries the small pinion *J*, the large driving gear *K* and the Carlyle-Johnson friction clutch *L*. Gear *K*, which can be best seen in Fig. 5, meshes with gear *V* which is at the center of the four rotating spindles, Fig. 4. Through a wide gear on the shaft by which gear *V* does the driving, rotation is carried to the four spindles by means of the four smaller gears *W*.

The Chuck Oscillating Mechanism

The function of pinion *J* is to rotate the auxiliary shaft *M* through connection with the gear at its left-hand end as viewed in Fig. 5. A pinion on the right-hand end of this shaft, where it emerges through the column of the machine, meshing with a gear on the cam-shaft *N* comprises the means of oscillating the work-holding chucks. This is accomplished through the action of cam *O* on shaft *N*. In this cam is a groove that guides a pin on beam *P* that extends through to the outer end of the machine as illustrated in Figs. 4 and 5 and in detail in Fig. 7. There is a rocker arm at the end of this beam that reciprocates shaft *Q* through a yoke and bushing. Now referring to Fig. 6, the inner end of shaft *Q* may be seen. This shaft marks the center of the four spindles and serves as a means for indexing them as will later be explained. A spider *R* is keyed to the end of the shaft *Q* and advances with it, under the action of beam *P* and the rocker arm just mentioned. Each of the four arms of the spider extends to one of the four work-holding spindles of the machine, and by means of yokes and collars on the spindles they are advanced or drawn back under the action of the spider. In order to make the oscillating action more clearly understood, Fig. 8 is presented. This represents the details of one of the chucks that are shown in general in Fig. 7. In Fig. 8, the spider arm for this spindle is indicated at *R*, governing the reciprocation of spindle *A*. The ball is shown at the end of the spindle at *D*. It is oscillated when spider *R* brings the spindle forward, causing sections *S* of the spindle to form a toggle joint as shown. This operation does not interrupt the rotation of the spindle, however, as

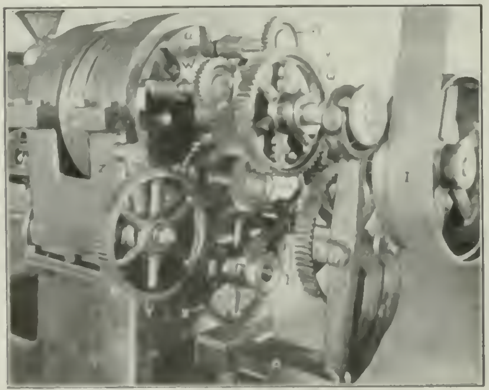


Fig. 6. Driving End of Machine with Gear Guards removed

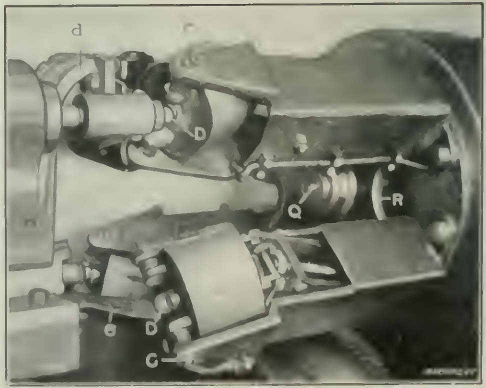


Fig. 7. Close range View of One of the Oscillating Chucks

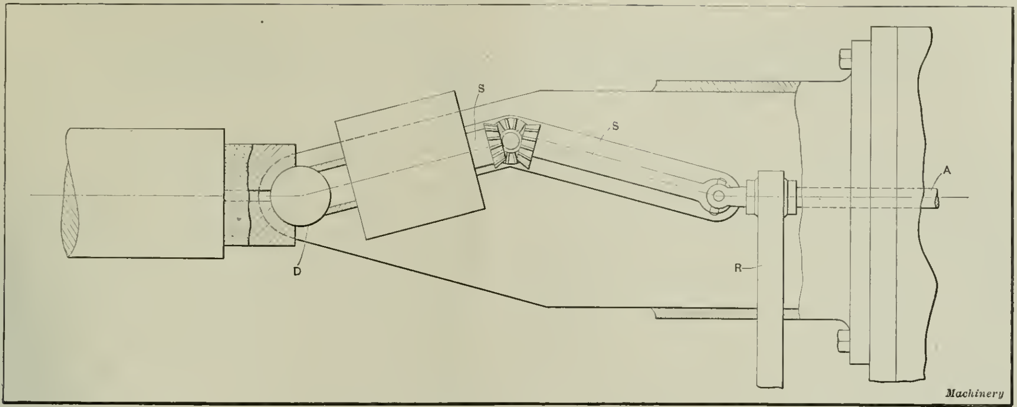


Fig. 8. Diagram illustrating Spindle Mechanism

by means of bevel gearing at the toggle joint the motion is carried through to the ball which may be seen on the chuck at *D*. This toggle motion is identical on all four chucks, being operated in the same manner for all four spindles as has been described and shown.

The Grinding Wheel Carriage

The manner of rotating and oscillating the balls while being ground having now been described, we may turn to the grinding spindle carriage above referred to. This is caused to advance for grinding the balls at one setting and then automatically retreat while the spindle indexing is taking place. In the face of barrel-cam *T*, Fig. 5, located on shaft *N*, is cut a cam-groove that guides a stud projecting downward from the bottom face of the grinding carriage. In accordance with the groove, the carriage, which is mounted on ways, is caused to advance and withdraw. The timing of the reciprocating agrees, of course, with the oscillating and indexing movements. The carriage is driven forward to exactly the same spot at each reciprocation, and to compensate for the wear of the wheel there are micrometer collars which may be seen at *U* on the ends of the grinding spindles. As a safeguard, the wheels are mounted with springs behind so that should a ball of too large a size be admitted to the machine by mistake, no damage will be done.

Method of Indexing the Spindles

We now come to an important part of the mechanism, namely, the indexing of the spindles. This is done by a modification of the Geneva motion and may be understood by referring to Fig. 6. Upon the end of the cam-shaft which extends back to the rear of the machine, there is a driving gear *X* which meshes with gear *Y* that is mounted on a stud extending from the column of the machine. Bolted to gear *Y* is a V-shaped arm *Z* that carries two roller studs that are spaced apart a distance equal to that between two of the eight slots in spindle carrier *a*. Arm *Z* being bolted to gear *Y* rotates continuously. At each revolution of gear *Y*, therefore, both of the pins on arm *Z* come into use, engaging successive slots in plate *a* and causing this plate, and consequently both spindles, to make an exact quarter turn. A locking bolt is provided for holding the spindles when not being indexed. This is not shown in the illustration. The object in using this double form of Geneva motion is to economize in the space between the center of plate *a* and the center of gear *Y*. It is essential that the oscillating and rotating motions of the spindles cease while the indexing takes place. This is accomplished by having a small cam on the end of gear *X* that, through a lever *b*, throws out clutch *L*, shown in Fig. 5, on the driving shaft. The throwing out of this clutch causes all motion to cease that would otherwise be transmitted by gear *K* through the gear train to the four spindles. As soon as the indexing has been completed, this clutch engages again.

Holding and Controlling the Balls while Being Ground

The holding of a perfect sphere by a small section of its surface is a difficult matter, but is well done on the Tolford machine by employing magnetism. Referring to Fig. 5 at *f* may be seen four commutator rings to which electric current is conducted. A switch *g* provides for shutting off the current. By means of brushes, the current is carried to each of the four spindles, terminating at the magnetic ball-holding chucks.

The Operation of the Machine

Having now seen how the various functions of the machine operate, we can turn to the operation of the machine on a "batch" of balls. The balls are placed in the hopper, which is shown at *c*, and perhaps can be best seen in Fig. 5, although it is shown in Fig. 4. The balls are carried to this hopper by means of a simple endless bucket chain which was not on the machine when the photographs were taken. After dropping down the chute, the balls are fed, one at each indexing, to the chuck on the spindle that may be seen at the end of chute *h* in Fig. 5. They are fed one at a time by using the familiar powder flask feed in which a gate is dropped down behind the feeding of each ball. The ball *D* in Fig. 5, after being held on the magnetic chuck, is carried with the indexing spindle to the upper position which is the first of the grinding positions. Here at the upper position, visible in Fig. 5, it is oscillated and revolved in connection with the end-working grinding wheel previously described. After the grinding time on this pole has elapsed, indexing brings this ball to the upper position at the opposite side of the machine, visible in Fig. 4, where it comes into contact with another end-working wheel. In order to work successfully, the timing of the indexing, oscillating, grinding carriage, and other movements must be absolutely accurate. All of these timed operations are controlled from cam-shaft

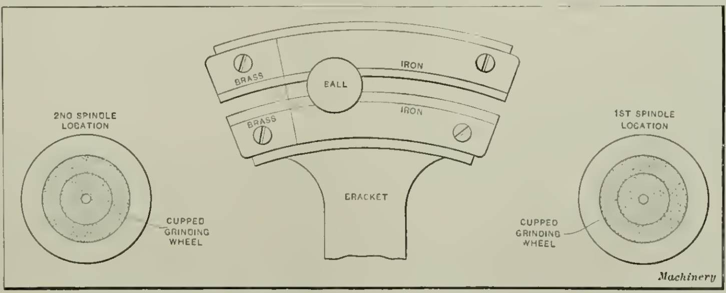


Fig. 9. Diagram illustrating Method by which Position of Ball in Chuck is changed

N, the indexing taking place every twelve seconds. The carriage holding the grinding wheels retreats just before the indexing period, and returns as soon as the indexing is done.

Changing the Location of the Ball in the Chuck Between the Grinding Operations

At the time of this indexing, however, an important operation takes place by means of which the position of the ball in the chuck is changed, thus presenting a new face to be ground. By referring to Fig. 7, in connection with the line illustration Fig. 9, an idea of how this is done may be secured. In Fig. 9 the spindles and ball-holding chuck have been omitted for clearness. There is a curved bracket *d* directly between the two grinding spindles and in the arc that the balls must traverse when the spindles index carrying the balls from one grinding operation to the next. On the face of this bracket there is a curved path or groove, formed of separated strips of metal. As shown in Fig. 9, the strips that form this path are of iron on one end and of brass on the other end. The steel strips are magnetized, the switch being shown at *i* in Fig. 5. By shifting the strips, the demagnetizing point may be changed at will. The path on the bracket is so located that when indexing, the ball just grazes the path groove. As soon as the spindle and its ball reach this bracket in the process of indexing, the magnetism in the ball-holding chuck is automatically cut out, and the magnetized path in the bracket attracts the ball. Thus the ball tends to cling to this path while it is passing, and though the grip of the chuck is broken, the ball is still loosely held in position, and the indexing causes it to turn on its axis while passing this path. By the time it has reached the "brass" section of the path, it has rolled slightly in excess of one-half revolution. Just as the ball leaves the magnetized portion of the path in the bracket *d*, magnetism is resumed in the ball-holding chuck, and as there is no counteracting attraction in the "brass" part of the path, it is picked up again by the chuck ready for the next grinding position. After undergoing another grinding, indexing takes place again, carrying the ball to the lower position shown in Fig. 4. This is the ejecting position, and, magnetism being cut off from the chuck, again the spring finger *j* causes the ball to be thrown out of the chuck and into a box from which it is taken by the automatic feed (not shown), and sent around the machine again. Before the spindle reaches the next position, which is the loading position, magnetism is again taken on by the chuck, and it is ready to receive a new ball from the powder flask feed.

It will be remembered in the description of the operation of the machine, it was stated that there were certain periods during which the magnetism was automatically released from the chuck. These are two in number at each indexing; one at the time the ball is being changed in its position in the chuck between the indexing, and the other at the time of ejection from the machine. This is accomplished by having fiber inserts in the commutator rings *f* so that the current is cut off while the brushes are passing over these sections. The current of the commutator rings is controlled by the switch *g*, and the current that is in the path bracket is controlled by switch *i*.

The grinding wheel spindles rotate at a speed of 15,000 R. P. M. and the ball-holding spindles turn at an approximate rate of 100 R. P. M. The oscillation of the chucks takes place at every indexing, or once every twelve seconds. At each grinding about 0.001 inch is removed from the section worked upon. In all, about 0.003 inch is taken from the balls in rough-grinding, and to do this the balls pass through the machine on an average of four times.

It is recommended that these machines be used in pairs; that is, one machine for rough-grinding and the other for finish-grinding. The machine is most efficient when working on balls three-eighths inch diameter and over, although, of course, a smaller sized machine would take care of the small balls equally well. It is claimed by the designer that in addition to turning out balls with a better finish, it will, on account of its more efficient grinding principle, grind balls much faster; it takes less power to operate; the cost of wheels is very low, owing to the fact that a one-inch wheel is of ample size for most commercial sizes of balls and the wheels do not wear out of true.

RESPONSIBILITY OF DIRECTORS

BY CON WISE

We have lately been seeing some of the results of directors failing to direct a railroad. It brings up the old problem of who shall manage any enterprise—whether it be commercial, industrial or what not. It has been pretty generally understood that an individual superintendent, or manager, can not be held responsible for results unless he is put in a position where he can do about as he pleases. The most important function of the board of directors was agreed to be the selection of that manager. Just now we are running on the other tack. We feel that the directors are trustees in whose hands the stockholders and the general public which the corporation serves have placed the management of the concern, and that they are responsible for everything done by those men whom they select to do the actual work. If this is to be the rule it will necessitate a very decided change in another way. If directors are to direct, it is necessary that they should know what they are directing and how to direct it. That is, every man on the board should be competent to step in and take the place of the manager. Not only should each one be competent, but he should be sufficiently conversant with what is actually going on so that he can step in at any time.

As we see this, it means that boards will have to be made up of men that are on the job in responsible positions, instead of being made up of financiers. If it does produce that result it cannot help but be a step in the right direction so far as the legitimate purpose of the corporation is concerned. There will be less violent fluctuation of the value of stock for the benefit of those on the inside who are now so easily able to make a "killing" whenever they feel the need of a little extra pocket money. It will produce more or less hesitancy about investing on the part of those whose idea of profits is to take something away from someone else, but we cannot feel that that would be an irreparable loss. The great bulk of investment is held by people whose income is dependent on the steady return of dividends, and not on the fluctuations of the market. These people, and they are really the ones that hold the money of the nation, will feel much safer in making their investments if they know that the mechanical industries of the country are in the hands of mechanics, and the agricultural interests in the hands of farmers.

The capital stock of machine tool manufacturers has never been widely distributed among the general public for the two following reasons among others: first, that no serious attempt has been made to distribute it; and second, that it has always been in the hands of people who would not resort to the methods of exploitation that have been the common practice with railroads and some other commercial ventures. If the wild cat element can be taken out of these latter securities, as we believe that popular opinion will make necessary, there will be a much better chance for the purely industrial stocks, because then they will all be on one basis. The manufacture of machine tools is always bound to be more or less seasonal. There are two reasons only for buying machinery, one because of improvements which necessitate throwing out the old; the other, the advent of new business. Machine tools practically never wear out. That is, wear can be repaired very easily and very cheaply if taken in time. New business only comes when all business is advancing steadily. Until we reach the millenium we are not likely to strike that condition. In the meantime the only way that the business can be stabilized is to carry a stock during dull times, and that means the use of more capital, which cannot be easily obtained while other lines of business make such plausible claims for its use.

* * *

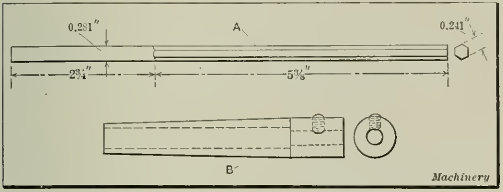
It has been estimated that out of the $100 paid by a first class passenger for a trip across the ocean, $6.50 goes toward paying the salaries and wages of the officers and crew of the vessel; $8.25 to provide food; $4.75 to insurance; $1.75 to repairs, $10 to pay port duties and other expenses while in port; $2.75 to agents; $3.50 to administration and main office expenses; $25.50 to pay the coal bill; $9.00 for depreciation of the vessel; and the remainder, about $28, constitutes the profit of the company.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

GRINDING VS. MILLING

Many articles on grinding vs. milling have appeared in the different mechanical journals but most of them have dealt with the grinding of cast iron on improved types of surface grinders or disk grinders. It is a generally recognized fact that a great deal of time and money has been lost by those manufacturing plants that have failed to take advantage of the improved method of production which grinding machines offer for handling certain classes of work. As an example of this, I may mention one particular job on which a saving of from ten to twelve hours per piece was effected through the use of the grinding machine. The part shown at *A* is a drawing punch used for producing seamless brass shells. It is necessary for this punch to be of a uniform hexagon shape and to have a taper of 0.001 inch in its entire length, in order to make it possible to strip the drawn shell from the punch. The stripping operation is performed by having the lower edge of the die engage the shell and strip it from the punch on the up-stroke of the press.



Drawing Punch to be ground and Work Holding Fixture

The method formerly employed for making these punches involved turning, milling, filing, hardening, straightening, grinding and lapping, in the order named. Owing to the slenderness of the punch, this work had to be handled very slowly and each punch cost about $5. Anyone who is familiar with the operation of drawing seamless shells will realize that the expense connected with using such costly punches would be considerable. Punches are seldom worn out. No matter how careful the press operator may be, he is likely sooner or later to put a shell on the punch in a way that causes the punch to be broken. The grinding method now used for making these punches has reduced their cost from $5 to 29 cents each. As the punch comes from the grinder, it is merely necessary to stone the corners and polish to give it the required finish. The only tools necessary for this purpose consists of the work-holder shown at *B*, and an index mechanism arranged on the No. 2 Landis universal grinder on which the punches were ground.

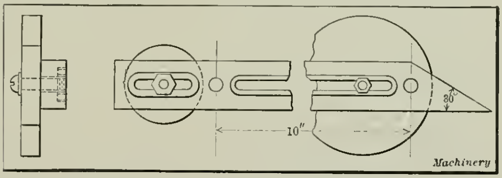
The arrangement of the index mechanism used for grinding these punches was as follows: The headstock spindle was taken out of the machine and six 7/16-inch holes were drilled in the periphery of the pulley used for driving the spindle when the machine is employed on chucking work. A milling machine with a vertical attachment and dividing head was used for locating these holes accurately. The holes were bushed to ¼ inch in diameter, after which the spindle was placed in the head of the machine and adjusted ready for use. The headstock was next taken to the drill press, where a hole was spotted in the headstock casting through the bushed hole in the pulley, which is of hollow construction and extends backward over the casting. When the spotted hole was drilled and bushed and the index pin made, the grinding of the punches was carried out with comparative ease.

The punches were made from letter M drill rod which was cut off to the required length and centered in a screw machine, after which the hardening and straightening operations were performed. The shank was next ground to a diameter of 0.281 inch, using a back-rest to provide the necessary support. The hexagonal end of the punch was then ground, using the special work-holder *B* which fits in the taper hole of the spindle and supports the work very rigidly. A 60-grain grade P aloxite grinding wheel was used, and it was found possible to rough-grind each side of the hexagon to within a few thousandths of the required size without springing the work. Two finishing cuts were then taken on each side of the hexagon. The work was finished complete without being taken out of the machine and about fifteen minutes was required to complete each punch. As the periphery of the wheel was used, each side of the hexagon was naturally a little concave, but this error was found to be negligible when using a wheel 10 inches in diameter. For the particular work for which these punches are used the concave sides are slightly advantageous, as the corners are brought up sharper than would otherwise be the case. The saving effected by this method of making the punches may seem unusually large to some readers, but if they will try making a similar punch by the two methods they will soon see that no exaggeration has been made in stating the case.

Newark, N. J. JOHN MAHON

PRECISION METHOD OF MEASURING ANGLES

Guy H. Gardner's description of precision methods of measuring angles, which was published in the October number of MACHINERY, seems to call forth one or two criticisms. If the scale used does not have a perfectly sharp corner in contact with the work, an error will be noticed. If the corner of the scale is bruised even enough to allow it to drop 0.001 inch, the resulting error in the angular measurement would amount to about 30 seconds. This is sufficient to emphasize the importance of the criticism without requiring further comment. It also appears that the clamped scale and indicator method shown at *B* in Fig. 2, could be applied in the case of the sine-bar by clamping it at the required angle, as is done with the scale. Perhaps a better method would be to clamp it high enough from the surface plate to enable the work to be inserted between the sine-bar and the plate.



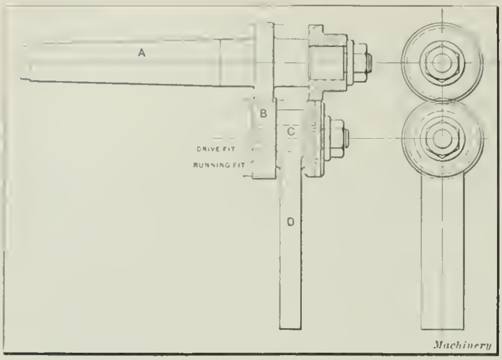
Universal Form of Sine-bar and Angle Gage

Many ingenious methods of obtaining and measuring angles have been described in MACHINERY, but I believe no one has described the universal gage shown in the accompanying illustration. It will be seen that this is a sine-bar provided with two slots and two screws for clamping disks of various diameters to obtain different distances between their centers. The bar is provided with one angular end which is found convenient in many cases. The slots are also found useful for clamping the bar to an angle-plate. The length of the bar will, of course, be decided by the character of the work, but having a distance of 10 inches between the buttons makes the calculations particularly easy to handle.

Turtle Creek, Pa. WILLIAM S. ROWELL

A GRADUATING DEVICE

The accompanying illustration shows a device for graduating index collars that has given very satisfactory results. It will be seen that the mandrel *A*, which is fitted to the lathe spindle, holds the work at its end and has a gear cut

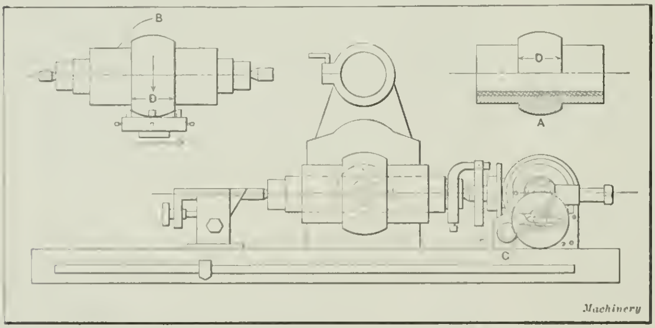


Gear driven Device for graduating Index Collars

from the solid metal. The gear on the mandrel meshes with the gear *B* which is keyed to the stud *C*, mounted in a holder *D* that is carried in the toolpost of the lathe. The graduating roll is keyed to the stud *C* and fed into the work, the graduation lines and figures being slowly rolled into the index collar in this way. The advantage that the geared drive for the graduating roll has over frictional contact of the roll and work, is that there is no possibility of the relative positions of the work and the graduating roll shifting, which would result in either impairing the accuracy of the graduations or entirely spoiling the work. H. F. D.

TURNING A BALL WITHOUT SPECIAL TOOLS

Not long ago, while working in a small jobbing shop, I was called upon to machine twelve self-aligning bearings of the type shown at *A* in the accompanying illustration. It was desired to produce the spherical surfaces as quickly as possible and with as small an outlay for special tools as was consistent with the necessity of holding the work within a limit of 0.0005 inch. The spherical surface of these bearings was 10 inches in diameter.



Method of machining Cylindrical Surface on Milling Machine

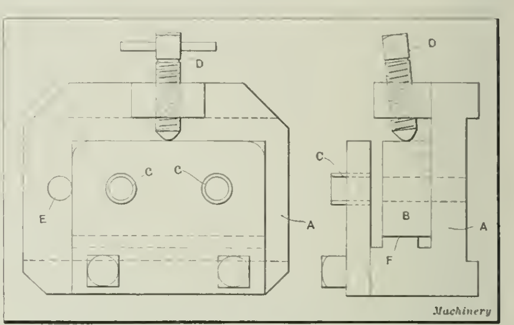
In handling this work, the first step was to babbitt the bearing and bore it to the required size. The work was then mounted on a mandrel and after removing the scale, the ends of the spherical bearing were faced and the shoulders *B* turned to within 1/64 inch of the required size. The work was next set up on the index centers of the milling machine, and while the cutter revolved in the direction shown by the arrow, rotation was also imparted to the bearing by means of the index crank *C*, the direction of rotation being shown by the arrow.

The accuracy of the spherical surface produced by this method depends upon the alignment of the center of the sphere with the center line of the milling machine spindle. Care should be taken to determine the alignment of these centers before the work is started. After finishing the spherical surface, the shoulders *B* were finished on the lathe. The cutter used for milling the spherical surfaces was of the inserted-tooth type and was made in the shop where the bearings were machined. The distance between opposite teeth of the cutter should be a trifle greater than the dimension *D* of the spherical bearing, but the distance between the teeth should not be great enough to allow them to strike the shoulders *B* on the bearing before the spherical surface has been turned to the required size. The results produced by this method proved entirely satisfactory, and the work was accepted without question.

New Haven, Conn. George Slider

DRILL JIG FOR RAPID PRODUCTION

In the September, 1914, number of Machinery, a short article was published entitled, "Drill Jig for Rapid Production." The accompanying illustration shows a jig for the same purpose, that is similar in construction but handles the work more rapidly. The base *A* of the jig is made of cast iron and arranged to suit the requirements of the work *B*. The bushings *C* are held in a bushing plate in the usual way.



Improved Type of Drill Jig with Means for Quick Clamping

The clamping of this jig is a simple matter and can be done very rapidly. One-half turn of the screw *D* clamps the work in the chuck. The 3/16 by 2 inch steel pin driven through the head of the screw enables it to be easily turned with the fingers. In loading the jig, the work is brought into contact with the steel pin *E* and face *F* on the jig, after which the screw *D* is tightened and the work is ready to be drilled. As the chips usually fall on the base of the jig when removing the work, they must be removed before another piece is put in place. An old brush can be used to clean out the chips from the jig.

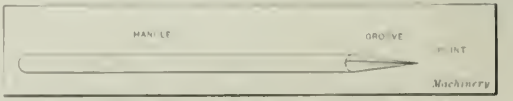
Toledo, Ohio. William H. Wolfgang

SPECIAL WOODEN DRAFTING PEN

It was necessary to send out good clear prints of a drawing which was expected to be changed later. To meet these requirements, we used a pen made of box-wood, sharpened down to a point and with a groove at one side as shown. The use of this pen saved a great deal of labor in erasing, as we found it much easier to erase lines made with it than would have been possible where an ordinary steel lettering pen was used. It is surprising how clearly a pen of this kind will write and the length of time that it will hold its point.

Lynn, Mass. R F. Pohle

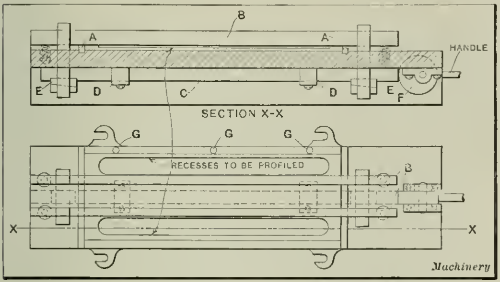
[The use of box-wood pens of the type referred to is not unusual in drafting-rooms, where they are found to give ex



Box-wood Drafting Pen which makes Lines that are easily erased cellent satisfaction for certain classes of work. Mr. Pohle's reference to the ease with which lines made with such a pen can be erased is new to us. The explanation is evidently found in the fact that the box-wood pen does not cut into the surface of the paper or tracing cloth as an ordinary pen will do. As a result, it is merely a case of removing the ink from the surface of the tracing cloth or paper instead of having to get it out of a diminutive channel made by the pen-point.—EDITOR.]

CLAMPING DEVICE FOR THIN WORK

A simple and useful clamping device for holding thin plates that are to be milled or profiled is shown in the accompanying illustration. This consists of a cast-iron base provided with four lugs for fastening it to the table of the milling machine. Referring to the cross-sectional view, it will be seen that stops *A* are provided to engage the ends of the work. If shorter pieces are to be machined, other slots can be cut in the base of the fixture and the stops placed in them. In this way, the fixture can be made to accommodate many different lengths of work.



Device for clamping Thin Work on Milling Machine

The two clamp bars *B* are forced down onto the work through the action of the slide bar *C* which is carried in two bearings *D* and provided with two wedges *E*, forced forward by means of the eccentric *F*. When the handle that turns the eccentric is brought to the vertical position—which releases the wedges *E*—a spring pulls the slide bar *C* back, allowing bars *B* to be raised by the small springs under them. The finished plate can then be removed and a fresh plate put in place. Caps are placed over the springs that raise the clamping bar, to exclude chips. The pins *G* also act as stops for locating the work sidewise. This clamping device has been found particularly useful in profiling recesses in plates ⅛ inch thick and of different lengths.

Schenectady, N. Y. CHARLES SERTL

BABBITT BEARINGS

The purpose of this article is to describe a form of babbitt spindle bearing that has been found to give exceptionally satisfactory results and to explain the method of procedure followed in molding and machining bearings of this type. Fig. 1 shows one of the half bearings, and it will be seen that flanged ends are provided to take the spindle thrust. The bearing is finished all over.

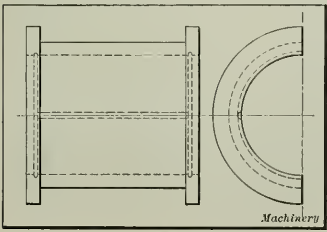


Fig 1. One of the Babbitt Spindle Bearings

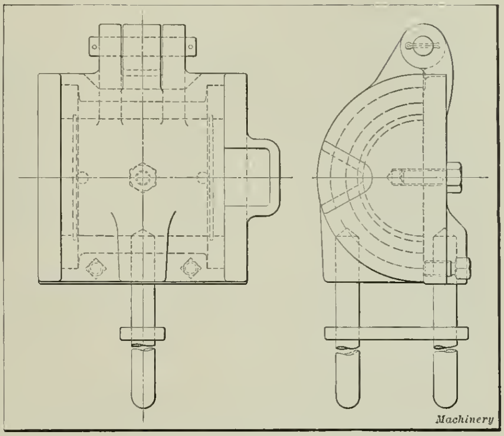


Fig. 2. Mold in which Babbitt Spindle Bearings are made

The mold for making these bearings is shown in Fig. 2. It will be seen that it is arranged with a semi-cylindrical mandrel secured to the base by means of cap-screws. The cover is hinged and provided with a handle for opening and closing it; and there is a second handle in the base of the mold, connected to the first by a plate with holes in it, through which the handles are slipped to clamp the cover down on the mold. The two screws in the front edge of the base are screwed down against the cover to force the cover up in case it sticks so that it cannot be easily lifted by the handle. The pocket at one side of the base is used for pouring the metal into the mold; this pocket is fairly large and allows the metal to flow freely. As this bearing is to be machined after pouring, an allowance is made in the mold to provide 1/32 inch of metal for finishing on all surfaces that are to be subsequently machined.

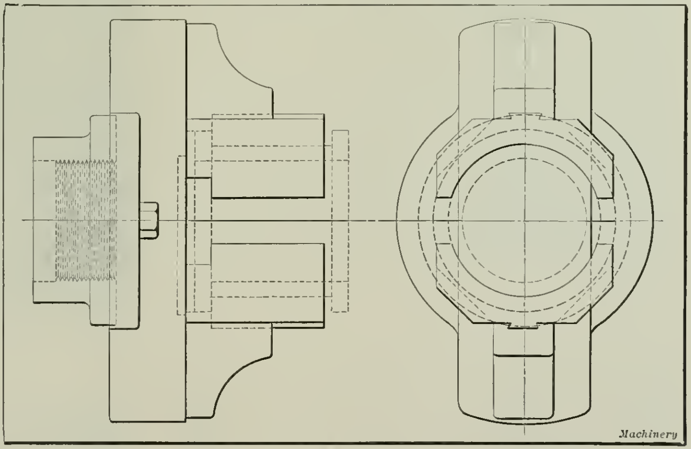


Fig. 3. Two-jaw Chuck for holding Bearing while boring and facing One End

After the metal has been poured and allowed sufficient time to cool, the bearing is taken to the trimming press where the riser from the mold is cut off. The bottom of the half bearing is then milled off, after which the bearing is bored, and turned and faced at one end. Fig. 3 shows a two-jaw chuck with special jaws for holding two half bearings in place while they are being bored, faced and turned on the lathe. After these operations have been completed, two of the half bearings are mounted on a mandrel of the form shown in Fig. 4, ready to be turned and faced at the other end, and to have the outer surface finished. The bearings are first held on the mandrel with clamps of the form shown in Fig. 5 ready to have the end faced and turned, the nut and ring being set back to provide for handling this operation. The nut is then screwed forward against the finished end of the bearing and the clamp is removed to provide for facing the inside edges of the flanges and turning the outer surface of the bearing. After this work has been done, the bearing is completed and is ready to be assembled on the machine in which it is used.

W. P. W.

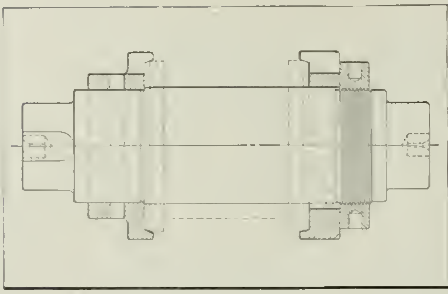


Fig. 4. Mandrel on which Bearing is held for Turning Operation.

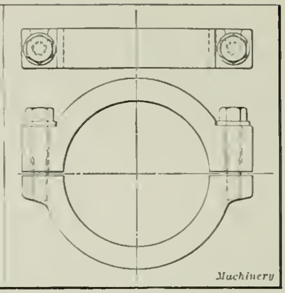


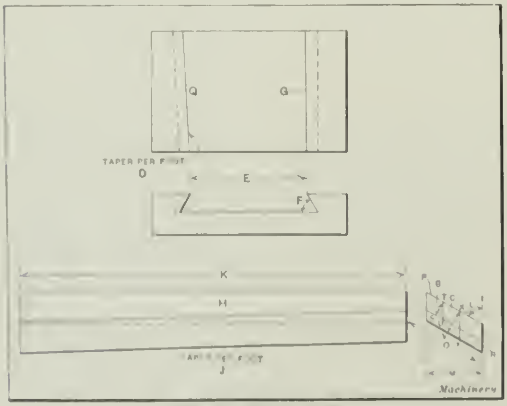
Fig. 5. Clamp for holding Two Bearings

DIMENSIONING TAPER GIBS

Taper gibs, although a very common detail of machine design for taking up wear caused by side pressure on the ways of machine tools, seem to be a feature to which too little time and attention has been given. Articles have appeared in the different mechanical publications from time to time touching upon the dimensioning of this type of gib so that its greatest width would be shown at a glance, which would assist in the preliminary operations on the rough casting. This seems to be a step in the right direction, but it is not enough. The methods in use at the present time, in many cases do not give the men in the shop all the information which a machine drawing is supposed to impart.

The dimensions in the accompanying illustration show quite clearly the point made. The dimensions on the slideways are correct and give all the information necessary for the machining of this part: E shows the width at the narrowest point; the taper per foot D shows the amount the piece of work must be set over on the table of the machine after the side G has been finished; and the angle F shows the angular setting of the tool-head to bring the slideways to their correct proportions.

The gib H, which is to be inserted between the slide and the above-mentioned ways, is the part that is here under consideration. The dimensions J, K, L, M, B and occasionally O are those commonly given. If the taper per foot of the gib at right angles to the surface P were the same as the taper per foot of the line Q as given in the illustration of the slideways, these dimensions would be all that would be required; but it will be found that if in the machining of the gib on its sides R and P, it is thrown up at one end the amount shown by J for each foot of length, it will not fit into its position by a considerable amount, which increases as the taper per foot is increased. This is the point which is many times left to the shop foreman to work out. One reason why this feature is not brought to light more often is that a gib planing fixture is used, which has been correctly figured by the tool designer; but nevertheless the fact remains that the working drawings should give complete information, so that the shop man will have no figuring of any kind to do in case he has no jigs or fixtures to aid him. In other words, the dimension C is required.



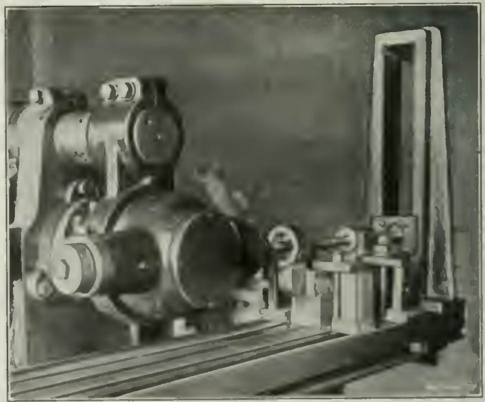
Dimensions for Taper Gibs

It will be well to assume the dimension B to be $\frac{3}{8}$ inch, the taper D, $\frac{1}{4}$ inch per foot as shown on the slideways, the gib length K, 12 inches, and the angle L 60 degrees. By figuring the triangles STU and VXY it will be found that the dimension C is not $\frac{5}{8}$ but 0.591 inch. This article may bring forward a further discussion of this subject.

Central Falls, R. I. NORMAN R. EARLE

MILLING MACHINE BORING-BAR

The accompanying illustration shows a boring-bar which I recently made for use on a No. 3 Cincinnati miller. This bar is driven by a vertical head which is swung around to a horizontal position. An outer bearing for the bar is clamped to the column at the far end of the table, this bearing being adjustable for wear. The work shown clamped in position on the table is a frame for a quick-acting chuck. The piece is bored, counterbored and faced at a single setting.

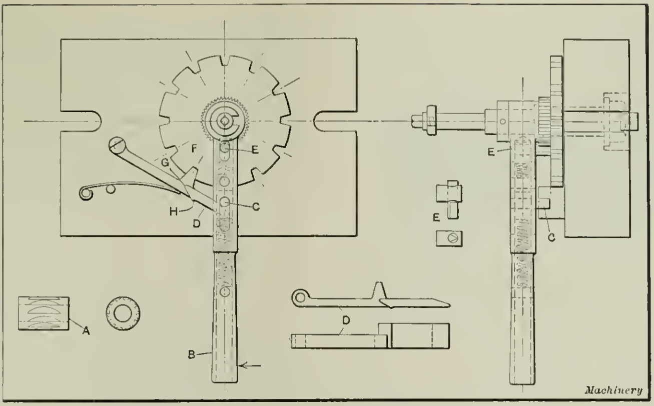


Milling Machine with Boring-bar mounted in Vertical Head

Beverly, N. J. ARTHUR A. BAUMGARTNER

QUICK-SHIFTING INDEXING FIXTURE

The accompanying illustration shows a quick-shifting indexing fixture for use on a milling machine engaged in milling the teeth of ratchets of the form shown at A. The blank is held on the fixture by means of a screw and slotted washer, the arrangement of which is clearly shown in the side view. The operation is as follows: The handle B is moved in the direction of the arrow, causing the pin C at the end of the oblong slot in the handle to force the pawl D out of its slot in the dial. As soon as the pawl is out of the slot, the V-shaped pin E, which is kept engaged with the ratchet F by a spring, will cause the shaft to which the dial is keyed to revolve. When the pin C has reached the point G, it will



Quick-shifting Indexing Fixture used in milling Teeth in Ratchet

release the pawl, which is then thrown back into contact with the dial by a spring. As the dial continues to revolve, the pawl will drop into the next slot and locate the work for milling the next tooth.

In returning the handle, the pin *C* will travel on the opposite side of the pawl, and when left in the curve *H* the spring behind the pin will hold the pawl *D* securely in the slot in the dial. The spring behind pin *E* is made just stiff enough to keep the pin from slipping when the pawl is out of a slot in the dial. The teeth in the ratchet *F* were cut with an ordinary thread cutter. This fixture is used on a hand miller and the teeth in the blank are cut with an ordinary angular cutter. This system of shifting could easily be applied to a horizontal attachment, and by substituting a center for the stud and inserting a ball thrust bearing, it could be used instead of an index head where quick shifting is desirable. For those classes of work for which it is adapted, a fixture of this kind enables a very satisfactory rate of production to be attained.

Schenectady, N. Y. ALFRED WISTRUP

CREAM SEPARATOR USED AS AN OIL FILTER

In one of the Western states, there is a hydro power plant used for pumping water for irrigation purposes. The equipment of the plant consists of horizontal turbines which are direct-connected to centrifugal pumps. Part of one of these units is shown in Fig. 1. The stuffing-boxes *A* of the turbines are supplied with a constant stream of water regulated by a valve, for the purpose of sealing them so that water, instead of air, is drawn into the draft tubes through the stuffing-boxes. Incidentally, the water keeps the packing cool and lengthens its life. In order to be sure that the required condition is secured, it is necessary to supply a little more water than will be drawn in by the draft tube. Sometimes the water is very muddy and at other times it is clear, so that although the volume may have been very closely regulated, it occasionally happens that, without warning, the sediment in the pipes and stuffing-boxes is washed out and a stream of water flows along the shaft and enters the bearings *B*, displacing some of the oil in the reservoir and forming an emulsion with the rest.

The plan finally adopted to overcome this difficulty consisted of placing deflectors *C* on the shaft between the stuffing-boxes and the bearings. These deflectors were made of four circular disks of canvas stitched together, soaked in tar, and then bound onto the shaft with twine. With the pumping units equipped in this way, the water follows the shaft until it comes to the deflectors, when it is carried to their outer edge and thrown off by centrifugal force. The water is caught in a pan placed to receive it and carried off through a drain pipe. Before this plan was adopted, a considerable quantity of oil contaminated with water had been accumulated. Several forms of filters were tried in the hope of finding a method of separating the oil from the water, but none of these methods proved successful until someone suggested that a cream separator might accomplish the desired result. A second-hand machine was purchased and the results secured with it were all that could be desired. Not only was the oil and water perfectly separated but all of the grit and dirt was removed from the oil, leaving it in fit condition to be used again in the bearings. The method of procedure was to heat the oil and water until it was quite warm, then to pour it into the receiver of the cream separator and operate the separator just as it would be used for its regular function of separating the cream from milk.

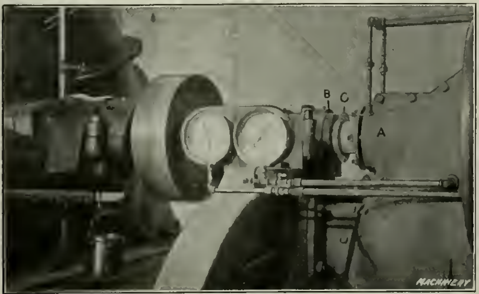


Fig. 1. Turbine Unit in which the Oil became contaminated with Mud and Water

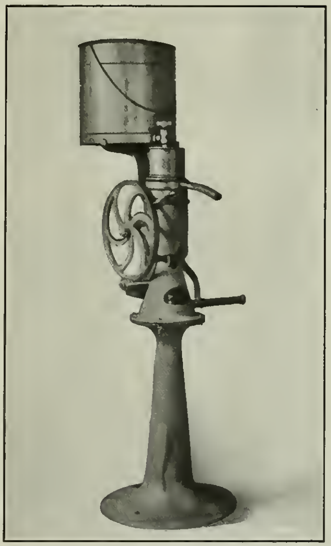


Fig. 2. Cream Separator used for removing Water from the Oil

A. J. HUMPHREY
Palisades, Colo.

COST DATA AND THE DRAFTING-ROOM

An editorial entitled "Cost Data Urgently Needed," published in the October number of MACHINERY, reminds the present writer of how little data is available in many drafting-rooms concerning the cost of material used in machine construction. Many draftsmen with good technical training cannot estimate the costs of materials and standard machine parts within even reasonable limits. This feature is given no attention in their college training and outside experience has taught them little in regard to the matter. When a designer determines the kind and quantity of material to be used, he should be guided to a considerable extent by balancing costs with comparative values.

The writer recalls an instance in designing a certain machine part, where unusual conditions made it desirable to specify a special material. After leaving the drafting-room, the blueprints passed through the usual routine in the superintendent's office, the estimating department, etc.; but after the machine was built, the designer learned that another material had been substituted owing to the high cost of the material called for on the blueprint. As this material was not suitable for the service required of it, it was but natural that the result obtained was unsatisfactory. Such incidents would not be likely to occur if the "powers that be" realized the value of furnishing the drafting-room with complete data on the cost of all materials which are used in the factory.

Moore, Pa. John Leafstrom

ACCURATE TAPERED PLUG GAGES

The writer was recently called upon to make a number of accurate tapered plug gages of various sizes up to 2 inches in diameter, and after studying the requirements of the work the following method was employed. The tool shown in Fig. 1 was made quite heavy to enable it to withstand the severe treatment which such tools frequently receive at the hands of the tool boy, etc. The two yokes *A* were rough-turned from machine steel forgings and the surfaces *B* were then ground on a surface grinder to insure having them parallel. The pieces *C* were made of tool steel; they were hardened, after which the surfaces *D* were ground and the surfaces *E* ground and lapped. The slots were made 1/16 inch larger than the screws, in order to provide for the required amount of adjustment.

This tool was used for gaging the tapered plugs while grinding, the method of setting for the proper taper in inches per foot being as follows: The block shown in Fig. 2 was made of machine steel with the holes of accurate diameter and accurately spaced between centers. Assuming that a plug is required with a taper of 1¼ inch per foot and 1 inch in diameter at the large end, it would be necessary to use accurate 11/16 and 1-inch plug gages in connection with the block. As the center distance of the holes in the block is exactly 3 inches, it will be evident that the difference in diameter of the plugs should be 5/16 inch to correspond to a taper of 1¼ inch per foot. In setting the gage shown in Fig. 1 all that is necessary is to insert the standard plugs in the block, Fig. 2, and then set the parallels to engage the protruding ends of the plugs. In case other tapers than 1¼ inch per foot are required, it would be necessary to make extra plugs with shanks to fit the holes in the block, and with the protruding ends of the proper diameters to correspond with the required taper.

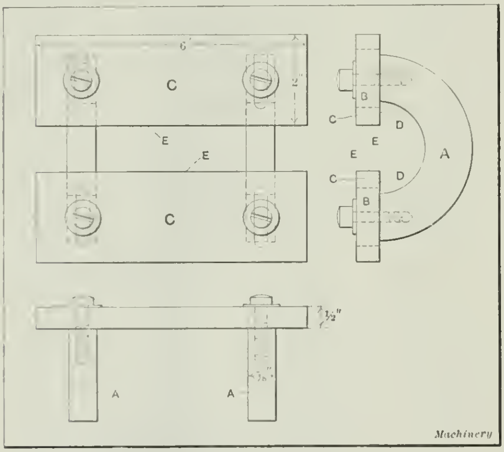


Fig. 1. Gage for measuring Tapered Work

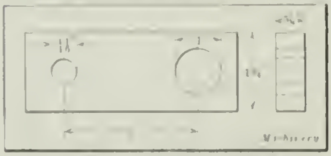


Fig. 2. Block for holding Plug Gages used for setting Gage shown in Fig. 1

The gage shown in Fig. 1 will be found useful in any grinding department as it is a simple matter to duplicate a special taper for a reamer or similar tool. A convenient method of using the device in a shop where the light is poor is to clamp a piece of cold-rolled steel in the vise and then clamp the taper gage to it. In this way the position may be adjusted in order to have the light fall in the required place. An adjustable stand to support this gage could also be made very cheaply. This would have a base to stand on the floor near the grinder and would be placed in the proper position to take advantage of the light. The use of such a stand would save the operator walking from the grinding machine to the bench for testing the taper on his work.

Newark, N. J. John Mahon

SUGGESTIONS REGARDING THE DEVELOPMENT OF PATENTS

Articles frequently appear in the technical press describing the difficulties encountered by inventors of limited means in perfecting their ideas and getting them adequately protected by patents. It would doubtless be to the interest of this class of men to know that there are a great many ideas constantly being worked out by engineers of unquestionable integrity, and if the embryo inventor knew that there are capable engineers ready to help him with good sound advice, there would be a smaller number of patents granted each year and the patents granted would be on ideas that had actual value. There appears to be a feeling among inventors of limited means that the service of a mechanical engineer is beyond their reach; and as a result, such inventors seek the advice of men who are not fully qualified for the work, but appear to be the best obtainable under the circumstances.

It might be of interest to the man with an idea which he wants to develop and patent, to know that the services of a high-grade, conscientious engineer are not beyond his reach; that if he submitted his idea for the consideration of such an engineer he would get the same class of service that is rendered to a large corporation, and that he could depend on such an engineer to give him fair treatment and reliable advice at a moderate cost. Furthermore, if such an engineer tells him that his idea is impractical and not worth patenting, he can take it for granted that the engineer knows what he is talking about and that he is really working in the interest of his client when he gives him an unfavorable opinion. On the other hand, if the engineer's report is favorable, the inventor may rest assured that he is not being guided by mercenary considerations when he recommends changes in design, for it is up to the inventor to adopt the suggestions or reject them. It is regrettable that our patent laws are so flexible that unscrupulous persons are able to take advantage of inexperienced inventors and "get away with it," but until the laws are changed, the writer's advice to the inventor is to consult a reputable mechanical engineer and at least get his opinion concerning the value of the idea before proceeding to obtain a patent on it.

Indianapolis, Ind. Frederick C. Frank

HARDENING HIGH-SPEED STEEL TOOLS

Of all the different methods for protecting the cutting edges of high-speed steel tools during the hardening process, none have proved more satisfactory or given better all-around results than that recommended by the Vanadium Alloys Steel Co. for the treatment of "Red-Cut" cobalt high-speed steel, this information being published by the company's selling agents, McKenna Bros. Brass Co., Pittsburg, Pa. When one stops to consider the delicacy of the cutting edges of such tools as formed cutters, dies, taps, etc., and that the cutting edges of such tools scale off less than 0.001 inch in the hardening process, if treated according to the following method, information on this subject will be recognized as a matter of vital importance.

Before entering upon a discussion of the method which it is the purpose of this article to describe, it will be of interest to know that it has been found to give equally good results when treating other high-speed steels such as "Novo," "Rex A-A," etc. The method of procedure is as follows: First remove all scale from the steel and clean it from oil, grease, etc. Then while the tool is perfectly cold, immerse it in water and next roll the wet tool in powdered boric acid. After this has been done, pre-heat the tool slowly to a temperature of about 1200 degrees F., remove it from the furnace at this temperature and again roll it in powdered boric acid. This treatment results in completely covering the tool with a coating of boric acid which serves to protect the surface of the steel from the decarbonizing action of the air. The tool is then replaced in the furnace and brought quickly to a temperature of 2300 degrees F., after which it is quenched in an oil bath.

In cases where it is necessary to draw the temper, the best results are obtained by employing a temperature of 900 degrees F. and permitting the tool to cool in the open air. The coating of boric acid that remains on the steel can be removed by soaking it in fresh cold water for a short time. Great care should be taken to have the tool perfectly cold before immersing it in water to remove the boric acid; otherwise, the tool may crack. These instructions apply particularly to the hardening of milling cutters, twist drills, taps, dies, etc., made of "Red-Cut" cobalt steel.

As an example of the efficiency of this method in treating other classes of high-speed steel, the following instance may be cited. A tap made of "Rex A-A" steel was heated in a gas furnace to 2350 degrees F. instead of 2250 degrees F., which was the proper temperature to employ; but the tap came out just as clean and free from scale and decarbonization as other taps of the same size and made of the same steel, which were heated to the correct temperature before quenching. It will be evident that in using this method for the treatment of other classes of high-speed steel, suitable hardening temperatures and drawing temperatures must be employed, as these temperatures naturally vary with different steels. A.

NOISE AND INDUSTRIAL ACCIDENTS

I have just read a book dealing with the subject of industrial accidents and their causes, in which the following causes are mentioned: poor natural or artificial illumination, overcrowding of equipment with insufficient space for the operators, slippery floors, inexperience or ignorance in operating machinery, carelessness and lack of discipline, unsuitable clothing, over-work and fatigue, poor ventilation and intoxication.

Noise is a very important cause of industrial accidents that is not mentioned in the book referred to. Noise and fatigue might properly be coupled together, because fatigue is often the direct result of noise. Be this as it may, it is certain that noise is often the direct cause of accidents, a typical case being that in which a machine slipped from an overhead crane and fell onto a workman. The crane operator saw the machine slipping and shouted to the workman but was unable to make him hear because of the noise in the shop.

Steps toward the elimination of unnecessary noise are now being taken by the management of progressive industrial plants. Not only is this a means of providing for the safety of the operators, but experience has shown that more work can be done in a quiet shop, that there are apt to be fewer mistakes made, and that the quality of the work will be improved. These are certainly points that the up-to-date manufacturer cannot afford to overlook. N. G. Near

A SAFETY LATHE DOG

In the October and November, 1912, numbers of Machinery, two articles appeared describing various forms of dogs and drivers. A number of excellent devices for this purpose were described, but the accompanying illustration shows what the writer believes to be a dog fully as good if not better than any of those shown in connection with the article referred to. Fig. 1 shows front and rear views of the dog and a detailed design of the parts is shown in Fig. 2. Referring to these illustrations, it will be seen that the socket type of safety set-screws is used, these screws being tightened by a wrench in the usual way so that there is no chance for the heads to strike the operator's hands or catch his clothing. The tail of the dog extends out at the back of the plate where it is out of the way. These dogs have been used for several years in the machine shops of the Oliver Iron Mining Co., of Norway, Mich., where they have given very satisfactory results.

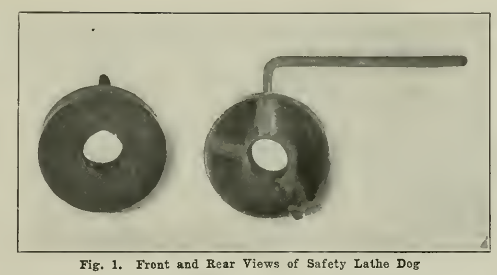


Fig. 1. Front and Rear Views of Safety Lathe Dog

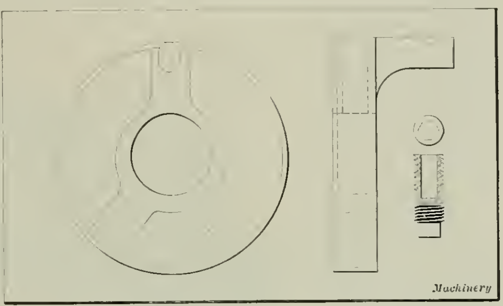


Fig. 2. Design of Safety Lathe Dog shown in Fig. 1

Norway, Mich. Henry Hosking

ECONOMICAL SHOP LAYOUT

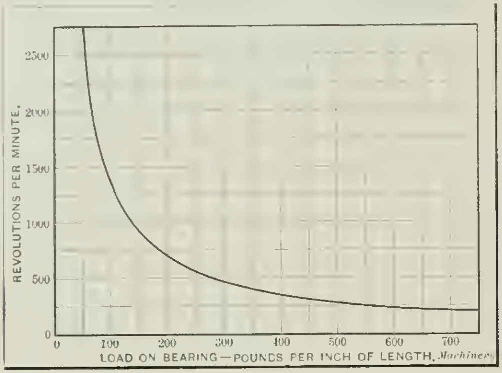
Manufacturers are realizing more and more the value of economical routing of material through the shops; and although competition may be forcing the realization of its necessity on them, the tendency toward maximum production at minimum cost is demanding a careful location of machinery. Owing to this fact the writer would like to make the following suggestion. When the plans of the building or buildings are completed the task of planning the proper location of machinery begins, which involves considerable thought and juggling of machines on paper. It is obvious that this process of locating machines is far simpler than moving the machines themselves when they have been set up in working order, but the method necessitates the gathering of considerable data relative to the space occupied by the machines and the space required by the operators. When these data are once gathered, it again requires valuable time in the drawing-room to prepare scale drawings of each machine on separate pieces of paper.

If machine tool manufacturers in compiling their catalogues would devote one page to small outline illustrations to a scale of ¼ inch to the foot, showing the space required by their machines, the space required by the operators, and also giving in small print the name and style or number of the machine, it would be a great time-saver, as the planner of a proposed shop would cut these illustrations out of the catalogue and with the aid of the building plan he would be ready to proceed with his work without calling upon the drafting-room until the final record was to be made.

Toledo, Ohio. R. F. Hill

CHART FOR SAFE LOAD ON JOURNAL BEARINGS

The problem of determining proper bearing sizes to fit varying conditions of speed and load is one with which every designer should be familiar, yet very frequently we see attempts made to design bearings without due consideration of the factors which determine the work done in the bearing. In overcoming the friction between a journal and its bearing, a certain amount of energy is expended which shows itself in the form of heat. The only means of getting rid of this heat is by conduction from the heat generating surfaces, through the masses of the shaft, bearing and bearing support, and thence by radiation to the outside air. Of course, the oil to a certain extent serves as a medium for the transfer of a part of the heat generated, by giving up its heat to the walls of the oil chamber; but by far the greater part is dissipated by conduction in the manner described.



Curve giving Safe Load per Inch of Bearing Length

Inasmuch as there is always some heat generated in the bearing, no matter how liberally it may be designed, there must always be a temperature increase in the bearing. If this heat can be carried off as fast as it is generated, the bearing will at some time in its operation reach a constant temperature. As the radiating capacity of any bearing is a fixed quantity, the temperature reached will depend on the rate at which heat is generated; therefore, in order that a bearing may not overheat, there must be some means of determining this rate, and fixing a limit to which the amount of heat generated may be carried. Between bearing surfaces, as in all cases where relative motion takes place between two surfaces in contact, the work done in overcoming friction depends on the rate of motion and the pressure existing between the two surfaces. This is modified to a certain extent by the character of the surfaces in contact, but for practical purposes, it is sufficient to consider the two factors of speed and pressure, and as the work done is proportional to each it is proportional to their product. By fixing the product of these factors as a constant, we have a means of limiting the work done in the bearing to a safe quantity.

It has been found by observation of a large number of bearings that were known to operate within a temperature rise of 40 degrees C. that if the rotative speed is taken in feet per minute, and the pressure in pounds per square inch of projected bearing area, the constant lies between the limits of 36,000 and 40,000. If we use the smaller number, and let

d = diameter of bearing in inches,
l = length of bearing in inches,
L = total load on bearing in pounds,
$\frac{L}{l} = P$ = load on bearing per inch of length.
N = revolutions per minute,

we have,

$$\frac{\pi d N}{12} \times \frac{L}{dl} = 36{,}000$$

which reduces to

$$\frac{NL}{l} = 137{,}000, \text{ or } NP = 137{,}000$$

From this we see that if the product of the revolutions per minute and the load on the bearing per inch of length does not exceed 137,000, the bearing will operate within the temperature rise specified. By plotting these factors, the accompanying curve was obtained, which presents this formula in a convenient shape for use. By reading across to the curve from revolutions per minute at the left, and thence down, the safe load per inch of bearing length will be found.

In determining the pressure on the bearing, any load due to belt or chain pull, or gear thrust, in addition to the direct weight of the shaft and member carried by it, must be taken into account. In the majority of cases the belt pull will be at an angle to the direct weight on the bearing; the gear thrust may be in any direction—most frequently, however, in the same direction or opposite to the direct weight. In any case, a resultant of the forces operating on the bearing must be taken and used as the final load figure.

It will be noted that the diameter of the bearing does not have to be considered in determining its safe load. While it enters into the formula as a factor of the rotative speed, it also has the function of directly reducing the pressure per square inch of bearing area, so that it is eliminated from the formula in its final shape. The diameter of the bearing is generally fixed from other considerations, being chiefly dependent upon the size of shaft required for stiffness, and for transmitting the given horsepower.

Westfield, N. J. ALAN M. BENNETT

CHECKING LIST FOR AUTOMOBILE TOOL DRAWINGS

The following is a checking list used with success in checking the automobile tool drawings of a large eastern automobile factory. If followed with care when checking, there are not many mistakes likely to get by the checker. It is advisable to have such a list, for as was the case with the company in mind, we had no regular checker but each tool designer checked his fellow tool designer's work. The list follows:

1. Is the size of sheet correct?
2. Is the layout of the model correct?
3. Can fixture be loaded and unloaded without interference?
4. Can the fixture be assembled?
5. Do figures "tie up"?
6. Are there enough dimensions on each piece?
7. Do the dimensions scale?
8. Are dimensions not to scale underlined?
9. Are finish marks on drawing?
10. Have "grind" notes and other necessary notes been included?
11. Does the fixture fit the machine and have bolt holes been provided?
12. Is the stock list and bill of material on the drawing?
13. Spot for marking?
14. Have title and piece number, pattern number, order number and sheet number been given?
15. Has provision been made for gaging on milling fixtures?
16. Is the pattern constructed in the simplest manner within reason?
17. If a chucking fixture, is it counterweighted?

Hartford, Conn. S. VICTOR BROOK

* * *

RECORD FOR HAULING LONG TRAINS

All previous records for hauling long trains were lately broken by the Erie R. R. Mallet "triplex" locomotive recently built by the Baldwin Locomotive Works. The train consisted of 250 fifty ton steel gondola loaded cars and a dynamometer car, the total weight of the train being 35,824,000 pounds, or 17,913 tons exclusive of the locomotive. The total length of the train was 8547 feet or 1.6 mile. The train was hauled by the locomotive twenty-three miles between Binghamton, N. Y., and Susquehanna, Pa. It was assisted in starting by pushers, but after the cars were under way, no further assistance was given. The locomotive weighs 853,000 pounds, and has a tractive power of 160,000 pounds. It has twelve driving wheels on each side, arranged in three groups of four wheels each. A pony truck in front and at the rear makes the total number of wheels supporting the unit twenty-eight. The design, originated by G. R. Henderson, consulting engineer of the Baldwin Locomotive Works, makes 89 per cent of the total weight of the engine and tender available for tractive effort.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

HARDINGE PRECISION LATHE WITH QUICK CHANGE OF SWING

To meet the requirements of tool-rooms, instrument factories and scientific shops where precision lathes are needed, Hardinge Bros., Inc., Berteau and Ravenswood Aves., Chicago, Ill., have added to their line the "Cataract" precision lathe with quick change of swing, which is illustrated herewith. The nominal swing of this machine is 9 inches, but raising blocks are provided which may be placed under the headstock, cross-slide and tailstock to increase the swing to 15 inches. Fig. 1 shows the machine arranged to swing 9 inches, while in Fig. 2 the raising blocks are shown in place to increase the swing to 15 inches. With the exception of the gear on the spindle, the entire change gear mechanism is carried by a frame attached to the end of the bed, and this construction makes it possible to effect the change in swing without interfering with the change gears.

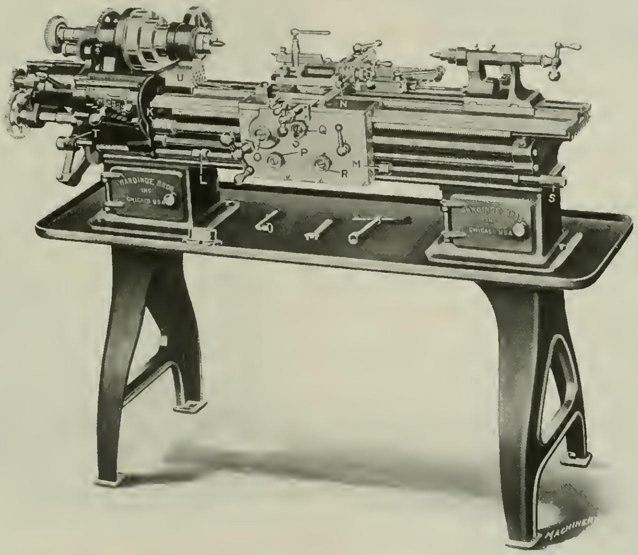


Fig. 1. "Cataract" Precision Lathe with Quick Change of Swing

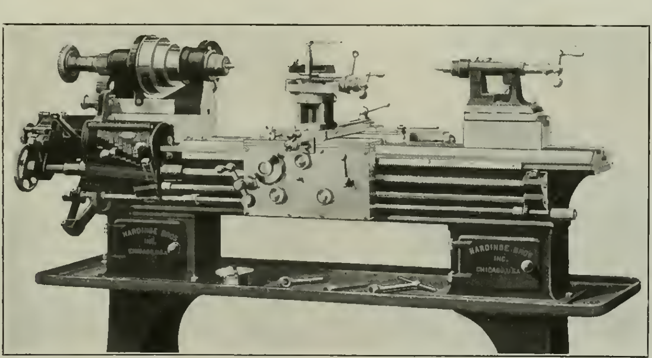


Fig. 2. Machine shown in Fig. 1, with Raising Blocks in Place to increase Swing to 15 Inches

Fig. 3 shows the headstock removed from the machine, and two brackets *A* and *B* which carry the auxiliary change gear mechanism are also shown in this illustration. In Figs. 4 and 5 two views of the head are shown with the brackets *A* and *B* mounted in place. It will be seen that two equal gears are carried by the bracket *B*, and these gears are employed to make the connection between the spindle gear and the gear on the stud *F* when the swing of the lathe has been increased to 15 inches. The gears on bracket *B* are merely idlers and do not affect the ratio of the gearing in any way. The gears carried on bracket *A* provide for making a reduction in the rate of feed. In order to use these gears the pinion carried on stud *F* is thrown out of mesh and the gear carried in the sector *C* is brought into mesh with the gears on the bracket *A*, which are now employed to transmit the motion from the spindle gear to the quick-change gears. The illustration shows the bracket *A* provided with gears which give a reduction of 1 to 2½, and by employing suitable gears any required reduction may be obtained.

The quick-change gear-box contains a nest of nine gears and the changes of feed are obtained by bringing the lever *G* into the correct position. Referring to Fig. 4 it will be seen that the different numbers of threads per inch obtained in each position are marked on the front of the box, the lever *G* being shown in the "lock-out" position. It will be seen that there are three numbers marked at each station in the quick-change gear-box, and with the lever *G* set at any given station the three numbers of threads per inch are obtained by means of gears which are engaged by manipulating the lever *H*. For instance, suppose it is required to cut a screw with 48 threads per inch. The lever *G* is set under 48 and the lever *H* is set in the "slow" position. At the same station on the quick-change gear-box where 48 appears, the numbers 24 and 12 are also marked. To engage the proper gearing for cutting screws with these numbers of threads per inch, the lever *H* is set in the "medium" and "fast" positions, respectively.

Any English threads which are not obtainable through the quick-change gears can be obtained by mounting the proper gears on the screw *I* and stud *J* and connecting them through the gear on the sector *D*, compounding the gearing at *D* when necessary. For instance, with a 20-tooth gear on stud *J* and a 100-tooth gear on screw *I*, provision is made for cutting a 100-pitch screw. Such being the case, it will be evident that to cut a 50-pitch screw it would merely be necessary to use a 40-tooth gear on the stud *J* instead of the 20-tooth gear formerly employed; or to put a 50-tooth gear on the screw *I* and leave the 20-tooth gear on the stud *J*. Suitable translating gears are provided for cutting screws with metric pitches.

In connection with the preceding description of the facilities for precision thread cutting, attention should be called to the connection *K* on the lead-screw. This connection provides for disconnecting the lead-screw in such a way that only a few minutes is required to remove the screw and replace it by one of another pitch. This is particularly convenient in instrument work where screws of special pitches are required, and in cases where it is occasionally necessary to employ a standard lead-screw which it is not desired to have in use on the machine any more than is absolutely necessary. The nut used on the lead-screw is 3½ inches in length so that ample wearing surface is provided.

The travel of the carriage is controlled by adjusting stops *T* and *S*, and stop collars *L* and *M*. The design is such that it is impossible to engage the lead-screw and feed-rod simultaneously. Referring to Fig. 1, the handle *P* is for the power feed and handle *Q* for the cross feed. The handle *R* controls the lock-out which makes it impossible to engage the feed-screw and lead-rod at the same time. The graduated disk *O* is arranged with a vernier so that accurate settings for the depth of cut can be made. The compound rest is equipped with a quick-acting nut which is operated by turning the handle *N* through one-half revolution to a stop. In this way the tool may be advanced or withdrawn up to 5/32 inch. This does not interfere with the regular use of the compound slide and will be found particularly convenient in threading taps and similar classes of repetition work. It relieves the operator of the necessity of continually watching the indexes and does away with spoiled work resulting from mistakes which even the most conscientious operator is likely to make occasionally.

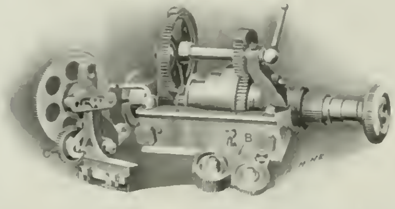


Fig. 3. Head and Auxiliary Gear Brackets A and B

The taper turning attachment is attached to the carriage and graduated to provide for cutting tapers expressed in degrees or inches per foot. The design of this attachment is such that it may be readily withdrawn to provide for running out the cross-slide quickly to insert the bolt for the raising block which goes under the compound rest when it is required to increase the swing of the machine to 15 inches. The taper attachment can be used on work up to 15 inches in length and is adjusted for various tapers by means of a fine pitch screw. The backing-off attachment is driven by a worm-gear carried on the spindle nose and is attached to a T-slot machined in the back of the hed. This attachment operates the cross-slide through a cam of suitable form.

Structural Features of the Machine

A general description has now been given of those mechanical features of the machine which make it particularly adapted for the most exacting requirements of precision work. By way of conclusion a brief description of the structural features will doubtless prove of interest. The head is 11½ inches long and is provided with adjustable bearings. These bearings are made of fine cast iron and the spindle is of hardened steel ground to an accurate finish. The bearings are lubricated by means of wicks which dip into an oil reservoir in the head of the machine. All dirt or dust is excluded from this reservoir and the wicks act as filters which effectually prevent any foreign matter from reaching the bearings. The spindle nose is made of the Hardinge patented form which provides for the quick attachment of faceplates, etc. The bed is machined to the same standard as the "Cataract" bench lathes manufactured by Hardinge Bros., so that turrets, milling attachments, etc., may be interchanged between different machines.

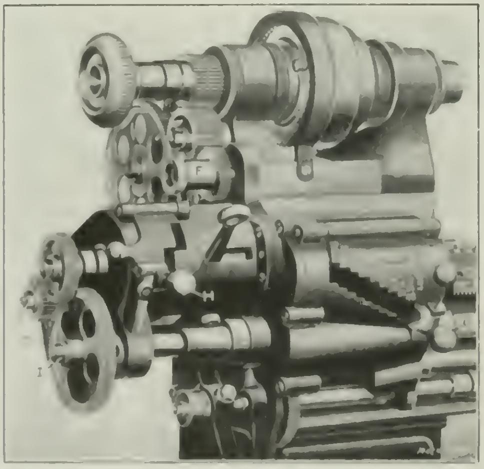


Fig. 4. Front View of Head End of Lathe with Raising Blocks in Place

The principal dimensions of the machine are as follows: Length of bed, 52 inches; total length of lathe, 64 inches; maximum distance between centers, 28 inches; swing over bed, 9 inches and 15 inches; swing over carriage, 6½ and 11½ inches; size of front spindle bearing, 2 inches long by 2 1/32 inches in diameter; size of rear spindle bearing, 2 inches long by 1⅞ inch in diameter; diameter of hole through the spindle, 1¼ inch; capacity of the draw-in chuck, 1 inch; floor space occupied, 24 by 64 inches; and net weight of machine, 900 pounds.

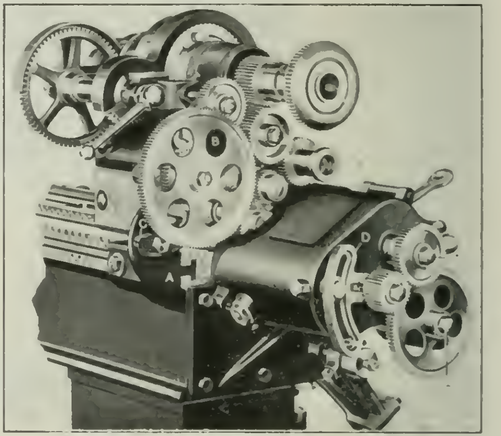


Fig. 5. Rear View of Head End of Lathe

B. & S. MILLING ATTACHMENT FOR CUTTING SHORT LEAD SPIRALS

The piece of work shown in position is a steel drum 6 inches in diameter on which a single thread of 1/18 inch pitch is required. The thread is rounded at the bottom and must be accurate in form and lead. The method usually employed in milling such leads is to connect the table feed-screw directly to the spiral head spindle by gearing in the proper ratio, so that the work is rotated from the screw. This, however, necessitates gearing up from the screw to the work in a considerable ratio, putting a load on the screw which results in uneven turning action and a poor thread. Accordingly, the attachment which is illustrated herewith was devised to overcome this difficulty.

The two most notable features are the method of applying power for driving the work, and the system of gearing employed to obtain the lead of the spiral. A small grooved pulley mounted on an expansion bushing is placed on the rear end of the machine spindle. This drives the large grooved pulley by a round belt. By mounting this pulley on a bracket slipped on the overhanging arm, sufficient adjustment is provided for keeping the belt tight or for using the same belt crossed or open. The remainder of the attachment consists of a bracket carrying a short shaft and a swinging arm, the shaft being driven from the grooved

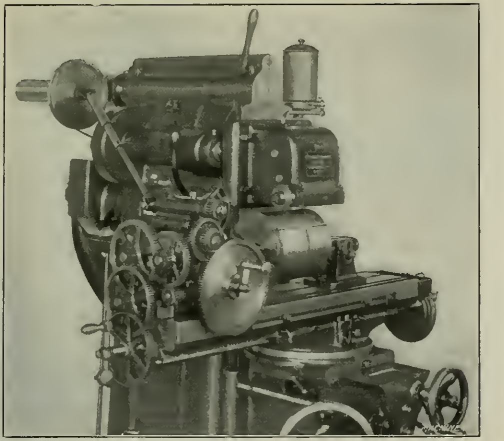


Fig. 1. Brown & Sharpe Milling Attachment for Use in cutting Spirals of Short Lead

pulley by a telescopic shaft and universal joints. The bracket is clamped over the dovetail on the top of the regular spiral head.

In place of the usual index plate a large gear is employed, through which the power is transmitted from the grooved pulley to the spiral head spindle, thus rotating the work. The movement of the work may be instantly stopped by means of the small lever on top of the bracket which operates a positive clutch. Eighteen holes are provided in the large gear to be used when cutting double, triple or other multiple threads. This independent driving mechanism does away with all driving stress on the table feed-screw. The regular feed mechanism is thrown out of engagement and the screw is only used to obtain the lead. This is accomplished by connecting the worm shaft of the spiral head to the table screw through triple compound gearing the ratio of which is 180 to 1. Power is therefore transmitted from the spiral head to the screw in a very high, descending ratio. The turning action of the screw is thus easy and smooth, resulting in threads of greater accuracy in lead and form than those obtained previously.

This attachment was designed by the Brown & Sharpe Mfg. Co., Providence, R. I., and it is arranged to be quickly placed on any regular Brown & Sharpe milling machine which carries a 10-inch spiral head. No fitting or drilling of holes is necessary, and very few extra gears are required in the triple compounding beyond those furnished regularly with the spiral head. A reverse gear and plate may be used in addition to those shown when cutting a thread of the opposite hand. Fig. 2 shows the attachment rigged for the same conditions but with a different system of gearing employed. Here the spiral head spindle is connected directly to the table feed-screw to give the same lead as before. The train of gearing is much simpler than in the previous case as the ratio is only 4.50 to 1. However, this method can only be used to advantage on single threads, as it does not permit of indexing, while the thread produced in many cases is not as accurate as when using the high ratio gearing. The cutter may be mounted on a regular rack-cutting attachment or a vertical spindle milling attachment when used on a universal milling machine. The latter attachment can only be used in the case of a large cutter, while the former permits the use of a small cutter. By using a universal milling attachment in this connection, the work may be done on a plain milling machine, the attachment having means for setting for the required angle of spiral.

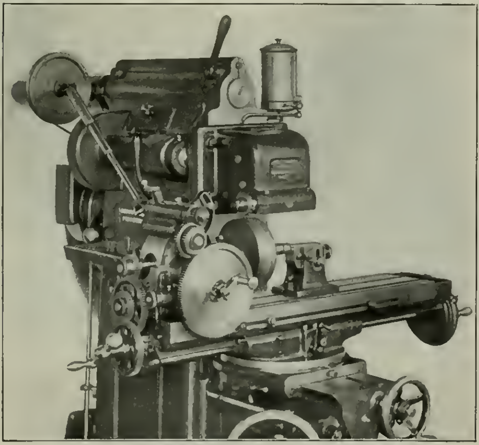
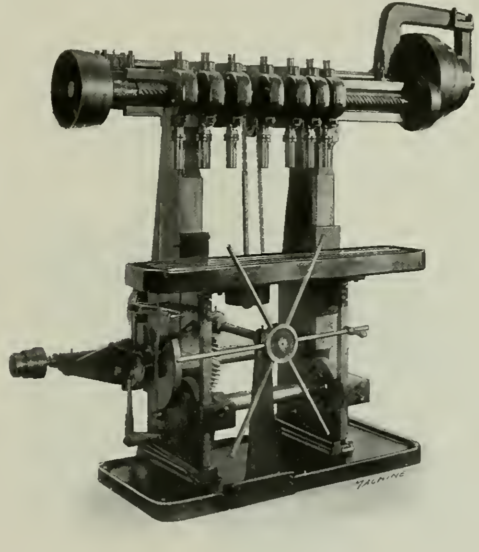


Fig. 2. Same Attachment shown in Fig. 1 but arranged with a Different System of Gearing

MOLINE DRILLING MACHINE

The latest addition to the line of "hole hog" machines built by the Moline Tool Co., Moline, Ill., is the No. 54 drill illustrated and described herewith. The characteristic feature of the design is that both cam and geared feeds are provided. For any special work that has to be handled in large quantities, a feed cam is made which is formed in such a way that the drill is quickly fed through any gaps that may exist in the work and also returned quickly to the starting point after the hole has been finished. The machine may be operated continuously or made to stop automatically at the loading point, as desired. The feed cams are easily changed so that it is entirely practicable to have a number of cams for handling different classes of work on the same machine. The cams are inexpensive, and as they materially increase the rate of production they should be used in machining all work which has to be handled in quantities. When small pieces are to be drilled, a sliding jig provided with alternate working and loading stations makes the use of stops unnecessary, the drill being operated continuously. For general work, the geared feed is used in connection with the automatic stop and quick hand return. This makes a valuable combination, as it combines the advantages of a special and general purpose machine.

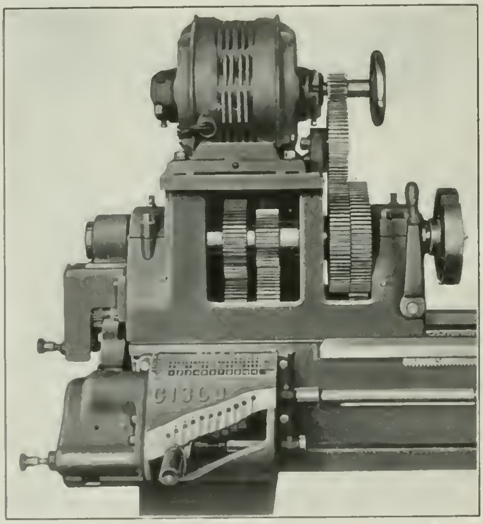


Moline No. 54 Drill equipped with both Cam and Geared Feeds

The No. 54 Moline drill has one main spiral gear, as shown in the illustration; but if so desired, it can be equipped with two main spiral gears, this design permitting holes to be drilled on closer centers. The machine equipped with the two gears is known as the No. 54-D machine. These machines are made in seven different lengths ranging from 4 to 10 feet, and are adapted for handling a great variety of bars, pipes, drop-forgings and castings. The machines 8 feet or more in length are built with three columns. The No. 54 machine is intended to take the place of the No. 8 cam-feed machine formerly built by this company. In addition to performing all operations which could be handled by the No. 8 machine, it has the advantages of being able to change the cams quickly, of only requiring one cam to be used instead of two, as on the No. 8 machine, and of being equipped with geared feed to adapt the machine for handling general classes of work.

MOTOR DRIVE FOR "CISCO" LATHE

The accompanying illustration shows the arrangement of motor drive which has recently been developed by the Cincinnati Iron & Steel Co., Cincinnati, Ohio, for use on the lathes of its manufacture. A 2½ or 3 horsepower, direct or alternating current motor of variable or constant speed, is employed. Three changes of speed are provided in the head, two of which are controlled by a lever at the front of the head which operates the friction, while the third is an open speed obtained through the face gear. In order to use the open speed, it is necessary to have the lever on the front of the head set in the neutral position. The illustration shows a new arrangement of the change gear box in which guides are provided for the tumbler so that the operator can easily obtain the various changes.

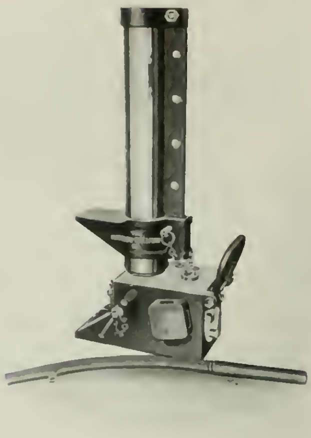


Arrangement of Individual Motor Drive for "Cisco" Lathes

The Cincinnati Iron & Steel Co. is sending 14, 16 and 18 inch lathes of its manufacture to San Francisco where they will be shown at the Panama-Pacific Exposition. One or two minor improvements have been made in the design of these lathes. A pull pin is provided at the end of the lathe and when this pin is in the neutral position, the lathe can be run at high speed with all of the gears from the first compound out. The design of the half-nut is such that it is impossible for the lead-screw to be clamped too tightly. The beds of these new "Cisco" lathes are made deeper and heavier and they are of "semi-steel" which affords unusual strength and permanence of alignment. This design and material will be used by this company from now on. Various other minor improvements have been made in the design of the machines.

WATSON-STILLMAN JACK

The Watson-Stillman Co., 192 Fulton St., New York City, has recently added to its line a hydraulic jack which embodies several important features in its construction. It is primarily intended for use as an emergency jack for street railway service, but is also suitable for use in many shops and factories where it is necessary to lift heavy work.



Watson-Stillman Emergency Jack

The following are the important features of the design: The claw can be moved vertically and adjusted to the most convenient height; and the claw and cylinder can be swung in a complete circle without changing the position of the jack. The cylinder is the moving part instead of the ram as in most types of hydraulic jacks, thus allowing the pump mechanism to stay in a fixed vertical position and permitting the working parts of the jack to be of simple and compact design. The piston is packed with leather rings, the valves are of the ball type and the passages are made of ample size. This jack is operated with a special oil which acts as a lubricant, prevents the working parts from rusting, cannot freeze and has no detrimental effect upon the packing. The pressure is released by means of a key which operates a small needle valve. Although the operating lever is only 18 inches in length, a man can obtain the maximum pressure without undue exertion. These jacks are built in 5 to 10 ton sizes with a ram stroke of 10 inches.

SLOCOMB DIRECT-READING MICROMETER

One of the latest products of the J. T. Slocomb Co., Providence, R. I., is a direct-reading micrometer for measuring the size of wire. This tool is provided with a direct-reading dial on which the size of the wire is given in steel wire gage, the decimal equivalent of an inch, and iron wire gage. It will be evident from Fig. 1 that the micrometer is easily held and operated with one hand, leaving the other free to handle the work to be measured. These features enable measurements to be made very rapidly.

The quick action of the micrometer is made possible by the provision of a coarse multiple-pitch screw that has a lead of ¼ inch. All measurements up to No. 80 steel wire gage, 0.25 inch and No. 36 iron wire gage may be read at one

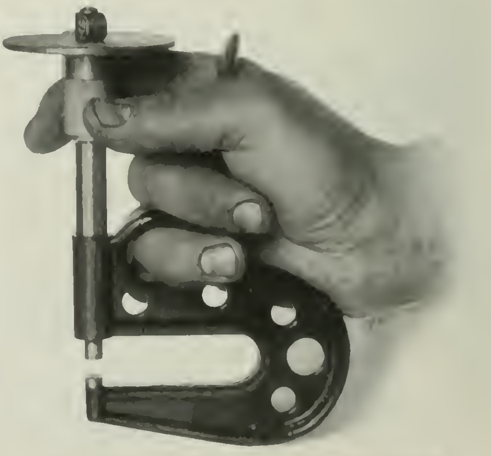


Fig. 1. Method of using Slocomb Direct-reading Micrometer

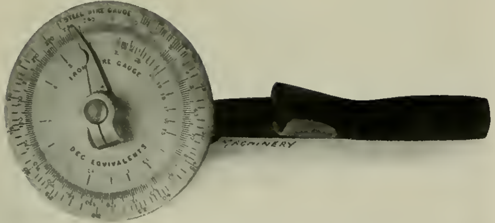


Fig. 2. Dial of Slocomb Direct-reading Micrometer

revolution of the screw. It will be seen from Fig. 2 that the steel wire gage is graduated at the outside of the dial, the iron wire gage at the inside, and the scale giving the equivalent size in decimals of an inch is located between the two wire gage scales. The graduation of the dial emphasizes the non-uniformity of the common wire gages. Evidently it was intended to have the gages uniform at the time they were developed, but there was no good means of making accurate measurements at that time.

A micrometer of similar design has been developed for use in measuring card clothing. The nice degree of accuracy necessary in the manufacture of this material is not generally known, the average machinist having little knowledge of it except for use in making file cards or file brushes. That the degree of accuracy attained in its manufacture requires the use of a special micrometer will doubtless come as a surprise to many readers of MACHINERY.

WATERBURY-FARREL THREAD ROLLING MACHINES

The machine illustrated in Fig. 1 is one of a series of special reciprocating thread rolling machines equipped with magazine feed, which has been added to the line of the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn. These machines are used for rolling threads of greater length than can be handled on the standard thread rolling machines built by this company. In working out the design, special attention has been paid to the maintenance of absolute rigidity in the frame and this feature has been further provided for by employing tie-rods at the part of the frame where the strain is greatest. These tie-rods prevent the frame from springing when threads of considerable length are being rolled and thus insure obtaining accuracy in the entire length of the thread.

Machines of this type are built for both hand feed and automatic magazine feed for headless blanks. In hand feeding the machine, the work is placed in front of a starting slide resting on an adjustable depth gage which is set to give the length of thread that is required. At the proper time, the blanks are pushed forward and gripped by the moving dies which roll the thread. The magazine feed is built for handling headless blanks that require threading on either one end or both ends, or for the entire length. This type of feed is adapted for threading pieces of the form used in harvester machinery, electrical machinery and special bolts, screws, etc., for a great variety of products which may require one end to have a right-hand thread and the other a left-hand thread. Of course, when threads are to be rolled simultaneously at each end of the blank, the diameter and pitch of the screws at both ends must be the same. Where the threads are rolled simultaneously on both ends of the work with a blank portion left between the threaded portions, the dies are separated by a filler of the same length as the portion of the blank which has to be left without a thread. Dies can be used for rolling either right- or left-hand threads as required.

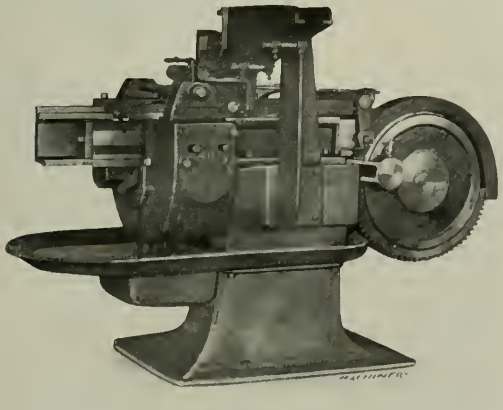


Fig. 1. Waterbury-Farrel Reciprocating Thread Rolling Machine

Fig. 2 shows examples of threads rolled on this machine. A screw with the gimlet type of point is shown at *A*; a machine screw thread rolled on one end of the blank is shown at *B*; a right-hand machine screw thread rolled at one end of the blank and a left-hand thread of the same type at the opposite end of the blank is illustrated at *C*; and at *D* a machine screw thread has been rolled the entire length of the blank. The machines are built with a pump, tank and lubricating system for keeping the dies flooded with lubricant while the threads are being rolled. They are built in several sizes with capacities up to and including screws 1 inch in diameter.

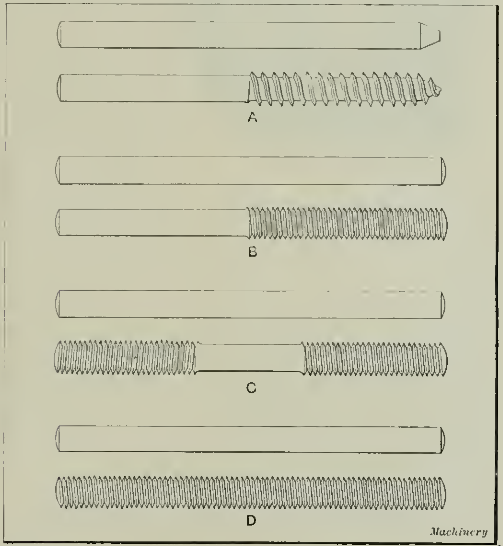
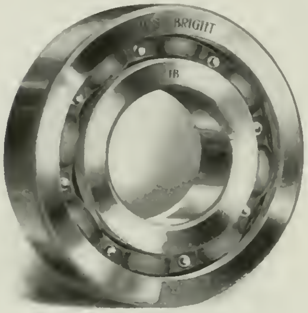


Fig. 2. Examples of Threads rolled on Machine shown in Fig. 1

HESS-BRIGHT "MONARCH" BALL BEARING

For use in the most severe classes of service where the requirements are so exacting that even ordinary ball bearings are unable to give satisfactory results, the Hess-Bright Mfg. Co., Front St. and Erie Ave., Philadelphia, Pa., has added to its line the "Monarch" ball bearing which is illustrated herewith. The races of this bearing are made heavier than those of standard annular bearings, to serve the double purpose of enabling the race grooves to be cut deeper and to provide more metal which will prevent the races from being sprung out of shape during the hardening and grinding operations or when placed in service. The ball cages are of cast bronze and made in two halves, which are riveted together. The design and construction of this bearing makes it more expensive than other types, but for the classes of service for which it is intended, the additional first cost is soon made up in a reduction of maintenance charges.

The general statement has been made that the races of this bearing are made exceptionally heavy to minimize distortion in the hardening and grinding operations, and when the bearing is placed in service. It may be mentioned in this connection that a special form of chuck has been designed for use in machining the races, which supports the work all around its circumference instead of concentrating the pressure at three points. This prevents straining the race and the production of consequent inaccuracies in machining. Those who are at all familiar with the application of ball bearings know that for carrying an ordinary radial load, the outer race is made a "sucking" fit in the bearing housing. The idea is to have the race free to slide in the bore of the housing but still to have it uniformly supported. Slight inaccuracies in machining the housing may cause the race to be unequally supported, in which case there is the ever-present possibility of springing the race. The exceptional thickness of the races of the Hess-Bright "Monarch" type of bearing reduces to a minimum the possibility of trouble arising from this source. Similarly, the inner race is customarily made a pressed fit on the shaft and any inaccuracy of the shaft may result in springing the race out of its true circular form. Here, again, the exceptional thickness of the race reduces the possibility of this kind of trouble. The greater thickness of the races gives the bearing an exceptionally high capacity for carrying thrust loads.



Hess-Bright "Monarch" Ball Bearing

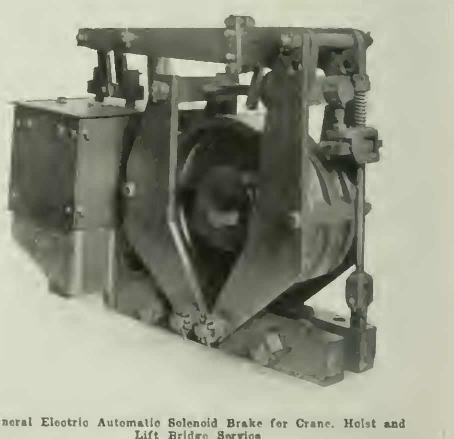
It has been stated that the ball cages are made of cast bronze. After these cages have been cast they are taken to a die where they are trimmed on the inside and outside to the required diameters. The cages are then taken to a hydraulic press where the inner surfaces of the ball pockets are subjected to high pressure in order to smooth the surface of the metal and bring each pocket to the required form. This method of finishing the ball pockets has been found superior to machining, and the small pits in the surface of the metal left from the molds act as oil retainers which are found to give good satisfaction in keeping the balls properly lubricated. One typical class of service for which the Hess-Bright "Monarch" bearing has been found particularly suitable, is on the armature shafts of the axle generators used in railway car lighting systems. The service conditions under which the bearings of these equipments operate are very severe, and wear in the bearings might result in bringing the armature into contact with the pole pieces of the generator, thus causing it to be put out of commission. That the new Hess-Bright bearings are well suited for the requirements of this service is evidenced by the fact that not a single case has been reported in which failure of the lighting system could be attributed to the bearings of the generating set on which they were used.

G. E. AUTOMATIC SOLENOID BRAKE

A new automatic solenoid brake for crane, hoist, lift bridge and similar service has recently been developed and placed on the market by the General Electric Co., Schenectady, N. Y. Exceptionally sturdy construction has been made inherent in the design on account of the severe character of the work demanded of the brake, and it is built in a complete line of standard sizes for both alternating and direct current application. All the sizes are so designed that they may be mounted on the floor even though ordered and shipped attached to the motor. In the larger sizes mounted on the motor (50 horsepower and over) the two base bars that support the brake are bolted to brackets, the latter being bolted to bosses cast on the motor frame. The two plate yokes that support each shoe are hinged at the lower end to the base bars, and act as levers for applying the necessary pressure to the shoes to make the braking effective. The force that operates the brake is transmitted to the free or top ends of the yokes through horizontal levers, which are attached to the movable element of the solenoid by means of links. When the solenoid is energized, the movable element is forced up to the end of its travel, releasing the brake; and when the coil is demagnetized, the brake is set by gravity. In the sizes below 50 horsepower, the brake has a box type of frame, which is attached to bosses on the motor frame. Cast yokes are employed in this type, but in other respects the brake is similar to that for motors with capacities of 50 horsepower and above. All these designs may be modified to suit the requirements of such special applications as lift bridges, printing presses, etc.

The brake has three unique features: an automatic solenoid air-gap adjuster, an automatic shoe clearance adjuster, and a floating top core type of solenoid. The solenoid air-gap adjuster is designed to maintain constant the distance between the upper, or floating, and the lower cores of the solenoid when the brake is on. The solenoid air-gap adjustment is made by means of a ratchet wheel, pawl and adjustment rod shown in the illustration, which represents the type of brake designed for motors of capacities of 50 horsepower and above. The pawl is so designed that when the air-gap in the solenoid, *i. e.*, the distance between the upper and lower cores, increases beyond a certain value, the pawl will engage with a tooth of the ratchet wheel and rotate it slightly when the movable element of the solenoid is forced up by the magnetic field of the latter to release the brake. This shortens the air-gap in the solenoid slightly, with the result that the movable element does not drop far enough when the brake is set for the pawl to engage the ratchet wheel again until the shoes wear sufficiently to permit it. One tooth on the ratchet wheel corresponds to a slight variation in the distance between the upper and lower solenoid cores, so the adjustment is very close.

In the shoe clearance adjuster, a rod attached to one of the base bars passes through a bracket bolted to one of the yokes. This bracket has a slot for a spring clamp attached to the rod. As the shoes wear, allowing the yokes to approach slightly nearer to the wheel when the brake is set, the spring clamp is moved up correspondingly by the bracket, these two parts being in contact when the brake is on. As soon as the brake is released, the right-hand yokes move back under the influence of gravity and the spring until the set-screw strikes the spring clamp. Thus the distance between these two positions of the shoes, *i. e.*, the shoe clearance, is maintained constant. The braking effect may be increased by changing the lever pin to one of the other sets of holes designed for it, and also by removing one or more of the weights on the movable element of the solenoid. An oil dash-pot, single acting in the dowoward direction, is supplied with the larger sizes to prevent any rebound of the movable element of the solenoid at the instant of setting the brake, thus giving a smooth application. The dash-pot effect may be varied, but


General Electric Automatic Solenoid Brake for Crane, Hoist and Lift Bridge Service

all dash-pots are correctly adjusted at the factory, using an oil that is little affected by changes in temperature.

The solenoids supplied with these brakes are enclosed, ventilated, rain-proof and provided with a floating top core. When the movable element reaches the upper limit of its travel, it strikes the floating top core which is held in place by magnetism and yields slightly, preventing a severe blow being struck. Since, in ordinary service, solenoids operate several times per minute, it is readily seen that this is a great gain, as it materially adds to the life of the coil and other parts, and also insures smoother operation. With respect to direct current brakes, a series wound coil is standard for crane work. All standard series brakes release on 40 per cent of the rated full load current of the motor to adapt them to dynamic braking. There are special applications which require a shunt winding, as, for instance, bridges where the motor coasts with the current off and the brake released. Alternating current solenoids are shunt connected. Coils for such high potentials as 2200 volts can be furnished, if desired, for standard frequencies ranging from 25 to 60 cycles. These are single phase and therefore suitable for single, two and three phase circuits without change.

Brakes are rated in pounds retarding torque at one foot radius on the brake wheel shaft, the term "retarding torque" being applied to the torque when the armature of the motor is rotating. When the armature stops rotating, the "holding torque at rest" of the brake increases considerably. This is due to the fact that the coefficient of friction when the wheel is at rest is greater than when it is rotating. All brakes have a maximum retarding torque of not less than the full load torque of the motors on which they are used. The design of the solenoid coil, shoes, and other parts is such as to permit of ready removal. All wheels are cast steel, as this metal gives maximum strength with minimum weight. They are perfectly balanced, and those for the mill type of motors and alternating current crane and hoist motors are taper bored to facilitate removal of the wheel. All wheels are of small diameter so as to have a small flywheel effect, and of wide face to insure ample wearing surface. The brake is so designed that the wheel cannot drop off even though it may accidentally work loose. The solenoid coil is connected to the controller so that when the latter is thrown to the "on" position, the movable element of the solenoid is raised, thereby releasing the brake and allowing the motor armature to revolve freely. When the controller is thrown to the "off" position, or when the power fails, the movable element drops, thus causing the brake to set and hold the motor armature from turning. In special cases, as for instance, in the service on a lift bridge where the brake and motor turn through an angle, the brake is set by means of a spring, which insures constant braking effect at all angles.

HORTON COMBINATION GEARED SCROLL CHUCKS

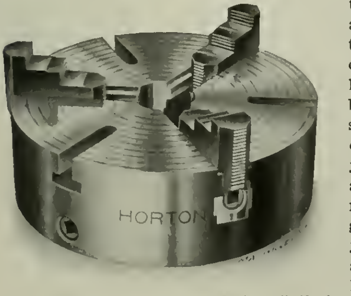


Fig. 1. Horton Combination Geared Scroll Chuck

A recent addition to the line of lathe chucks manufactured by the E. Horton & Son Co., Windsor Locks, Conn., is illustrated in Fig. 1; and Fig. 2 shows the parts of this chuck. This is known as a combination geared scroll chuck because all of the jaws may be operated in unison by means of the scroll gearing, while each jaw may be operated independently by means of a screw. It will be seen that the chucks are equipped with solid reversible jaws, and this style of chuck is made with either three or four jaws. In order to avoid the inconvenience arising from the possibility of having the screws drop out when the jaws are removed for the purpose of reversing them, a special form of screw carrier has been designed, this carrier being shown in detail in Fig. 3. The socket in which the screw is held is just a little more than semi-cylindrical so that the screw cannot drop out, and it will be seen that the plug *A* is threaded into the end of the carrier and locked in place by two binding screws. The independent screws are made in a screw machine, after which they are threaded, carbonized, heat-treated and ground from end to end. The screws are exceptionally large and are not necked down at the ends, so that maximum strength is obtained.

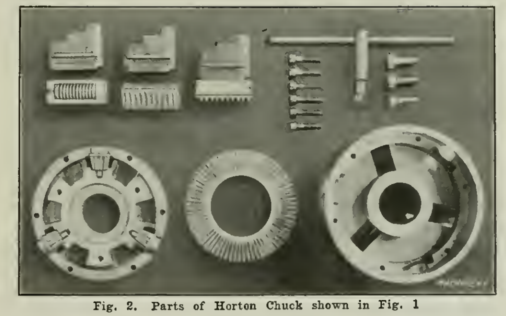


Fig. 2. Parts of Horton Chuck shown in Fig. 1

The standard jaws and screws of the form used in the new Horton independent chucks are employed in the combination geared scroll chuck. The size of the screws is such that in chucks of the 6-inch size and larger, only one wrench is required, which is used for operating both the scroll pinions and the screws which control the independent movement of the jaws. The pinion which operates the scroll gear has exceptionally strong teeth, and by referring to Fig. 2 it will be seen that a steel band encircles the hub of each pinion. This band is pressed onto the hub, and in addition to taking the end thrust of the pinion the band adds to its strength. It has already been mentioned that both three- and four-jawed chucks are now being manufactured, and both styles of chucks are made in sizes ranging from 4 to 24 inches in diameter.

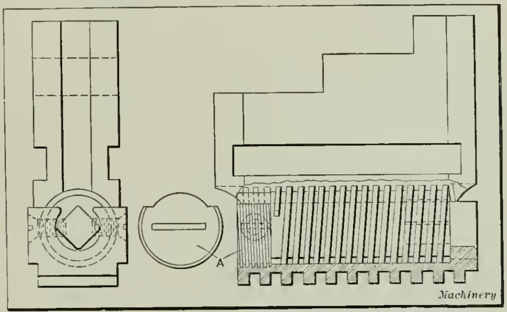


Fig. 3. Design of Screw Carrier for Geared Scroll Chuck

Fig. 4 shows another new product of this company, which is known as style 50-C independent four-jawed chuck. It will be seen that this is of the reversible jaw type. Steel thrust blocks of rectangular section are provided in the body of the chuck. These are hardened and ground, and carry the thrust of the screws. The screws are of large diameter; they are self-contained within the chuck body and have large thrust

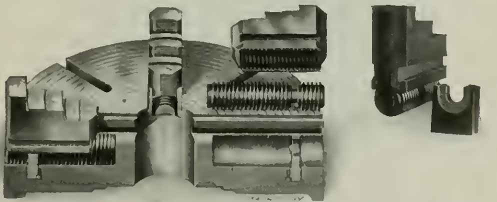


Fig. 4. Horton No. 50-C Independent Four-jawed Chuck

contact against these hardened thrust blocks. After being threaded the screws are heat-treated and ground. The illustration makes the design clear without requiring an extended description.

BRISTOL LONG DISTANCE INDICATING AND RECORDING SYSTEM

A new electrical long distance transmitting, indicating and recording system has been placed on the market by the Bristol Co., Waterbury, Conn. In this instrument, Bard's patented long distance induction balance movement is employed; and Bristol recording instruments, when equipped with this electrical transmitting system, are capable of producing automatic and continuous records of pressure, liquid levels, temperatures, mechanical motions, etc., even at distances of many miles from points at which the transmitters are located. Fig. 1 shows a standard unit of this transmitting and recording instrument, including the transmitting indicator for installation at the point where the pressure or temperature, etc., is measured, and the receiving recorder which is installed at the remote point where it is desired to have the record produced. The two instruments are shown connected by three wires, one of which is connected to a source of alternating current, as for instance, a lighting circuit. This long distance system is particularly well adapted for use under ordinary operating conditions because of its simplicity of construction. There are no sliding or make-and-break contacts employed, and the effects of variation of temperature or resistance along the circuit are negligible. The recording instrument may be installed many miles distant from the measuring and transmitting device. For instance, if 110 volts and No. 14 copper wires are used, the recorder may be located thirty miles from the transmitter, or if No. 12 leads are used the recorder can be installed forty miles or more from the transmitter. The transmitting device is mounted in a moisture proof case, and can be installed outdoors if necessary.

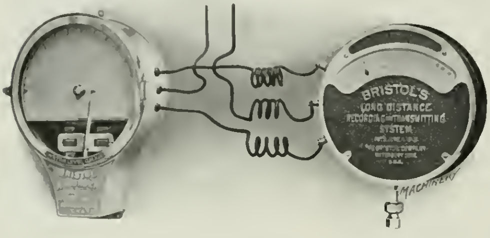


Fig. 1. Arrangement of the Standard Transmitting and Recording Instruments

The fundamental principle of the Bristol long distance transmitting and recording system is that of the induction balance. The transmitting instrument and the receiving instrument are each equipped with two pairs of coils arranged to swing in a horizontal plane over iron cores. Fig. 3 shows the interior of one of the transmitting instruments. In this instrument the helical form pressure tube and the electrical transmitting device are shown in the operating position. The complete outfit consists of two pairs of mechanically balanced solenoids arranged to swing horizontally back and forth over the ends of soft iron cores and connected in parallel to an alternating current circuit. One pair of the solenoids is used for the transmitting instrument, the other pair for the receiving instrument. The front view (Fig. 2) of the transmitter shows one pair of the solenoids *A* and *B* on spools that are connected and supported on a shaft, the ends of which rest in jewel bearings at *G* and *F*, and which is free to swing back and forth over laminated soft iron cores *C* and *D*. The top view (Fig. 4) shows the solenoids *A* and *B* of the transmitter in section, and by the dotted outline the position to which the solenoids may swing is also indicated. A similar pair of balanced solenoids is placed in the receiving recorder or indicator at the distant point. When the solenoids *A* and *B* of the transmitter and receiver are connected in parallel to an alternating current circuit, and the transmitter coils *A* and *B* are held in a certain position by the operating mechanism located at *E* (water level gage, pressure gage, thermometer, etc.) the relative amounts of current flowing in solenoids *A* and *B* will depend on their positions on the iron cores *C* and *D* due to the inductive effect exerted in this way.

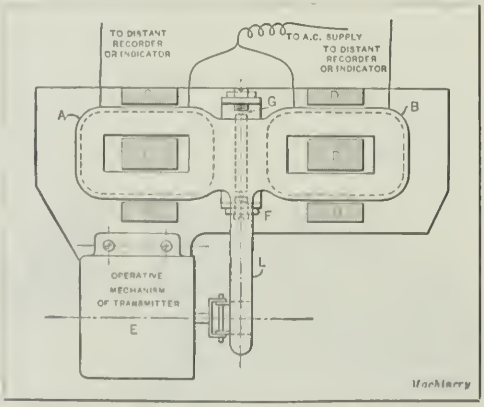

TO DISTANT RECORDER OR INDICATOR
TO A.C. SUPPLY
TO DISTANT RECORDER OR INDICATOR
A
G
B
F
L
OPERATIVE MECHANISM OF TRANSMITTER
E
Machinery

Fig. 2. Diagram showing Arrangement of Transmitter Solenoids

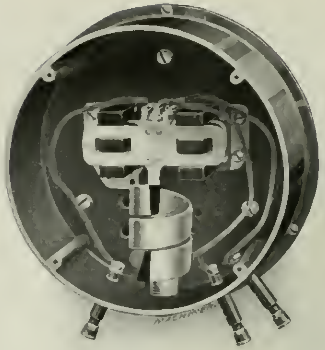


Fig. 3. Interior of the Transmitting Instrument

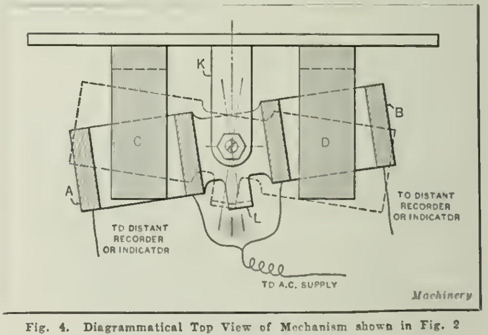

K
B
C
D
A
L
TO DISTANT RECORDER OR INDICATOR
TO DISTANT RECORDER OR INDICATOR
TO A.C. SUPPLY
Machinery

Fig. 4. Diagrammatical Top View of Mechanism shown in Fig. 2

At the receiving instrument the other pair of solenoids are mechanically balanced and free to take an angular position which will be the same as that of the transmitter, since the flow of current will be the same in the corresponding solenoids of the receiver as in the transmitter. If the angular position of the pair of solenoids at the transmitter is changed by the operating mechanism, thus moving one of the solenoids off and the other on to the iron cores increasing the inductance in one solenoid and diminishing it in the other—the flow of current will be proportionately increased in one coil and diminished in the other. The variations of current at the distant receiver will correspond with the variations at the transmitter, and cause the pair of solenoids of the receiver to seek a position of balance which will be the same as that of the solenoids of the transmitter. In the transmitter the operating mechanism is linked directly to the balanced solenoids by means of an arm *L*. In the receiver the recording pen or the indicating pointer is connected to a similar

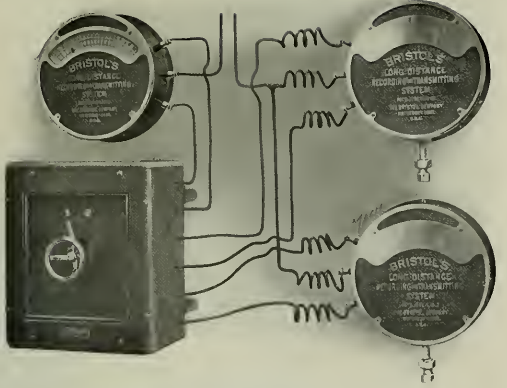


Fig. 5. Combination Outfit including Two Transmitters and One Receiving Indicator, connected to Two-point Rotary Switch

arm through a simple and practically frictionless multiplying mechanism.

Various combinations of transmitting and receiving instruments, of either the indicating or continuous recording type, may be furnished. Fig. 1 illustrates the standard equipment including a transmitting indicator and a receiving recorder, but it is possible to furnish the transmitter and receiver in either the indicating or recording type. Fig. 5 shows a combination outfit including two transmitters and one receiving indicator connected with a two point rotary switch so that readings may be obtained with the indicator of the pressures, temperatures, etc., from either of the transmitters. A great variety of applications for this apparatus will probably arise, owing to its flexibility and extreme simplicity.

WILLSON SAFETY GOGGLES

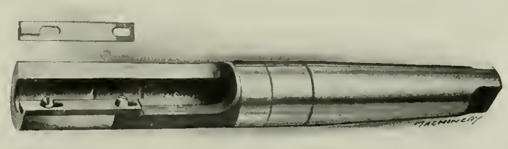
About a year ago announcement was made of the Willson safety glasses which were developed to protect the eyes of men engaged in chipping castings and in other classes of work where the eyes were likely to be injured through flying particles of metal. It was necessary to make these glasses quite heavy, owing to the nature of the service for which they were intended; and to guard against injuries resulting from broken glass, a safety flange was provided to prevent the glass from being driven inward in the event of either of the lenses being broken by flying chips of metal. For such work as operating grinding machines where there is no danger of the glasses being broken, the weight of the type of glasses referred to was found to be an undesirable feature; and for use in such work, T. A. Willson & Co., Inc., Third and Washington Sts., Reading, Pa., has placed a new goggle of somewhat similar design upon the market.

Willson Safety Goggles for Machinists and Grinding Machine Operators

The frame is made in such a way that the goggle is light in weight although quite substantial, so that it will stand rough shop usage. An adjustable bridge enables the wearer to fit the goggles easily to his face; this bridge is pliable and securely attached to the "eye wires." The bridge does not touch the top of the nose, the weight of the glasses being distributed over the sides of the nose and the cheeks, and the goggles can be worn over spectacles. The guards to prevent flying particles of dust and grit from entering the workmen's eyes around the sides of the glasses are of fine wire mesh and add very little to the weight of the goggles. A fine quality of glass is used to insure freedom from eye-strain. The frames are made of rust-proof metal so that the goggles may be thoroughly sterilized before being given out to another workman. The "temples" are placed outside the side guards and fold over the front of the glasses. A case is provided with each set of these goggles.

TRIANGULAR CORE DRILL

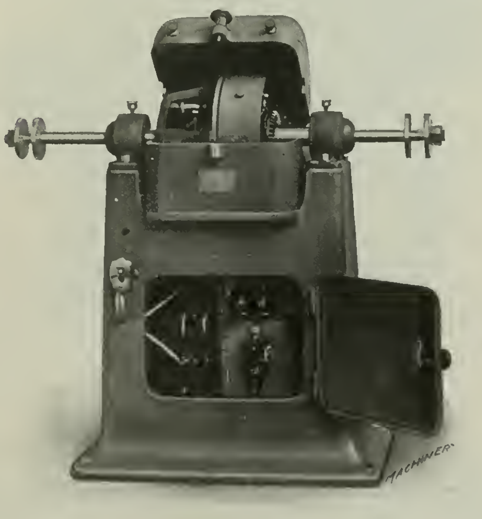
The latest product of the Triangular Tool Co., Erie, Pa., is the core drill for extracting test "coupons" for use in making tensile or bending tests of material. The feature of this tool is the inserted cutter which may be adjusted to compensate for wear and can be readily replaced instead of grinding down the end of the tool itself. The cutter holder is made of heat-treated chrome-vanadium steel to enable it to stand up under hard service. The cutter is of high-speed steel. This tool will core out a piece in from 20 to 25 minutes without requiring the tool to be withdrawn to clear out the chips. In using this tool, it is recommended to employ a speed of about 25 revolutions per minute with a feed of 0.010 inch per revolution when working in high-carbon steel, while in low-carbon steel a speed of 50 revolutions per minute with a feed of 0.005 inch per revolution will be found satisfactory. The drill has a No. 5 Morse taper shank and two cutters are provided with it.



Triangular Core Drill for taking Test "Coupons"

SPRINGFIELD BALL BEARING BUFFING MACHINE

A recent addition to the line of the Springfield Mfg. Co., Bridgeport, Conn., is the style BM motor driven ball bearing buffing machine which is illustrated herewith. This machine is driven by a Westinghouse type S. K. interpole commutating motor which delivers 3 horsepower and runs at 2200 revolutions per minute. Referring to the illustration, it will be

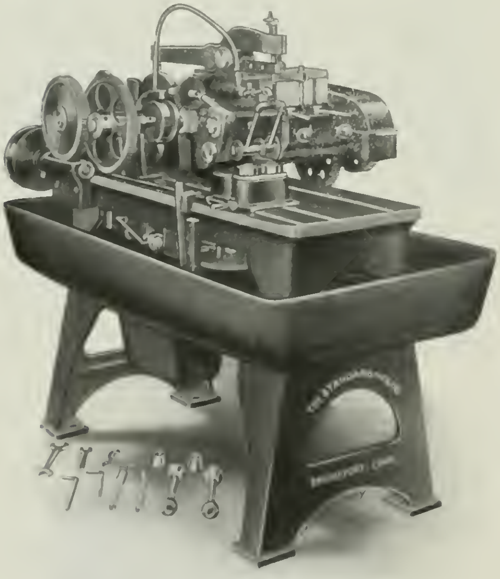


Springfield Buffing Machine with Motor Cover Raised and Door in Base Open seen that push-buttons are provided for starting and stopping the machine. The motor is of standard design with the exception of the armature shaft which is made of high-carbon steel and of sufficient length and diameter to meet the requirements of the machine it is to drive.

The motor is rigidly bolted to the frame of the buffer and is enclosed in a dust-tight case; the upper half of this case is mounted on hinges and by loosening the thumb-screw at the front, it can be thrown back to expose the motor for inspection or adjustment, as shown in the illustration. An opening is also cast in the base below the motor which is covered with fine-mesh wire gauze. The bearings are bronze bushed and of the ring oiling type. The principal dimensions of the machine are as follows: Size of wheels, 12 by 2 inches; height to center of spindle, 36 inches; floor space occupied, 21 by 48¼ inches; weight of machine, 1250 pounds.

STANDARD MANUFACTURING MILLING MACHINE

The No. 3 automatic manufacturing milling machine which is here illustrated was designed for machining four-jawed, square jaw clutches. Two of these pieces are milled simultaneously, and in handling this work the operation of the machine is entirely automatic. The problem of milling these parts presented some difficulty owing to the fact that the cut is off center and that the sides of the slots converge toward the center of the clutch disk. After the first cut is made on both pieces mounted on the table of the machine, the work is indexed through one-quarter revolution and the second cut is taken, this process being continued until four cuts have been made in both of the pieces. The work is then indexed through an amount sufficient to bring it into the required position to mill the other side of the slots, and at the same time the cutters themselves are moved over to the opposite side of the center line. Four more cuts are then taken, thus machining the opposite sides of the slots. The entire operation is done automatically. Many varieties of manufacturing milling operations are done on these machines, including such work as cutting various forms of gears, ratchets, sprockets, saws, cutters, knurls, taps, etc.



Standard Manufacturing Milling Machine for cutting Square Jawed Clutches

The cutter spindle of the machine is made of hardened and ground tool steel and has a long taper bearing which provides ample compensation for wear. The spindle may either be driven direct or through the back-gears and is carried by a slide having vertical movement, which, in turn, is carried by a slide that provides horizontal movement. By means of these two slides any combination of vertical and horizontal movement may be obtained. The cam-shaft is mounted at the rear of the machine and is driven through a worm and worm-wheel. This shaft carries the stroke cam, the cut cam and the index cams. This machine is made by the Standard Mfg. Co., Bridgeport, Conn.

"AVEY" BALL BEARING DRILLING MACHINE

The No. 2½ high-duty ball bearing drilling machine which is illustrated and described herewith is one of the recent additions to the line of the Cincinnati Pulley Machinery Co., Cincinnati, Ohio. This machine is built with either plain hand feed, or with power feed and means for automatically reversing the travel of the drill in one or both directions. The machine with the automatic feed mechanism is very flexible, it being possible to operate it as a fully automatic or as a semi-automatic machine, or the automatic mechanism can be entirely disconnected and the machine fed by hand. As there are many factories which have certain pieces that they manufacture in quantities, and which can be handled rapidly, the problem of getting such pieces into and out of the jig is quite simple, and for drilling this kind of work all of the automatic mechanism on the machine is employed.

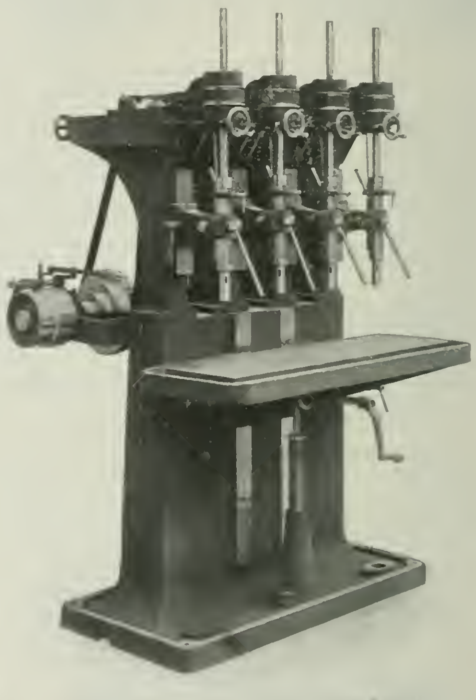


Fig. 1. "Avey" No. 2½ Ball Bearing Drilling Machine

For classes of work which are more or less difficult to handle, more time will be required between successive strokes of the drill, and in handling such work the automatic trip for the down feed of the drill is thrown out, so that the return of the spindle is still taken care of automatically but the power feed clutch must be thrown in by hand For other classes of work all of the automatic movements are disconnected and the drill is fed by hand. The stop collar on the spindle sleeve can be so adjusted that there is very little time wasted between successive operations of the drill; but on the other hand, if the work is of a character which requires considerable time to set up, the stop collar can be set in a po-

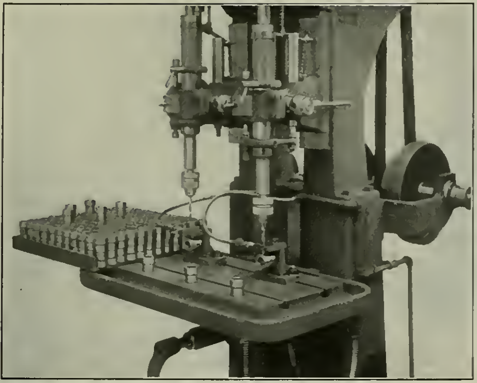


Fig. 2. Machine set up for drilling Steel Bushings—Production 10,000 per Day

sition which allows the spindle to feed down for some distance before it engages the work. Four spindle speeds are obtainable, the highest of which should not exceed 3000 revolutions per minute, and three changes of feed are provided, which are 0.005, 0.008 and 0.012 inch per revolution of the spindle. Different feeds can be furnished to meet the requirements of different classes of work.

The principal dimensions of the machine are as follows: Spindle bore, No. 2 Morse taper; diameter of spindle, 1 inch; width of belt, 1½ inch; height of machine to top of spindle cone, 79 inches; total traverse of spindle, 13¾ inches; distance from center of a spindle to column, 7½ inches; distance between spindle centers, 10 inches, and maximum distance from spindle to table, 33½ inches. An idea of the rate at which work can be drilled on this machine will be gathered from the following: A steel bushing with a wall 9/32 inch in thickness had to have a 17/64-inch hole drilled through the wall. These pieces were turned out by an unskilled operator at the rate of 1186 per hour. Allowing for changing drills and other unavoidable losses of time, it is safe to say that the daily production during a working day of ten hours would be 10,000 pieces. For drilling steel, a pump and piping is provided to deliver lubricant to the tool.

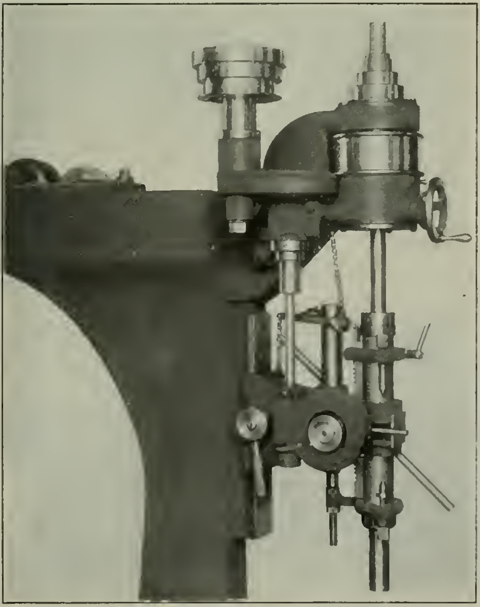
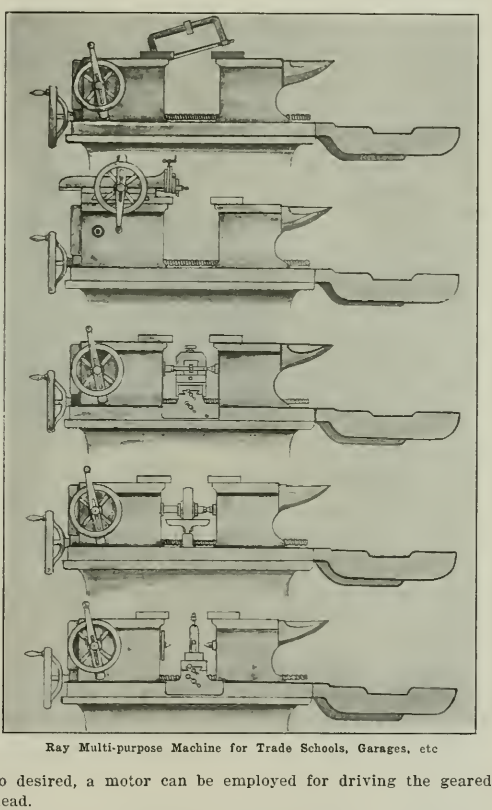


Fig. 3. Arrangement of Feed Mechanism

RAY MULTIPLE MACHINE

The Ray Mfg. Co., 247 Monroe Ave., Grand Rapids, Mich., has recently placed on the market a machine which comprises a lathe, drill press, shaper, milling machine, grinding wheel, hacksaw, forge, anvil and vise in a single unit. This machine is particularly intended for use in trade schools where students may become familiar with these types of equipment before starting work on high-class machine tools which might readily be damaged. Garages and small machine shops will also find it well adapted to their needs.

The forge receives the air blast from a small fan located inside the head, this fan being driven by the handwheel located at the front of the machine. The same handwheel drives the spindle in which the milling cutter arbor, drill, chuck or center and faceplate are held. The anvil is made from a steel casting and a fiber shim is placed between the anvil and bed of the machine in order to prevent vibration from crystallizing the metal. The anvil is also used as one member of the vise and is drawn along the bed by a screw operated by the handwheel at the end of the machine. The two handwheels govern all movements of the machine, but if so desired, a motor can be employed for driving the geared head.

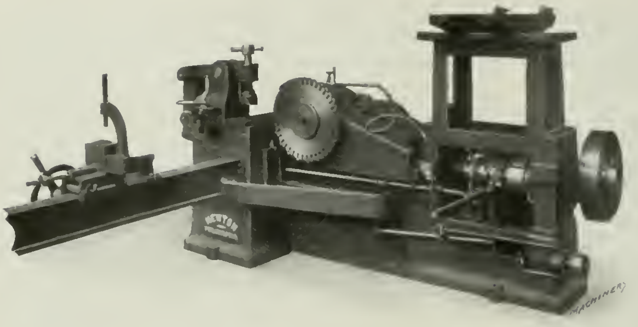


Ray Multi-purpose Machine for Trade Schools, Garages, etc

This machine is provided with or without a stand and is portable—a feature which makes it particularly useful in many shops where it is more convenient to take the machine to the work. The low cost of this machine should enable it to command a market in many shops where a cheap, general purpose tool is required.

NEWTON 22-INCH COLD SAW

The milling saw for cutting off bar stock which is illustrated herewith, is a recent product of the Newton Machine Tool Works, Inc., Philadelphia, Pa. The machine is equipped with a saw 22 inches in diameter and has a maximum capacity for stock up to 3½ inches in diameter. It is equipped with an air-controlled clamp and stock trolley provided with a



Newton 22-inch Milling Saw for cutting off Stock

length duplicating gage; and all operations necessary between making consecutive cuts are performed in fifteen seconds.

The saddle of the machine is of box type construction and provided with underlocking gibs which are cast solid with the saddle. Horizontal adjustments are made by means of tapered shoes. Geared feed is provided from a feed-box in which the arrangement of sliding gears enables any combination to be instantly obtained without the removal of gears. Provision is made for controlling the machine from either the front or the rear, which adds greatly to the convenience of operation. In addition to hand adjustment and power feed, the saddle has power quick return. Adjustable automatic safety release for the feed and fast power traverse, are provided.

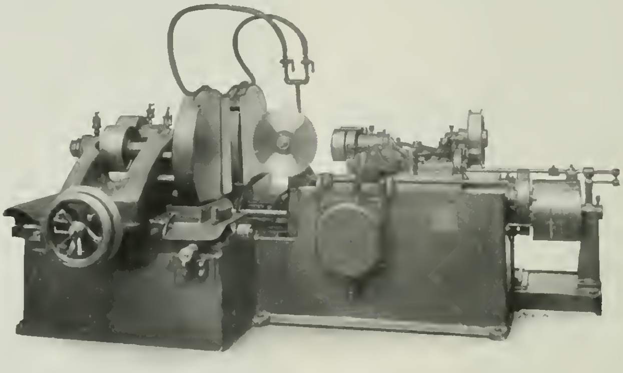


Fig. 1. Front View of Springfield Circular Saw Grinder

A lubricating system is provided which delivers a copious flow of cutting compound, and the base of the machine is designed to take care of the overflow, the reservoir being located in the base at the rear. The illustration shows the machine equipped for belt connection to an individual motor mounted on top of the pedestal, but a countershaft could be employed in cases where individual motor drive is not desirable.

An idea of the capac'ty of these machines may be gathered from the fact that running under actual shop conditions it has been found possible to cut off annealed stock 3½ inches in diameter, containing 0.70 per cent carbon and 0.70 per cent manganese, at a rate of thirty pieces per hour. Running at this rate the machines have been operated continuously for over fifty hours, which means that they will have cut off over 1500 pieces.

SPRINGFIELD CIRCULAR SAW GRINDER

The Springfield Mfg. Co., Bridgeport, Conn., has recently added to its line a machine for the purpose of grinding the clearance or taper on circular saws, blanks or disks up to 36 inches in diameter. Both sides of the work are ground simultaneously so that economical operation is obtained. This machine is also adapted for grinding work with parallel faces The saw or disk to be ground is loosely mounted on a stationary arbor and rotated by two power-driven rolls which engage the work on each side and are held in contact with it by spring tension. The rolls are driven by a belt from the countershaft, the power being transmitted to the rolls through a train of gears. The rolls revolve at constant speed and the studs on which they are carried, are mounted in slides arranged in such a way that they may be separated by means of an eccentric and hand lever to provide for entering the saw. By traversing these rolls back and forth parallel with the face of the saw, a uniform speed is obtained. This traversing movement of the rolls is automatically controlled by tripping dogs which are set according to the size of the work; the same dogs govern the travel of the grinding wheel heads.

Provision is made for stopping the wheel heads at the end of their stroke to allow a few extra turns of the saw to be made in order to obtain a clear grinding cut against the shoulder. The grinding wheels are driven from a drum on the countershaft. They are mounted on high-carbon steel spindles which run in large bronze bearings. The heads are long but narrow and provided with taper gibs for taking up wear. They are mounted on a cross-slide of ample proportions and provision is made for swiveling the heads to obtain the required taper on the work. An adjusting screw facilitates setting for any desired taper or clearance of the saw that is to be ground. The grinding wheels are fed in by hand and both wheels may be fed simultaneously or independently of each other, according to the requirements of the work. The bed is of heavy box section reinforced by cross ribs. A pump is provided which supplies a copious stream of water or cooling compound to the work, the spray being caught by guards and returned to the overflow tank from which it is delivered to the pump tank. The principal dimensions of the machine are as follows: Largest diameter of saw that can be ground, 36 inches; size of grinding wheels, 20 by 3 inches; size of grinding wheel spindle bearings, 2½ by 6½ inches; diameter of saw driving rolls, 6 inches; floor space occupied, 6 feet 8 inches by 9 feet; weight of machine, 8000 pounds.

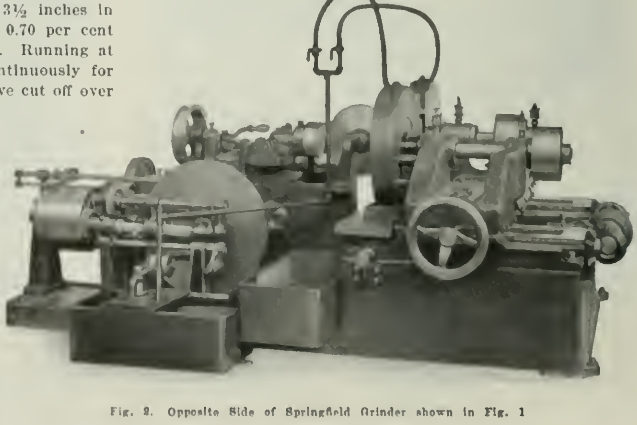
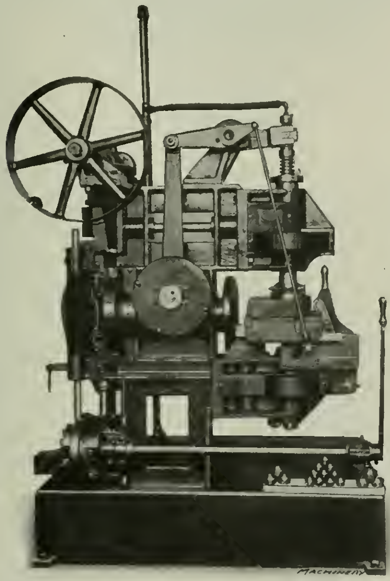


Fig. 2. Opposite Side of Springfield Grinder shown in Fig. 1

POTTSTOWN SEMI-AUTOMATIC UNION MACHINE

The machine here described is intended for machining malleable iron lip union heads and tails. It is built in combinations of any number of units up to four, which are mounted on a single base; in this way the requirements of different shops are met, and by having more than one unit under the control of a single operator, he is kept constantly busy. The work is chucked in a vertical position which makes it possible to equip the machine with a pump and piping that supplies cutting lubricant through the hollow upper spindle, thus flooding all tools, giving long life to the tools and a good finish to the work. This is also the means of enabling the highest possible speed to be utilized.

In operation, the fitting is clamped in the chuck and the machine started with the controlling lever, after which it passes through the cycle automatically, performing the operations of facing, under-cutting and tapping. When the fitting is finished, the machine comes to a standstill and the chuck is drawn back clear of the tools, after which the fitting drops through the back of the chuck into a receptacle placed to receive it. While the chuck is withdrawn, the next blank is placed between the jaws, after which the chuck is pushed up against a stop, thus gripping the work and bringing it into line with the spindles of the machine.

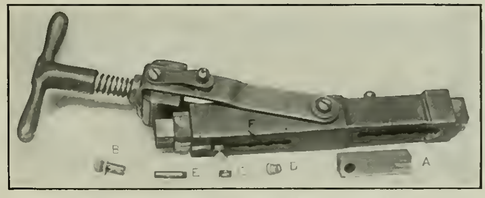


Pottstown Semi-automatic Machine for machining Unions

It has already been stated that the machine is controlled by a single lever at the front, and this lever makes it possible to stop the tools at any point of the cycle and return the machine to the starting point. In case a tool breaks, this lever makes it possible to stop the machine instantly, thus preventing further damage to the tools, which might occur if the machine were allowed to pass through an entire cycle before coming to a stop. The time required to finish a ¾-inch union is 20 seconds, while the finishing of a 1¼-inch union takes 30 seconds. This machine is the latest product of the Pottstown Machine Co., Pottstown, Pa.

MUELLER TELESCOPIC SOCKET WRENCH

The accompanying illustration shows a telescopic socket wrench which is made by Louis Mueller, 1719 Central Ave., Cincinnati, Ohio. This wrench is designed to take the place of the common type using a number of loose sockets, and it will handle all sizes of both hexagon and square nuts for ⅛ to ⅝ inch bolts. The telescopic feature eliminates the use of loose parts and makes a very compact tool.



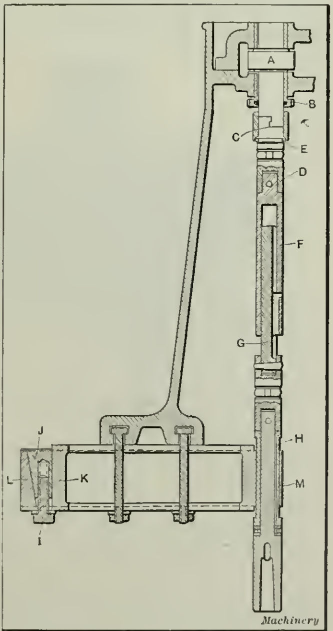
Mueller Telescopic Wrench and Some of its Parts

Referring to the illustration, one of the telescoping sockets is shown at *A*, the movement of the sockets being controlled by knobs *B*. These knobs are fastened to washers *C*; they work against the tension of springs *D* and are a sliding fit on pins *E* which are inserted crosswise in the sockets. To bring out any required socket, the knob *B* is pressed down until the flat portion just below the shoulder comes into line with the narrow slot *F* in the wrench; the knob can then be advanced to the next circular opening so that the socket is brought out ready for use. On relieving the pressure on the knob *B*, the spring *D* forces the knob out into the circular opening, thus holding the socket in place. The way in which the wrench is swiveled around to bring either end into action will be evident from the illustration.

IMPROVED ARM AND SPINDLE FOR BAUSH MULTIPLE DRILLS

The accompanying illustration shows an improved form of spindle and supporting arm construction which is now used on the multiple spindle drilling machines built by the Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass. Referring to this illustration, it will be seen that the spindle gear *A* is supported on both sides by long bronze bushings and the lower bushing is fitted with a packing nut *B* which forms an oil-tight joint around the bottom of the bearing. This makes it possible to keep the gear chamber filled with oil, thereby insuring perfect lubrication of the gears and bearings.

It is often desirable to remove one or more spindles from the head of a multiple drilling machine in order to facilitate the adjustment of the remaining arms. This is provided for in the improved Baush construction by the joint connection *C*, which makes it an easy matter to assemble or disconnect the spindle. This is done by removing the spring *D* to enable the collar *E* to be dropped down to expose the connection. To reconnect the spindle, it is merely necessary to pass the collar up into its original position and snap the spring *D* into place. The universal ball joint is



Improved Type of Arm and Spindle Construction now used on Baush Multiple Spindle Drills of the improved Baush pattern made with a solid ball grooved at right angles, two sets of driving blocks and two sockets. With this construction a very simple but powerful joint is secured.

It will be seen that the spindle proper consists of two telescopic members *F* and *G* which are keyed together. This provides for adjustment of the length of the spindle when it is placed in various positions, and means of compensation for differences in the length of the drills. The drill socket bearing *H* is of bronze and has a vertical adjustment of 1¼ inch to further compensate for variations in the length of the drills. All drill sockets are fitted with standard Morse taper holes and are provided with ball thrust bearings.

The feature of the adjustable arm is the method of clamping the drill socket bearing in the desired position. To accomplish this it is only necessary to operate a single screw which is located at the outer end of the arm so that it is always accessible. This screw *I* draws down the wedge *J* which is held between the end of the arm *K* and the wedge block *L*. The wedge block is electrically welded to a piece *M* known as the clamping strip, which is a U-shaped member encircling the arm and bearing *H*, and has its outer ends connected to the wedge block *L*. When the wedge *J* is drawn down by means of the screw *I*, the drill socket bearing is securely clamped into a curved recess in the arm; and by loosening the screw the vertical adjustment of the drill socket is easily taken care of without disturbing the location of the arm which is attached to the head of the machine by two standard T-bolts. It will be evident that with this improved type of spindle and arm, a great saving of time can be made in disconnecting the spindle and making adjustments of the various spindles to take care of drills of different lengths.

SELLEW ADJUSTABLE DRILL HEAD

The Sellew Machine Tool Co., Pawtucket, R. I., has recently placed on the market another type of adjustable drill head in which all of the gearing is completely enclosed. This head has spindles which may be adjusted to provide for multiple drilling or tapping operations on circles of different sizes. The head is especially suitable for machining such parts as electric motor frames, gaskets, flanges, pipe glands, etc. The spindles are mounted eccentrically in plates which may be revolved about their centers in order to adjust the spindles to any position within the range of the head. Figs. 1 and 2 show the heads with the spindles set at the two extreme positions of their range, and the way in which the adjustment is made will be readily understood by referring to the illustration of the under side of the head shown in Fig. 2. The edges of the plates in which the spindles are mounted are graduated in such a way that they may be quickly indexed and clamped in position to locate all of the drills on a circle of a given diameter and to have all of the spindles equally spaced according to the number of spindles in the head. This design not only makes it possible to totally enclose the gearing to provide for the safety of the operator and to have the gears flooded with oil, but it also makes a very rigid construction which overcomes any strain due to the pressure of the feed.

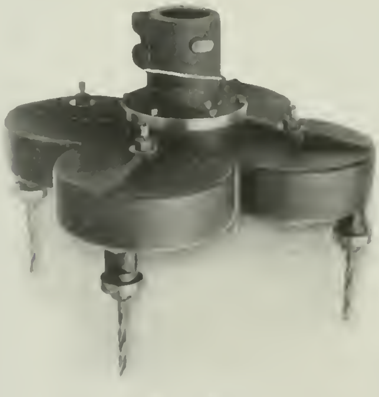


Fig. 1. Top View of Sellew Drill Head

The head is connected to the drilling machine quill by means of a flanged sleeve. The regular tapered driving shank drives the center gear of the head which meshes with intermediate gears around which the spindle pinions are adjustable. While the connecting sleeve clamp and the quill hold the head in perfect alignment with the machine spindle, additional support is afforded at the lower end by means of a long bearing for the tapered driving spindle in the head. This center driving spindle is also arranged with a tapered hole the same as that of the drill spindle, so that a center hole can be drilled at the same time that the spindles in the head are working. Using an arbor with a pilot, the work or jig can be revolved, facilitating the indexing of the work where a large number of holes are to be drilled in multiples of the number of drills in the head. The connecting sleeves and driving shanks are interchangeable so that the same heads may be used on different sizes or makes of machines. The gearing and spindles are of alloy steel and the spindles are equipped with ball bearings. Heads of this type are made with up to six spindles. With the smallest size of head, the spindles may be adjusted as close as 1 inch, while the maximum range of the largest size of head is a circle 24 inches in diameter. The accompanying illustrations show a head which may be adjusted between circles 6 and 24 inches in diameter.

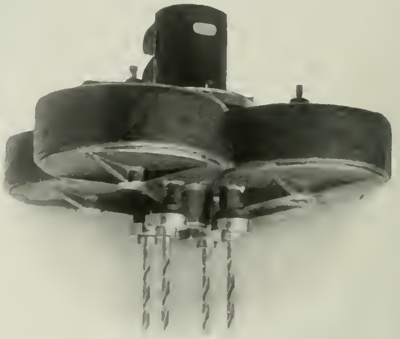


Fig. 2. Under Side of Drill Head showing how Adjustment is made

CORRECTION

In the description of the New Britain buffing lathe made by the New Britain Machine Co., 64 Bigelow St., New Britain, Conn., in the November number of MACHINERY, an error was made in stating that it was necessary to pull up the handle in order to raise the pivoted head to bring the driving belt into contact with the pulley. To raise the head for this purpose the handle is pushed down. The illustration presented in connection with this description showed the machine in the stopped position instead of in the operating position, as stated.

NEW MACHINERY AND TOOLS NOTES

Friction Clutch: Holyoke Machine Co., Worcester, Mass. This clutch is of the rim friction type, there being a complete circle of frictional contact of wood on iron. The shoes are easily removed so that the replacement of the wooden frictions is easily effected.

Bending Brake: Dreis & Krump Mfg. Co., 2909 South Halstead St., Chicago, Ill. A motor-driven bending brake which has a capacity for handling plates up to ½ inch in thickness and up to 16 feet in length. The machine is driven by a 20-horsepower electric motor.

Hydraulic Press: Metalwood Mfg. Co., Detroit, Mich. A self-contained hydraulic press adapted for general machine shop work where forced fits have to be made. The machine consists of a stationary base and a head cast integral with the hydraulic cylinder, the two members being held together by tie-rods.

High Pressure Gas Cylinder Stud Valve: International Oxygen Co., 115 Broadway, New York City. A stud valve for use on high-pressure gas cylinders which is adapted for withstanding pressures up to 2500 pounds per square inch. The valve is especially suitable for use on cylinders containing oxygen, hydrogen and similar gases.

Pocket Calculator: Small, Small & Co., Waltham, Mass. A small pocket calculator which is the equivalent of a 6-inch logarithmic scale arranged in circular form. The instrument can be used for a great variety of calculations which are handled on the ordinary slide rule and is convenient to carry, owing to its exceptionally compact form.

Casehardening Compound: German Compound Co., 151 Franklin St., Boston, Mass. Hardening and carbonizing compounds which, when sprinkled on red hot steel, provide for carbonizing to a depth of 1/64 inch. In addition to the rapidity with which this can be used, it is said that very little smoke or objectionable gas is given off.

Crane Controller: Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. A line of magnetic switch controllers in which overload protection is provided for by means of two overload relays, one of which is located on each side of the line. After the relays have operated, they are automatically reset by throwing the master switch to the off position.

Rail Hacksaw: A. Reitlinger, 170 W. Broadway, New York City. A portable machine for cutting rails. The machine is clamped to the flange of the rail and the cut started at the bottom. It is operated by a handle which is provided with a knuckle joint so that it may be swung down to allow a train to pass over the machine without removing it from the rail.

Safety Lathe Dog: Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago, Ill. A lathe dog which combines convenience and efficiency with protection for the machine operator. The head of the binding screw is covered with a special shield which prevents the possibility of the operator's hands being cut or his clothing caught by the head of the screw.

Oxy-acetylene Welding Outfit: Willners Machine Co., Chicago Heights, Ill. An equipment in which the acetylene generator is of the type in which the gas is rendered non-explosive by mixing it with oil gas. The acetylene and the oil gas are generated simultaneously and in addition to being suitable for welding and cutting operations, the gas may be used for lighting, heating, etc.

Shear: Cleveland Punch & Shear Works Co., Cleveland, Ohio. Heavy-duty plate shears built for the Riverside Works of the Otis Steel Co., Cleveland, Ohio. One machine has a capacity for cutting 1¼-inch plates 84 inches in width; and the other two machines have a capacity for shearing plates 156 inches in width, one of these machines accommodating 1-inch stock and the other ¾-inch stock.

Tire Heater: Hauck Mfg. Co., 140 Livingston St., Brooklyn, N. Y. A portable machine which can be easily set up at any point where work is to be done. The apparatus consists of a cast-iron combustion chamber provided with eight burners leading to the tire. The burners are equipped with adjustable sleeves to adapt them for the requirements of different sizes of work. Kerosene oil is burned in the heater.

Multiple Spindle Drill: National Automatic Tool Co., Richmond, Ind. In the August, 1914, number of MACHINERY, the "Natco" No. 20 high-speed multiple drill of this company's manufacture was illustrated and described. Since that time, the National Automatic Tool Co. has brought out a No. 22 machine which is heavier and more powerful but otherwise similar in design. The chief points of difference between these two machines are that the No. 22 will carry a larger size of head with more spindles, and that the table is correspondingly increased in size to provide for handling larger work. The feed box and feed mechanism below the table are also of somewhat different construction.

Horizontal Multiple Spindle Drill: Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass. In the November number of MACHINERY, reference was made to the special multiple spindle drilling machine built by this company for drilling all of the holes in an automobile transmission case without requiring the work to be reset. This is a special purpose machine on which two opposed horizontal heads and one vertical head are provided. The Baush Machine Tool Co. has recently developed a machine of this type on which there are two opposed horizontal heads, which are adapted for meeting any conditions where drilling is to be done on both sides of a piece of work. In other words, this is a universal machine, while the former machine was built for a special class of work.

Multiple Spindle Drills: Rockford Lathe & Drill Co., Rockford, Ill. In the February, 1914, number of MACHINERY the two-spindle sensitive floor drill manufactured by the Rockford Lathe & Drill Co., Rockford, Ill., was illustrated and described. This company has recently brought out machines of the same type equipped with three and four spindles. In designing these machines particular care has been taken to make the design and method of operation as simple as possible. The column is of the box type, braced in such a way that exceptional rigidity is secured. The table is raised and lowered by a handwheel; adjustable supports are provided, and the table may be removed for refinishing, should it become badly worn. The spindles are provided with ball thrust bearings and stop collars.

Pipe Machine: Williams Tool Co., Erie, Pa. A motor-driven 16-inch pipe threading and cutting-off machine. The driving motor is mounted on an auxiliary base at the rear of the machine and direct connected. In other respects this machine is the same as the 16-inch machine of this company's manufacture which has been on the market for about a year. This machine cuts off and threads pipe from 7 to 16 inches in diameter. The die head is carried on a sliding carriage and is furnished with eight sets of interchangeable dies which are operated by a handwheel. There are four changes of spindle speed, these changes being controlled by levers on the operating side of the machine. The spindle is equipped with a powerful three-jaw chuck on both ends; the rear chuck is fitted with flange grips for making up flanged work.

* * *

PORTABLE COMPRESSED AIR PUMPS

Compressed air leaks rapidly through minute openings, and leakage losses are one of the serious troubles met with in all compressed air installations. Were it not for the fact that the waste of compressed air is so great wherever leakage exists, its use would undoubtedly be much more extensive in machine design than it now is. One method of overcoming the trouble is to do away with the common system of stationary air compressor and distributing pipes, and to furnish the compressed air where required as it is needed, by means of a portable air compressor. This is being done to some extent in garages for inflating tires, etc. Instead of installing a stationary compressor and lines of piping with vents at various points for the convenience of the garage workman, a portable compressor driven by an electric motor is furnished. This compressor, weighing but a few pounds and mounted on wheels, can be quickly taken to any place in the garage and there connected to a convenient lamp socket. It pumps air in any quantity required to a pressure of 100 or 125 pounds per square inch, and as soon as the need is filled, the electric current is shut off and all waste stops.

The same principle is being employed to a considerable extent for hydraulically operated machines. Instead of having a central pumping plant and a costly accumulator and pipe system, each press or other machine is provided with its own hydraulic pump and electric motor. The motor and pump supply water under pressure to the hydraulic system as required, and the moment the need ceases pumping is discontinued. The advantages of this system are flexibility, low cost of up-keep and simplicity of installation.

* * *

ANNUAL MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

The annual meeting of the American Society of Mechanical Engineers will be held at the Engineering Societies Bldg., New York City, December 1-4. The tentative program includes the following papers:

Floor Surface in Fireproof Buildings. By Sanford E. Thompson.
Reinforced Concrete Factory Buildings. By F. W. Dean.
Measuring Efficiency. By H. L. Gantt.
Standardization in the Factory. By C. B. Auel.
Operation of Grinding Wheels in Machine Grinding. By George I. Alden.
Friction Losses in the Universal Joint. By P. F. Willson and W. J. Malcolmson.
Steam Locomotive of Today. (Sub-committee Report.)
Factors in Estimating Tool Steel. By John A. Mathews and Howard J. Stagg.
Standardization of Chilled Iron Crane Wheels. By F. K. Vial.
The Mechanical Elimination of Seams in Steel Practice, Notably Steel Rails. By R. W. Hunt.
The Rate Flow Meter. By H. C. Hayes.
A New Volume Regulator for Air Compressors. By Ragner Wikander.
Physical Loss of Methane Gas. By P. F. Walker.
Lubricating for Testing and Investigating Liquid Flow Meters. By W. S. Giele.
The Clinkering of Coal. By Lionel S. Marks.

The John Fritz medal will be awarded to Prof. John E. Sweet, honorary member and past president of the society, Wednesday evening, December 2, with appropriate ceremonies.

NEW PLANT OF THE BROWN INSTRUMENT CO.

Users of Brown pyrometers and Keystone electrical instruments will be interested in learning that the Brown Instrument Co. and the Keystone Electrical Instrument Co. are now located in their new factory at Wayne Junction, Philadelphia, Pa. The factory is a new two-story brick building in which the manufacturing department is located on the second floor, while the first floor is given over to the office, the receiving and shipping rooms, and to a locker and wash room for employes.

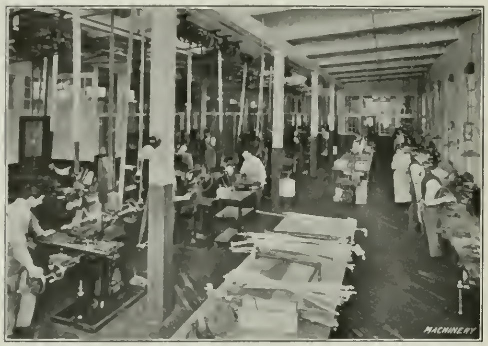


Fig. 1. View of Machine Shop in New Factory of the Brown Instrument Co.

In laying out the equipment in the manufacturing department, the arrangement has been worked out so that the work passes in a continuous circuit, thus avoiding unnecessary loss of time in transit. The inspection department is located at the center of the floor, the machine shop being located on one side and the assembling department on the opposite side. Windows communicating with both departments are provided so that the inspectors can receive work from either the machine shop or the assembling room. All work receives a double inspection. Parts made in the machine shop are handed in through the window of the inspection department where they are looked over to make sure that they fulfill all requirements, after which they are passed on through the window at the opposite side to the assembling department, where the work of putting together the component parts of the instruments is handled. After each instrument is finished in the assembling department, it is sent back to the inspection room where it is carefully tested before being shipped.

Figs. 1, 2 and 3 show views in the machine shop, the inspection department and the assembling department, respectively. In reference to the machine shop it may be stated that the most modern forms of equipment are provided for handling the light machining operations involved in the manufacture of this company's product. On the left-hand side of the view of the inspection department, the work of testing pyrometer couples is shown. For this purpose five of the couples to be tested are placed in a furnace with a standard couple which has been calibrated by the Bureau of Standards, Washington, D. C. The temperature of the furnace is gradually raised and the indications of each couple are compared with that of the standard couple by means of a switch which enables first the standard couple and then the couple which is to be tested, to be connected with the indicating instrument. Any inaccuracies which are discovered in this way are corrected and subsequent tests are made until the required degree of accuracy has been obtained.

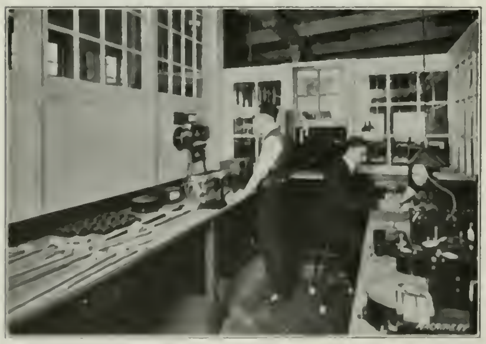


Fig. 2. Inspection Department—testing the Accuracy of Pyrometer Couples

Fig. 3 shows a general view of the assembling department from which an idea of the layout of the equipment can be obtained. In assembling the fine mechanism which forms a part of the Brown and Keystone instruments, it will be evident that good light is an essential feature in securing satisfactory results. This requirement is well taken care of in the new factory by having the work benches run around the sides of the room where advantage may be taken of natural light afforded by an ample window area. The most modern means of artificial illumination also forms part of the equipment, so that the work need not suffer on dark winter afternoons.

It has already been mentioned that after the work is finished in the assembling department, it goes back to the inspection department where the accuracy of each instrument is finally determined before it is sent to the customer. After being passed by the inspector, the work is sent down to the shipping room on the main floor. On this floor there is also a room equipped with sanitary wash basins and metal lockers. Each employe has an individual locker. In going through this factory, the visitor is impressed by the fact that the building and its equipment, and the despatch and care with which the work is handled and passed from department to department, is all that he should expect to find in a plant given over to the manufacture of high-grade scientific instruments.

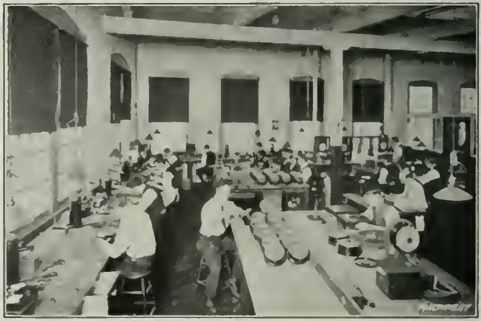


Fig. 3. General View of Assembling Department

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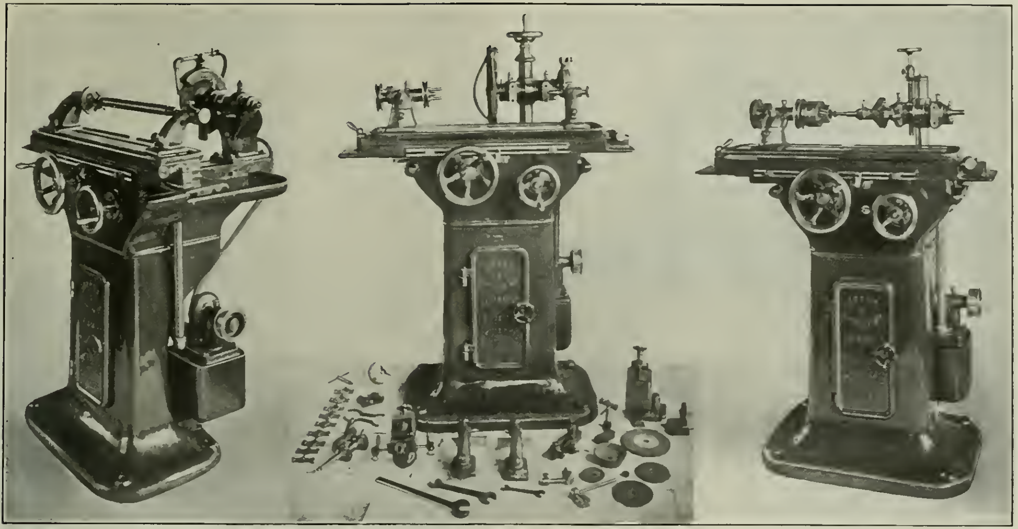
ON SPECIALIZATION IN MANUFACTURE

The degree to which specialization of manufacture is carried on in the United States is to some extent indicated by the fact that there are several concerns making brass and bronze bushings for bearings. One concern making a specialty of this line has been in business for seven years. It was organized with the idea of specializing in bearing metal, as the founder saw an opportunity in this line owing to the fact that the average engineer or designer is not as familiar with the different characteristics and properties of bronzes as he is with other metals. This concern ships from 5000 to 15,000 finished bushings a day, costing from 5 cents to $12 each. It is an organization of bushing makers, trained to produce this one line who devote all their time and energy to it exclusively. The result is that the company can furnish the average manufacturer bronze bushings and bearings costing from 25 to 50 per cent less than his own cost. Besides saving money, he obtains a much higher grade of article than is made in the average shop. The concern in question issues a price list in which 1300 standard sized bushings are listed.



Figs. 1 to 3. "New Century" Plain and Universal Grinders, and Application of Internal Grinding Attachment

"NEW CENTURY" CYLINDRICAL GRINDER

The "New Century" cylindrical grinder which is illustrated and described herewith is one of the recent products of Jones & Shipman, Ltd., Leicester, England. The machine is adapted for both internal and external cylindrical grinding and the design has been worked out along lines which provide for the rapid production of accurate work. The machine is suitable for manufacturing operations and is adapted to requirements of repetition work. It will be seen from Fig. 1 that the column is of massive rectangular construction, and the base has a three-point bearing contact with the floor. The slides are constructed so that the working surfaces are always covered and automatic spring roller lubricators supply the oil to the slide-ways. The table and slides are held down by their own weight, obviating the friction incident to the application of bottom guides and "keep" plates. The top table has a front edge machined perfectly true and all attachments are made with faces to correspond; by means of an angular slot and locking device the attachments are always pulled up securely to this master face on the table, thus insuring perfect alignment. The top table may be rotated to provide for grinding tapered work.

The head has been carefully designed for operation at high speed, the spindle being accurately ground and fitted in adjustable phosphor-bronze bearings which are dust-proof and self-oiling. The head is a heavy box section casting which is bolted to the cross-slide, and the ways of the cross-slide are always covered and protected from dust. Fig. 1 shows the plain grinding machine, the universal grinder is shown in Fig. 2, and in Fig. 3 the machine is shown set up for an internal grinding operation. The universal machine is well adapted for tool-room work and the attachments and various parts provided for use in connection with it are shown in the illustration. Three of the fixtures for the universal machine are shown in operation in Figs. 4, 5 and 6. In Fig. 4 the universal V-clamp fixture is shown. This fixture is adapted for handling various classes of work and can be swiveled to meet the requirements of different operations. Fig. 5 shows the universal swivel vise in which work is held for surface grinding operations. It will be seen that this vise is provided with two swivels and graduated dials which enable the work to be set for grinding any angle.

In Fig. 6 the gear cutter dividing head is shown set up on the machine. In grinding a cutter on this attachment, an index plate having the same number of divisions is mounted at the opposite end of the mandrel from the work. This index plate has notches which are engaged by a spring plunger to locate the work for grinding successive teeth. Other fixtures for use on this machine include a twist drill grinding fixture which is attached to the cross-slide, a fixture for taper shank cutters which consists of a hollow spindle bored No. 4 Morse taper, with collets to take Nos. 1, 2 and 3 Morse tapers, a high-speed internal grinding attachment which gives speeds up to 40,000 revolutions per minute, centers to carry cylindrical work up to 12 inches in diameter, and a special fixture

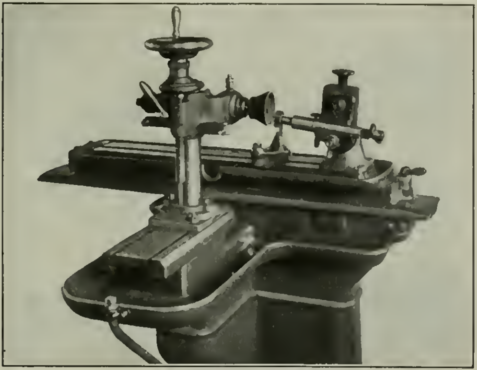


Fig. 4. Universal V-clamping Fixture

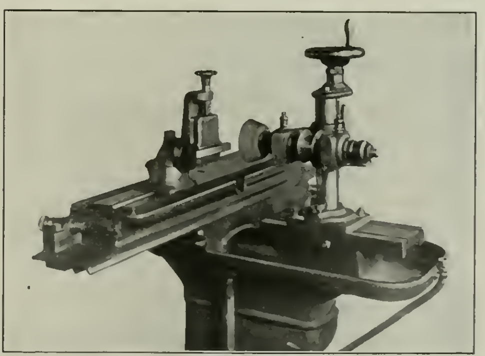


Fig. 5. Universal Swivel Vise for Use on Surface Grinding Operations

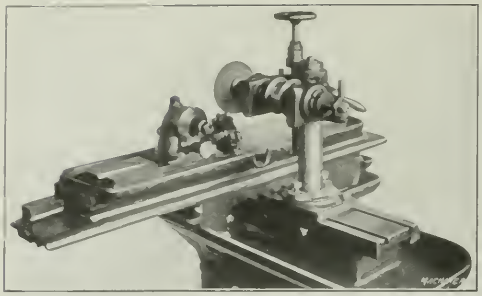


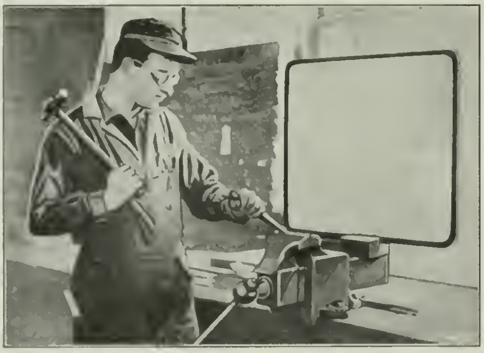
Fig. 6. Dividing Head for Use in grinding Cutters

for grinding the sides of saws, cutters, collars, etc. The principal dimensions of the machine are as follows: Working surface of table, 27½ by 4 inches; longitudinal traverse of tables, 17½ inches; swing of centers, 8 inches; cross traverse of wheel slide, 5 inches; size of wheel used, 8 by ¾ inches; net weight of machine, approximately 800 pounds.

* * *

SHIELD FOR PROTECTION AGAINST FLYING CHIPS

The accompanying illustration, reproduced from the safety bulletin of the Illinois Steel Co., shows a shield for protecting workmen from flying chips. It is an adaptation of the ordinary frame canvas shield, its peculiar feature being that it is mounted on an iron block of sufficient weight to hold the shield always in vertical position. No other support is required. Hence it can be moved around at will, placed almost anywhere on a bench or vise and at an angle, if desired.



Shield for Protection against Flying Chips

Another adaptation of the same idea is having the base to which the shield is attached fairly broad and heavy and rounded on the bottom so that if knocked over it will automatically return to an upright position.

* * *

HIGH CONDENSER VACUUM

Within recent years engineers have been striving for higher and higher vacuums in order to increase the efficiency of steam turbines, but it is only recently that the feat of obtaining a vacuum one per cent higher than the theoretical has been accomplished. A recent test made in the hydraulic laboratory of the Wheeler Condenser & Engineering Co., Carteret, N. J., on one of its turbo-air pumps, showed vacuums considerably higher than the theoretical for quantities of air up to about twenty cubic feet of free air per minute, when the vacuum fell to 100 per cent or the theoretical. The explanation of the paradox is that it is customary in condenser work to consider the vacuum corresponding to the temperature of the water passing through the pump. The hurling water is subjected to a cooling effect caused by the high vacuum and this reduces the temperature of the water and also reduces the vapor tension and increases the vacuum obtainable.

MANDREL FOR TURNING PARALLEL SURFACES

BY ARTHUR E. BLOFIELD*

Where it is required to turn two surfaces exactly parallel, the mandrel shown in Figs. 1 and 2 will be found very useful. This is nothing more than an expanding mandrel which is provided with an accurately finished shoulder, against which the work may be located. A small saw is shown mounted on the mandrel. If we assume that it is required to turn the two sides of this saw exactly parallel, the method of procedure followed would be to first turn one surface. The work would then be removed from the mandrel and the finished surface placed against the locating shoulder, after which the opposite side would be turned; and owing to the way in which the work was held while turning the second side, it will be evident that both sides would be exactly parallel.

The parts of the mandrel are shown in Fig. 2, and referring to this illustration in connection with the following description, the construction of this tool will be readily understood. It will be seen that the nut *A* has a fine thread cut on the outside of it, the nut *B* being threaded internally to screw onto the extension on the nut *A*. The nut *A* is also threaded internally, the thread being of the proper size to screw onto the threaded extension *C* on the mandrel. The split bushing *D* is carried inside of the extension on the nut *A* and is held in place by the small plate *E*, the edge of which fits into the annular groove in the split bushing *D*. A second split bushing *F* fits over the bushing *D*. In preparing to use the mandrel, the bushing *F* is slipped over the end of bushing *D* and the nut *B* is screwed onto the nut *A* to bring the locating shoulder to the required position. The work is next slipped over the bushing *F* and the nut *A* is then screwed back onto the mandrel to expand the bushings over the tapered pilot *G*, thus securing the work firmly in place. On relatively thin work, the internal pressure of the split bushings would be sufficient to cause serious distortion and inaccuracy, if it did not actually break the work.

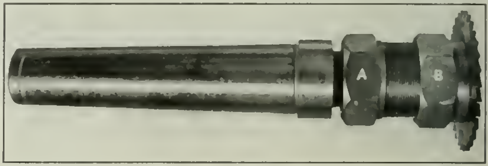


Fig. 1. Mandrel designed for Use in turning Parallel Surfaces

To avoid this difficulty, a stop nut *H* is provided on the threaded extension *I* on the mandrel. The nut *H* is set in such a position that nut *A* can only be screwed back a specified distance, this distance being such that the internal pressure cannot be sufficient to damage the work. In addition to the particular purpose for which this tool was designed, it could be used for handling a variety of other classes of work for which an expanding mandrel is required.

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* Address: 511 E. 78th St., New York City.

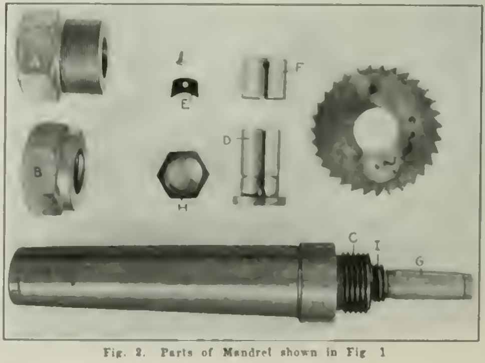

Fig. 2. Parts of Mandrel shown in Fig. 1

LOCATION AND DESIGN OF FACTORY BUILDINGS*

Factory design requires a broader knowledge of engineering than do most types of buildings. For this reason it is the work of an industrial engineer rather than an architect. The industrial engineer should be an engineer with a fair working knowledge of architecture, and of civil, structural, mechanical and electrical engineering. It is essential to the economical design of any building which is to house machinery and human beings doing work which involves repetition of the same act, that the designer of that building should have a very clear working knowledge of all the machinery installed and the processes which are to be carried on in the finished structure. The work of the industrial engineer should commence, if possible, before the location of the factory is determined upon. The first consideration is, of course, the proper locality for the industry. This is largely an economic problem which the engineer may or may not be required to study.

The cost of any manufactured commodity to the retailer consists of the following items: Cost of raw materials, cost of transportation of these raw materials to the factory, cost of labor on materials, cost of power, overhead charges, including interest on money invested, depreciation of plant, insurance, office time and advertising, cost of distribution, profit to the manufacturer.

It should be the duty of the engineer to study these items and to so arrange them that they will occupy their proper place, bearing upon the factory location. This place is, of course, different in different kinds of factories. In the fabrication of structural steel, for instance, perhaps the most important factor is freight. This includes freight from the rolling mill to the factory and freight on the finished product from the factory to the consumer. In some parts of the United States this freight amounts to more than half the cost of the finished product. However, in the manufacture of candy, for instance, the freight is of small importance and the proximity to the market and the cost of labor is of greater importance.

Having determined on the vicinity in which the factory is to be built, the next consideration is the purchase of the exact site necessary for the project. The exact area of land which is necessary is usually a troublesome question. Most successful projects are hampered by lack of room to provide for their growing needs. On the other hand, it is a serious handicap to a young industry to be burdened with heavy interest charges and taxes on land not at the time in use.

The size and shape of the area necessary for present needs is usually determined by making a preliminary plan of the whole project. With the approximate area required clearly in mind, a search of the locality will usually show a number of available sites. For projects of some importance, plats are usually prepared showing how the proposed sites may be developed. These plats should show the approximate grades and elevations of all adjacent streets, the location of sewer, gas, water and power connections and the available connection to adjacent railroads or sidetracks. At this time a study should be made to determine the number and length of sidetracks which will be required. In general, the track should be long enough to hold as many forty-foot cars as the company will need to load and unload in any one day.

After the exact location of the site is determined, the plans of the buildings must be prepared. It is, of course, a mistake to make the final plans of any building before its definite location is settled. The natural grades of the land itself, the streets, the points of the compass and the condition of the subsoil almost invariably change the plans to such an extent that they must be revised or redrawn. All of these conditions should be determined by an exact survey before work on the plans commences.

The first plans to be prepared should be complete machinery plans. A study should be made of the progress of the materials through the shop. In general, the manufacturing processes should be so arranged that there will be no lost motion. The different materials which go to make the finished product should all travel through the various parts of the factory in such a way that they will arrive at the assembling room without having traveled any greater distance and without having been transferred more times than is absolutely necessary. Leaving the assembling room, the materials should go by the shortest possible route to the storage and shipping rooms. This part of the work is, of course, best planned with the prospective superintendent of the shop. The building should be built to suit the machinery. The columns and beams, the height of stories, the location of heating and plumbing pipes, the sprinkler system, and natural and artificial lighting should all be arranged to that one end.

There are two general types of factory buildings. The first is the ordinary one-story building with a hip roof which may or may not be surmounted by a monitor. It usually has a large unobstructed floor space to provide for the movement of cranes and other large machinery. The second type is the warehouse type of one or more stories in height. Industries which require a clear floor space of more than twenty-five feet in either direction are usually housed in one-story buildings because it is expensive to carry the weight of upper floors on long spans. Where the materials manufactured are of such size that columns spaced from sixteen to twenty-five feet on centers are not objectionable, the building of several stories is usually found to be more economical.

A one-story building costs the most per square foot of floor area. This cost per square foot of floor area decreases somewhat with the number of floors built, up to four stories. Above that height the cost per square foot gradually increases. There is comparatively little difference in the cost per square foot of floor area between a three- and an eight-story building.

If basement floor space is suitable, it is the cheapest which can be obtained, except where the loads to be carried on the first floor are extremely heavy. A one-story shop building in fire-proof construction will cost from $1.25 to $2 per square foot of floor space area, depending upon the height of the story, depth of footings, length of spans and kind of exterior finish used. Fire-proof buildings of more than one story may be built for as little as fifty cents per square foot of floor area. These approximate figures do not contemplate any sort of plaster or interior finish except whitewash. They do include a properly finished cement floor. The cost per square foot decreases as the size of the ground plan increases. It is more for a long, narrow building than for a square building. However, a factory building should not be made too wide on account of the difficulty in properly lighting the interior. For ordinary factory work from forty feet to fifty feet is the best width. A building of this width can be lighted with a story height of from twelve to fourteen feet. If the width of the building be made from seventy-five feet to one hundred feet, then the story height should be increased to from fourteen feet to sixteen feet, the windows being placed as high as possible.

The most common type of roof is the A-shaped roof. This roof has many advantages. It is easy to keep water-tight, it clears itself of snow easily, and with monitors or ventilators at the peak provides good ventilation for the factory. A better type of roof, where light is essential, is the sawtooth roof. This roof is made up of a series of pitched roofs, rising toward the north and stepping down with a vertical step, in which windows are installed. These windows, facing toward the north, admit a diffused light which illuminates the floor below without casting shadows. If the windows in the sawtooth construction are arranged to swing, they provide as good ventilation as the old monitor type.

The most unsatisfactory problem in shop building is probably the roof. It first must be water-tight; second, if the building is to be heated in winter it must be of such material that condensation will not occur on the under side; third, it should be fire-proof; fourth, it must compete with a large number of cheap roofs which are lacking in one or all of these qualifications. A standard roof construction consists of three-inch hollow book tile, laid on steel tees. This

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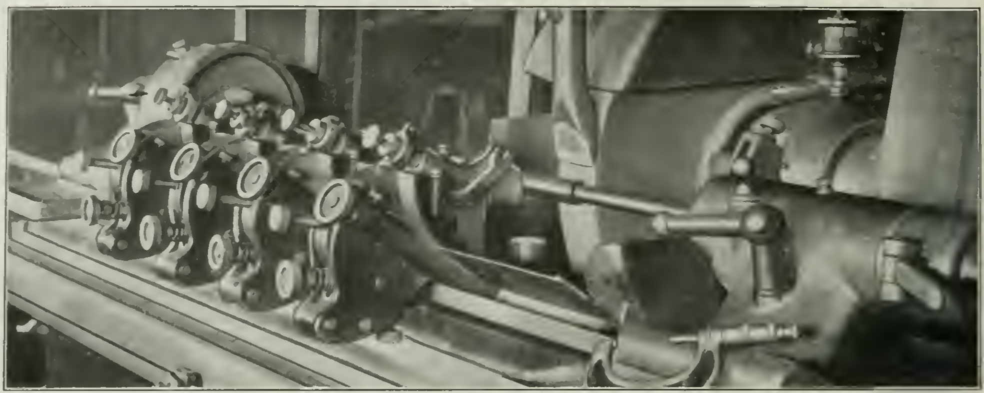
* From a paper by W. E. King, published in the "Journal of the Association of Engineering Societies."



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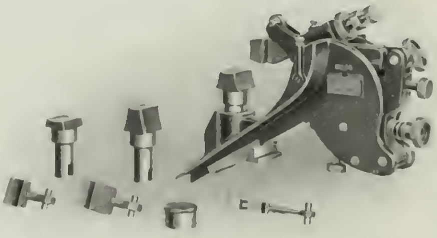

OUR new Combination Plain and Universal Back Rest can be adjusted as a plain, semi-universal or universal rest. It has all the well-known features of our Universal Back Rests, is capable of the same delicate adjustments, and has the same efficient means of automatically maintaining an even support against a piece until it is ground to size. It is particularly useful in this respect when grinding long, slender work.

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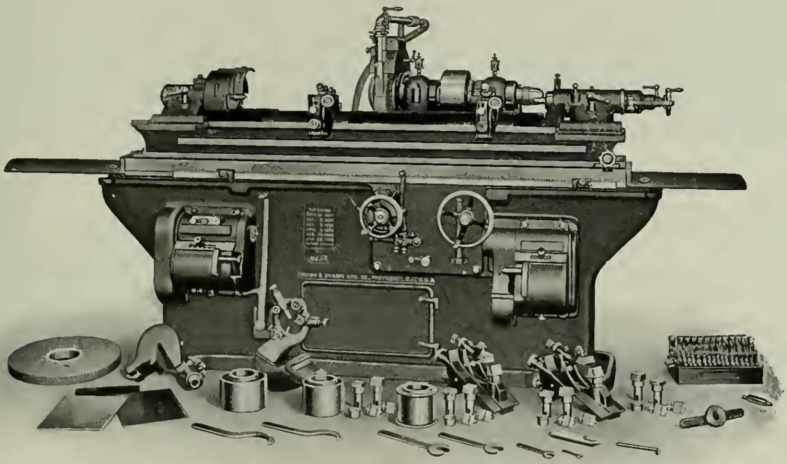

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READ PAGE 75

tile is covered with some good prepared roofing that is cemented and tacked to it. This roof is very expensive, but it fulfills all the requirements stated above. It costs, including supports, about thirty cents per square foot.

In the modern factory building the question of material of the outside walls is not an important feature because from 75 to 100 per cent of the wall area is occupied with windows and doors. The old-style shop building did not, as a rule, admit enough light. Windows should be so arranged that light will reach every point from at least two directions and be of as near the same intensity in both directions as possible.

Another question upon which there is usually some argument is the kind of windows to be used. The three types most in use are the standard wooden sash, the rolled steel sash and the fire underwriters' sash of sheet steel or copper. The underwriters' sash is very little used for shop buildings, because of the expense. It will, however, greatly reduce the insurance rate upon such walls of the building as have a bad fire exposure. Underwriters' sash costs about $1 per square foot, glazed with one-quarter inch wire glass and set in place.

The most satisfactory sash at the present time, for factory work, is the rolled steel sash. This is a comparatively new product, having been on the market only a few years. Where large areas are to be glazed the small size of the steel muntins and mullions permits the maximum amount of light to enter the building. The cost of steel sash set in place and glazed with double strength glass runs from forty cents to forty-five cents per square foot, depending upon conditions. The cheapest sash to use is undoubtedly the double hung wooden sash with which we are all familiar. Its cost is from twenty-five to fifty cents per square foot, in place. It allows of 50 per cent opening for ventilation.

Factory buildings of more than one story naturally divide themselves into four general classes, according to the materials of which they are constructed. These classes are, frame construction, slow-burning timber construction, structural steel and reinforced concrete.

In the frame construction class should be included all buildings having either brick or timber walls, wherein the floors are of wood and the joists narrow and spaced close together. Such buildings are the cheapest that can be built. If such a building is anything more than a temporary structure, the fire hazard, the danger to employes upon the upper floors and the lack of rigidity for supporting machinery are disadvantages which justify a type more in accordance with the rules laid down by the fire underwriters.

In the slow-burning mill building construction as described by the fire underwriters, the walls must be of brick or stone. It differs from the frame construction in that the joists are spaced from three feet to six feet apart and are timbers of considerable size. The floors are matched planking. All stairs and elevator hatchways must be enclosed, with doors at each floor opening. This construction is, of course, somewhat more expensive than the frame construction. Its principal advantage is that it takes an insurance rate about 20 per cent less than the frame construction.

Any timber construction has several advantages over more permanent types such as concrete or steel. Alterations in the buildings, due to changes in processes of manufacture and the installation of new machinery, are much more cheaply and rapidly made. The expense of attaching shafting and machinery to the finished structure is considerably less. Wooden buildings are much more rapidly constructed than either reinforced concrete or structural steel buildings.

A better construction consists of steel columns and beams throughout. The floors may then be made of reinforced concrete or tile. If the columns and beams are covered with fireproof material such as tile or concrete the building may be regarded as the best type of building which modern civilization has produced. It is also the most expensive, costing from 5 per cent to 20 per cent more than a reinforced concrete building. The insurance rate for such a building, as compared with a frame building, is 40 per cent less, without a sprinkler system, the frame building rate being $1.50 per $100, and the steel construction rate $0.90 per $100. With a sprinkler system this rate would be reduced to about $0.36 per $100. In fact, many buildings of this type take a rate of ten cents to twenty cents per $100.

A properly designed concrete building is the very best building which can be put up for many industries. It is entirely fireproof and takes the same rate of insurance as a fireproof steel building. Such buildings are probably the most rigid type which can be constructed. The floor spans of a concrete building may be made economically from sixteen feet to twenty-four feet in length. The exact span for minimum cost depends, of course, upon the expense of the foundations. The more expensive the foundation piers, the longer may be the economical span.

Finally it may be said that in the last analysis the most economical factory building is the one where each worker is given the best conditions for doing his work for the least cost.

* * *

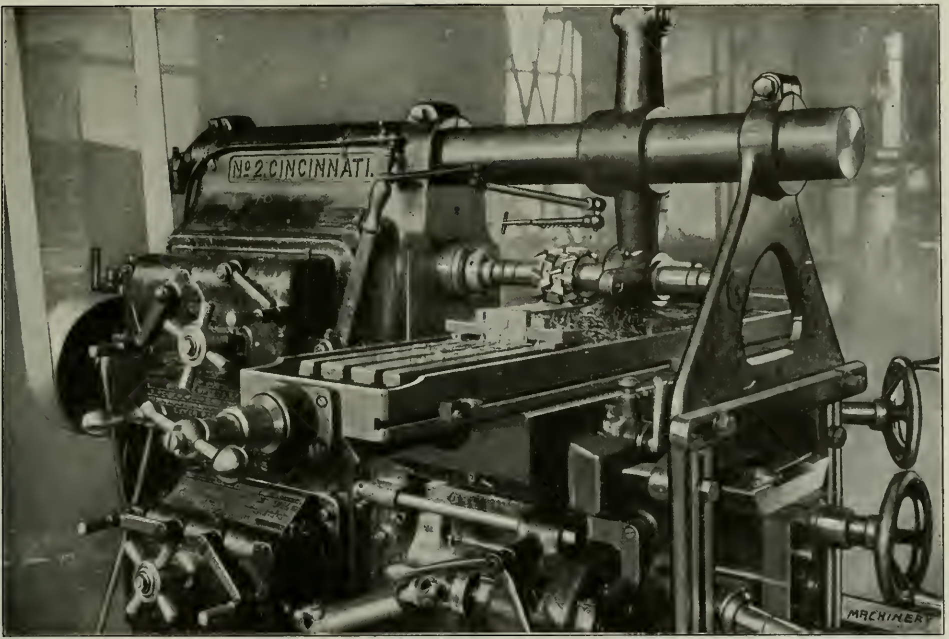
DECARBONIZATION OF STEEL IN SALT BATHS WHEN HEATING FOR HARDENING

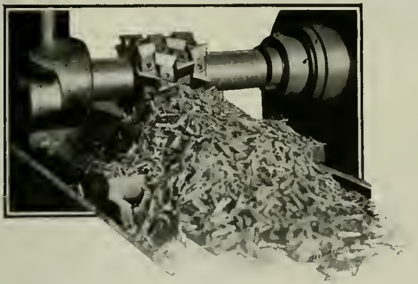
In the April, 1911, number of MACHINERY, an article was published entitled "The Use of Barium Chloride for Heating Steel for Hardening." This article recorded experiments undertaken to show the effect of barium-chloride baths on steel at high temperatures. These experiments were undertaken in connection with regular hardening work, and while they were quite conclusive in character, they did not pretend to investigate the subject on a scientific basis. A French engineer, M. Portevin, of Paris, has made some investigations in the same direction, using more thoroughly scientific methods, and his conclusions agree very closely with those recorded in MACHINERY nearly four years ago.

The use of baths of molten salts, for heating steel prior to hardening is becoming more and more widespread. These salt baths allow of a much more rapid heating and of adjusting the temperatures very accurately. Besides this, superficial oxidation on the objects to be hardened is avoided, but superficial decarbonization occurs instead and becomes strongly marked in cases where the heating is prolonged. In the experiments referred to, the main object was to determine the amount of decarbonization. Samples of steel containing 1.46 per cent of carbon were used in the form of small cylinders about ¾ inch in diameter and ⅜ inch thick. These were heated in potassium chloride for varying periods, at a temperature of 1830 degrees F. Samples were examined after heating, without quenching. It was found that after heating for fifteen minutes in the bath, the percentage of carbon at the surface was 0.9, the thickness of this decarbonized layer being 0.007 inch. After heating for two hours, the carbon content on the surface was only 0.4 per cent, and the thickness of the decarbonized layer 0.040 inch. When one sample was heated for five hours, the carbon on the surface was reduced to 0.2 per cent, the thickness of this layer being 0.060 inch. The steel tested was ordinary carbon tool steel, 1.46 per cent carbon, 0.28 per cent manganese, 0.10 per cent silicon, and 0.025 per cent phosphorus.

Another sample was heated to 1380 degrees F. and quenched in water, and then tested by means of a Shore sclerometer. This test indicated the effect of the heating in the salt bath on the hardness. After heating for fifteen minutes, at 1380 degrees F., the Shore scleroscope indicated a hardness of 80; after two hours heating, a hardness of 41; and after five hours, a hardness of 32. This is, of course, the hardness of the surface. If the decarbonized surface were removed, full hardness would be revealed.

Experiments were also undertaken with baths of potassium chloride at 1650 degrees F., and in a bath consisting of 90 per cent of potassium chloride and 10 per cent of ferro-cyanide. In every case, the results were similar; that is, the carbon content on the surface was considerably reduced and the thickness of the decarbonized layer was increased with an increase in the time the object was submerged in the bath. The conclusions to be drawn, therefore, are that salt baths should not be used for heating tools to be hardened, except in cases where a sufficient portion of the surface of the tool can be ground off, so that the decarbonized layer may be removed.





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Of the mail arriving from the United States to the Consular office at Iquique, Chile, during a period of five consecutive days from American firms, 40 per cent was prepaid with two cent stamps only, instead of the required five cents. In one of the business houses in Chile, the head of the firm goes to the post office and looks over the short-paid letters to his address and pays penalty only on letters from those persons with whom his firm is in correspondence. On mail from other sources the penalty postage is not paid, and hence not received by the firm to whom it is sent. The administrator of the post office states, according to a consular report, that few if any letters with short-paid postage are received from Europe, but that a large number come from the United States and that these rarely reach the addressees. The firms to whom short-paid letters are sent believe that if such a small matter as postage is overlooked or neglected, it may be expected that negligence will be found in a great many other departments of the firm from whom the letter is received, and that lack of proper attention to invoices, packing and shipping orders may be expected; hence, they refrain from doing business with such firms.

* * *

EXCHANGE BETWEEN RUSSIA AND THE UNITED STATES

In a consular report from Petrograd, it is stated that the commercial relations between Russia and the United States will, without doubt, be much closer in the near future, providing the financial questions involved are adjusted. There is no settled rate of exchange between Russia and the United States and only a small amount of Russian money is available in the United States for payment on orders. It is suggested that it is necessary for an arrangement to be made with American bankers or manufacturers whereby purchasers in Russia may deposit Russian money in a bank there to the credit of American bankers, and then that the bank there may cable directly that the required sum has been deposited. American bankers and manufacturers could then obtain the money from Russia as soon as a rate of exchange has been established. The Russian and English Bank in Petrograd offers to pay three per cent interest on deposits of this kind at the present time. No money panic has occurred in Russia and the gold, silver and paper rubles have not fluctuated in value since the declaration of war. Prices should be quoted in rubles and not in dollars.

* * *

PERSONALS

John A. Schroeder, formerly general sales manager of the Hyatt Roller Bearing Co., has resigned his position.

W. S. Chase, general sales manager of the National-Acme Mfg. Co., Cleveland, Ohio, sailed October 27 for London on a business trip.

W. S. Rogers, president of the Bantam Anti-Friction Co., Bantam, Conn., was elected representative to the state legislature at the recent election.

A. J. Strong, factory and sales manager of the Bock Bearing Co., Toledo, Ohio, has resigned his position. Mr. Strong has not as yet joined any other organization.

B. Elshoff recently resigned his position as superintendent of the electrical department of the Canadian Westinghouse Co., Ltd., to become works manager of the Diehl Mfg. Co., Elizabeth, N. J.

Charles L. Samson has resigned the position of mechanical engineer with the Griffin Wheel Co., Chicago, Ill., and has taken the position of master mechanic of the Hamilton Mfg. Co., Two Rivers, Mich.

Edwin Frank, formerly in the hydraulic department of the Allis-Chalmers Mfg. Co., West Allis, Wis., has been appointed instructor in mechanical engineering at the University of Illinois, Urbana, Ill.

Ellsworth Haring has terminated sixteen years' service with Hermann Boker & Co., New York City, and has organized a business in the tool steel and specialty line, with temporary offices at 648 A Hancock St., Brooklyn, N. Y.

F. E. Liddle has resigned his position as superintendent of the American Gear & Mfg. Co., Jackson, Mich., on account of ill health. C. S. Spencer, formerly assistant superintendent of the American Gear & Mfg. Co., has been promoted to the position of superintendent.

William J. Dyer has resigned his position with the Honolulu Iron Co., Honolulu, Hawaii, as designing and constructing superintendent of machinery for the cane sugar industry, and has opened an office as consulting engineer in the Stangenwald Bldg., Honolulu, Hawaii.

Joseph Schaeffer, European representative of the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn., arrived in New York, October 31 on the steamer *New Amsterdam*, sailing from Holland. Mr. Schaeffer does not expect to return to Holland until the war is over.

Arthur H. Lymn of London, England, inventor of the Lymn process, presented a paper at the monthly meeting of the American Society of Mechanical Engineers, New York City, November 10, entitled: "The Development of the By-Product Gas Producer Industry in Europe."

W. C. Buell, Jr., for the past seven years general manager and engineer for the Westmacott Gas Furnace Co., Providence, R. I., has resigned and taken the position of assistant manager and engineer of the Bellevue Furnace Co., Detroit, Mich., manufacturer of oil and gas furnaces, kilns, special fire brick, tiling, etc.

H. H. Hodell has been elected president of the Van Dorn & Dutton Co., Cleveland, Ohio, to fill the vacancy caused by the death of James H. Van Dorn. Mr. Hodell is president of the Cleveland Galvanizing Works Co., and was one of the founders and a vice-president of the Van Dorn & Dutton Co. D. B. Van Dorn, president of the Van Dorn Iron Works Co., was elected vice-president to succeed Mr. Hodell.

James Cran, a well-known contributor of articles on blacksmithing, heat-treatment of steel, etc., has resigned his position as foreman blacksmith with the Pond Machine Tool Works, Plainfield, N. J., and will hereafter devote himself to artistic blacksmithing, difficult repair work, etc. Mr. Cran has achieved considerable prominence as a producer of artistic iron work, ornamental table pieces and other interesting and difficult examples of forging.

Arthur E. Meyer, for the past five years connected with the sales department of the Toledo Machine Tool Co., Toledo, Ohio, has resigned his position and has become connected with the sales department of the E. W. Bliss Co.'s Chicago branch. The Chicago branch territory has been extended from a hundred mile radius to include the states of Wisconsin, Indiana, Illinois, Minnesota, Iowa, Kansas and Missouri. Mr. Meyer is the author of a number of articles on press design which appeared in MACHINERY a few years ago.

* * *

OBITUARIES

Louis A. Lincoln, president and treasurer of the Bay State Tap & Die Co., Mansfield, Mass., died November 5, aged forty-three years. Mr. Lincoln was the chief organizer of the company, its first place of business being in Taunton, Mass. In 1903 it was moved to Mansfield, where it has since been located. Mr. Lincoln was the first president, and afterward became president and treasurer.

Henry H. Boggs, vice-president and general manager of Strong, Carlisle & Hammond Co., Detroit, Mich., died November 1, following an operation for gall-stones, aged forty-seven years. Mr. Boggs was born in Springfield, Ohio, and was educated in the public schools. He began his career as a machinists' apprentice in 1883 with the St. John Sewing Machine Co. of Springfield, continuing with the company for four years; following his apprenticeship, he worked for the William Whiteley Co. of Springfield for two years and with the Machinists' Supply Co. of Chicago for four years. He entered the employ of the Strong, Carlisle & Hammond Co. of Cleveland in 1897, and when in 1908 the Strong, Carlisle & Hammond Co. of Detroit was incorporated, Mr. Boggs became vice-president and general manager. He was a Mason and a member of several Detroit societies and clubs. Those associated with Mr. Boggs in business feel that they have lost a generous friend, and the many who knew him in a business way will learn of his death with regret, as his council regarding mechanical matters was held in high esteem. He was married in 1896 to Anna L. Barker of Springfield.

* * *

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC.

of MACHINERY, published monthly at New York City, required by the Act of August 24, 1912.

Editor, Fred E. Rogers	140-148 Lafayette St., New York
Business { Alexander Luchars, President	" " " " "
Managers { M. J. O'Neill, General Manager	" " " " "
Publisher, The Industrial Press	" " " " "
Owners of one per cent or more of the stock —	
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Matthew J. O'Neill	" " " " "
Fred E. Rogers	" " " " "
Louis Pelletier	" " " " "
H. I. Brown	" " " " "
Erik Oberg	" " " " "

There are no bondholders, mortgagees or other security holders.

MATTHEW J. O'NEILL, General Manager.

Sworn to and subscribed before me this 30th day of September 1914.

HARRY B. HEALEY,
Notary Public No. 84, Kings County,
Certificate filed in New York County No. 74
(SEAL) (My commission expires March 30, 1916.)

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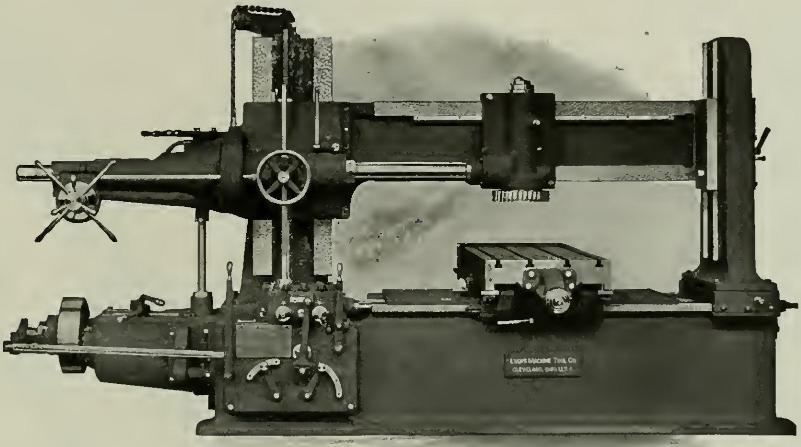

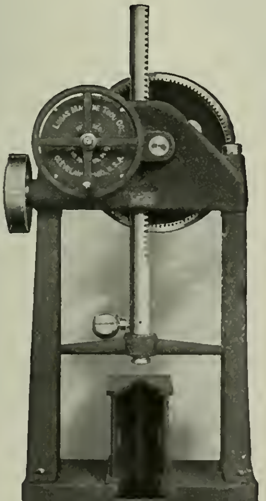

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COMING EVENTS

December 1-4.—Annual meeting of the American Society of Mechanical Engineers, New York City; Engineering Societies Bldg., 29 W. 39th St., headquarters. Calvin W. Rice, secretary.

December 9-12.—Eighth annual convention of the National Society for the Promotion of Industrial Education, Richmond, Va. C. A. Prosser, secretary, 140 W. 42nd St., New York City.

December 12-19.—Second International Exposition of Safety and Sanitation, Grand Central Palace, New York City. F. W. Payne, manager, Department of Exhibits, 29 W. 39th St., New York City.

June 9-11.—Annual convention of the American Railway Master Mechanics Association, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

June 14-16.—Master Car Builders' annual convention, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

SOCIETIES, SCHOOLS AND COLLEGES

Pratt Institute, Ryerson St., Brooklyn, N. Y. Circular calling attention to its free library which is placed at the disposal of every visitor under the guidance of a special librarian. It comprises a working library of over 1200 picked books, 150 technical periodicals, patent office reports, trade catalogues, etc.

State Trade Education Shop, Bridgeport, Conn. Bulletin 1914 containing an outline of the work of the institution and its purpose, a review of the trades taught, and showing some of the work accomplished by the student apprentices. This book was designed and printed in the State Trade Shop by the printing apprentices and is a creditable production of which they may be justly proud. The various trades taught in this school are: carpentry, cabinet work, patternmaking, machine work and toolmaking, drafting, printing, linotype operating, sewing, dressmaking, millinery, etc.

West Side Young Men's Christian Association, 318 W. 57th St., New York City, has organized a course of lectures on exporting and importing which was opened early in November. The director of the course is Dr. John Franklin Crowell, former president at Trinity College, Durham, N. C., now of the "Wall Street Journal." Among the subjects to be taken up are choice of markets, how to organize exporting campaigns, foreign exchange, peculiarities of conditions and people of different countries, packing methods and shipping arrangements, trade routes and international connections, the problem of credits, correspondence and trade literature, and social, economic and political aspects of business in foreign countries.

NEW BOOKS AND PAMPHLETS

Safety and Welfare of the Workman. By Rear Admiral A. B. Willits. 12 pages, 6 by 9 inches. Reprinted from the U. S. Naval Institute Proceedings, Annapolis, Md.

Standard Methods of Gas Testing. 180 pages, 6 by 9 inches. Published by the Department of Commerce, Washington, D. C. as Circular of the Bureau of Standards No. 48.

Units of Weight and Measure—Definitions and Tables of Equivalents. 68 pages, 6 by 9 inches. Published by the Department of Commerce, Washington, D. C., as Circular of the Bureau of Standards No. 47.

Analysis of Printing Inks. By J. B. Tuttle and W. H. Smith. 20 pages, 6 by 9 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper of the Bureau of Standards No. 39.

The Veritas Firing Rings. By A. V. Bleininger and G. H. Brown. 10 pages, 6 by 9 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper of the Bureau of Standards No. 40.

Measurements on Standards of Radiation in Absolute Value. By W. W. Coblentz. 14 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Scientific Paper of the Bureau of Standards No. 227.

Industrial Gas Calorimetry. By C. W. Waidner and E. F. Mueller. 150 pages, 6 by 9 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Technologic paper of the Bureau of Standards No. 36.

The Testing of Potentiometers. By Frank Wenner and Ernest Weibel. 40 pages, 6 by 9 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Scientific Paper of the Bureau of Standards No. 223.

Safety Rules to be Observed in the Operation and Maintenance of Electrical Equipment and Lines. 50 pages, 6 by 9 inches. Published by the Department of Commerce, Washington, D. C., as Circular of the Bureau of Standards No. 49.

Observations on Finishing Temperatures and Properties of Rails. By G. K. Burgess, J. J. Crowe, H. S. Rawdon and R. G. Waltenberg. 67 pages, 6 by 9 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Technologic Paper No. 38.

Adjustments of the Thomson Bridge in the Measurement of Very Low Resistances. By F. Wenner and E. Weibel. 68 pages, 6 by 9 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Scientific Paper of the Bureau of Standards No. 225.

Sheet Metal Working. By F. Georgi and A. Schubert. 160 pages, 5½ by 8¾ inches. 125 illustrations and two folding plates. Published by Scott, Greenwood & Son, London; and D. Van Nostrand Co., New York City. Price, $3, instead of $2 as stated in the November number.

Gearing. By A. E. Ingham. 181 pages, 6 by 9 inches. Illustrated. Published by D. Van Nostrand Co., New York City. Price, $2.50.

This work by a British author deals with spur and bevel gears, worm-gearing, spiral gears, helical gears and contains an appendix of trigonometrical tables. Tables of tooth parts accompany the text, and silhouettes of involute gear teeth ranging from 11 diametral pitch to 3 inches pitch. A table of pitch line and outside diameters for cut gear circular pitches is given, ranging from ¼ inch circular pitch to 4 inches. Another table is pitch angles for bevel gears with axes at right angles; tables of increment and decrement angles are also given.

Materials of Machines. By Albert W. Smith. 215 pages, 4¾ by 7⅜ inches. 36 illustrations. Published by John Wiley & Sons, Inc., New York City. Price, $1.25.

This work, by Prof. Smith of Sibley College, Cornell University, has been rewritten for the second edition. Its object is to supply elementary knowledge of metallic materials used in the construction and operation of machines, and it was intended primarily as a textbook for students in the mechanical engineering courses. It deals with fuels; electric furnaces; refractory materials; metallurgy of iron and steel, copper, lead, tin, zinc and aluminum; testing of materials; relation of iron and carbon; cast iron; steel; heat-treatment of steel; non-ferrous alloys; and the selection of materials for machines.

Electric Welding. 48 pages, 6 by 9 inches. 22 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

This is No. 127 of Machinery's Reference Books, covering a subject of general interest to mechanical men. Although the electric welding process passed out of the experimental and into the practical stage several years ago, the subject is still one that is rather vague to most mechanics. Electric welding, however, plays an important part in the manufacture of so many articles, and the possibilities opened up by the process of electric welding are so great, that mechanical men generally are eager to be informed upon this new topic. The book reviews the various electric welding processes that have been developed, and then deals in detail with the electric resistance process of welding, also known as the Thomson process or the incandescent process; the point and ridge method of electric welding—an application of the Thomson process; electric arc welding; and electric soldering.

Mechanism of Steam Engines. By Walter H. James and Myron W. Dole. 170 pages, 6 by 9 inches. 183 illustrations. Published by John Wiley & Sons, Inc., New York City. Price, $2.

This work, by Profs. James and Dole of the Massachusetts Institute of Technology, was prepared as an elementary treatise on kinematics of reciprocating steam engines and steam turbines, and was intended primarily for students in the mechanical engineering courses. No claim is made for originality of treatment or for discussion of new principles. The aim has been to handle the subject in a manner suitable for the purpose intended. The work deals with reciprocating steam engines, single-valve engines, valve diagrams, typical problems on the slide-valve engine, governing devices for single-valve engines, riding cut-off valves and their governing devices, multiple-valve engines, hand-operated reversing and controlling gears, valve setting, steam turbines and turbine valve mechanisms and governors.

Shop Systems. 39 pages, 6 by 9 inches. 32 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

This is No. 139 of Machinery's Reference Books, covering four typical shop systems used in representative machine-building plants. The systems described are: a general shop system; a stock-keeping system; an effective follow-up system; and a routing system in a machine tool shop. The systems outlined in this book have proved of value in the manufacturing establishments where they are used. They may not apply directly to the conditions in other plants, because certain details may have to be changed and some of the forms modified, on account of the conditions that are peculiar to each shop; but there are certain fundamental principles that must be embodied in all shop systems, and the general outlines of the systems described can be followed and will prove of value to those who have to devise new systems or are endeavoring to improve upon old ones.

Autogenous Welding. 40 pages, 6 by 9 inches. 22 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

During the last fifteen years, several interesting and valuable processes for joining metal parts have been developed. Of these, perhaps none is more remarkable than the oxy-acetylene and the oxy-hydrogen processes for welding and cutting metals. There are no inexpensive treatises on this subject on the market, and the book under review has, therefore, been brought out to give mechanical men such practical information about the processes as will be helpful to them in their work and aid them in understanding the possibilities of the use of the autogenous welding processes. The book contains chapters on the oxy-acetylene and oxy-hydrogen processes of metal cutting, on autogenous welding, and on the preheating of metals to be welded. In addition, there are special chapters dealing with the welding of tanks and retorts, the repairing of cylinders by autogenous welding and the manufacture of tubing by this means.

Precision Locating and Dividing Methods. 45 pages, 6 by 9 inches. 39 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

This treatise, which is No. 135 of Machinery's Reference Books, covers a subject of great interest to toolmakers and others who are engaged in accurate work. In this book various approved methods of locating work and accurate dividing and spacing methods, such as are used more particularly in tool-rooms, are illustrated and described. In the three chapters on precision locating methods, accurate dividing and spacing methods and locating work for boring on the milling machine, the button method for locating holes is taken up in detail, the disk method is illustrated and described, and the method of obtaining accurate angular measurements with disks is covered, as is also the size block method and the master plate method. A great number of accurate dividing and spacing methods are illustrated and described, both for spacing along straight and circular lines. The book can be recommended to all who are engaged in accurate machine work.

Care and Repair of Gas and Oil Engines. 48 pages, 6 by 9 inches. 14 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

This treatise, which is No. 129 of Machinery's Reference Books, has been prepared mainly from notes compiled by J. L. Hobbs, who has had long and varied experience with the care and repair of gas and oil engines. The book is written in a thoroughly practical manner and covers the usual difficulties met with in the operation of gas and oil engines. A general description of internal combustion engines is given, and then follow chapters on compression, carburetion, ignition, lubrication and cooling systems. In each case, the troubles that are likely to develop are dealt with and remedies given. A chapter is also included on the installation of a gas engine, giving valuable information on the points to be taken into account. Several full page illustrations showing sectional views of various types of gas and oil engines are included. The book should prove of value to anybody who has to do with the care or repair of gas and oil engines.

Broaching. 40 pages, 6 by 9 inches. 36 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

The cutting of keyways and the machining of holes in metal to shapes other than round, by broaching, is an old practice, although it has attracted comparatively little attention until within the past ten years. Now the broaching process is used very extensively and there is need for a treatise dealing with the broaching machine, broach making and broaching operations. Comparatively little has been published on this subject in the trade periodicals, and nothing whatever has been presented in book form previous to the publication of the book under review. It was therefore deemed that a specific service would be rendered the mechanical trades by preparing such a treatise, and the present book is the result of the collaboration of Franklin D. Jones, Douglas T. Hamilton and Chester L. Lucas, associate editors of Machinery, who here present a comprehensive and valuable collection of material relating to this important subject.

Cutting Lubricants. 36 pages, 6 by 9 inches. 31 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

The cutting lubricants to be used for machining operations constitute a very important factor in the results obtained in the machine shop. The book under review, which is Machinery's Reference Book No. 124, contains information relating to the various lubricants, oils and compounds to be used for different classes of machining operations and for different kinds of metals. It also gives a comprehensive review of the pumps, piping systems, oil pans and tanks used for storing the cutting lubricant for machine tools and for conveying the lubricant to the cutting point of the tools. Numerous illustrations showing clearly by line engravings the exact construction of the devices described are included. The book should, therefore, prove of value both to the operators of machine tools, in aiding them to select the proper cutting lubricant to use, and to the designers of machinery or attachments who have to devise ways and means by which the cutting lubricant is to be conducted to the cutting point.

Drawing, Forming and Bending Dies. 40 pages, 6 by 9 inches. 41 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

Comparatively little information has been published in book form relating to the subject of drawing dies. A large majority of work which, in the past, has been made from castings is now made from sheet steel by drawing up bosses and reinforcing ribs to strengthen the work. The development in the art has been rapid and the definite information available on the subject relating to the diameters of shell blanks, the depth and diameter reductions of drawn shells, the lubrication of dies and other practical points are given in this book, which is No. 126 of Machinery's Reference Books. A number of practical hints for die-makers in the making of forming dies are also given and, in addition, numerous examples of successful designs of drawing, forming and bending dies. The book thus gives the reader a comprehensive review of the present state and methods of the art. Toolmakers, tool-designers and those responsible for the output of punches and dies will be especially interested in this book.

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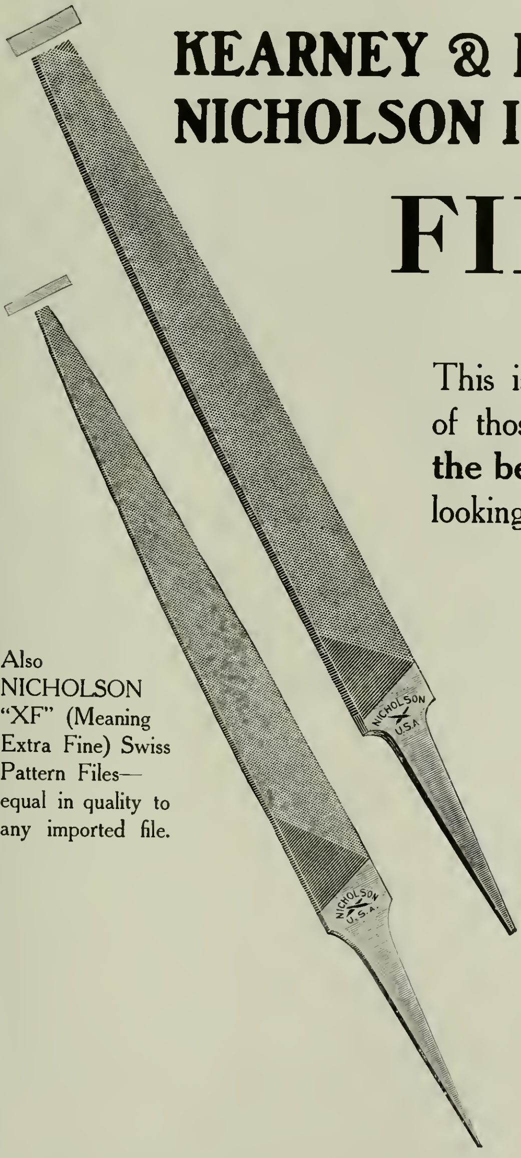
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Power, Heating and Ventilation. Parts I and II. By Charles L. Hubbard. 229 pages, 6 by 9 inches. 183 illustrations. Published by the McGraw-Hill Book Co., Inc., New York City. Price, $2.50 each.

This work is issued in three parts, namely: Steam Power Plants, Heating and Ventilating Plants, Isolated Plants and Small Groups. The third part is in press. Part I treats of heat; steam; fuels and combustion; boiler horsepower; types of boilers; design of tubular boilers; boiler furnaces; boiler settings; chimneys; mechanical draft; boiler accessories; steam engines and turbines; auxiliary apparatus; pipe, fittings and valves; details of power plant design; and care and management of boilers and engines. Part II treats of the physics of heating and ventilation; heat loss from buildings; ventilation; furnace heating; boilers; pipe, fittings and valves; direct steam heating; indirect steam heating; hot water heating by gravity circulation; hot water heating by forced circulation; exhaust steam heating; electric heating, fans; forced blast heating and ventilation; special devices; heating and ventilating different types of buildings; care and management of heating and ventilating plants. Both parts are of the second edition and have been revised and reset, bringing them up to date and eliminating obsolete material.

Strength of Materials. By Erik Oberg. 47 pages, 6 by 9 inches. Published by the Industrial Press, New York City. Price, 25 cents.

This book covers in a simple and direct manner the principles of the strength of materials and the methods used in calculating the strength of parts met with in machine design and engineering work generally. The formulas are given in the simplest manner possible, so that they can be directly employed by the practical man. No attempt has been made to show how the formulas are derived mathematically, as this would be impossible in a book of limited size. Numerous examples have been given to show the application of the rules and formulas to specific problems. A special effort has been made to indicate the use of standard engineering handbooks in connection with the calculations of strength of materials, and numerous references are made to tables and formulas found in works of that kind. The five chapters of the book cover principles of the strength of materials; tension, compression and shearing stresses; beams and bending stresses, torsional stresses and applications; shafting; springs; columns; flat plates; cylinders cylinders and tubes; and spherical shells.

Arithmetic Simplified. By Erik Oberg. 48 pages, 6 by 9 inches. Published by the Industrial Press, New York City. Price, 25 cents.

During the past seven years MACHINERY has published a series of over 140 25-cent Reference Books, many of which are of an educational nature and intended for home study. These books necessarily contain mathematical treatment of various shop problems, and it has been found that in some cases mechanics have not been able to get the full benefit because their knowledge of arithmetic, especially of fractions, has been too limited. The present work, which is No. 137 of MACHINERY'S Reference Books, and which covers in a very simple manner the arithmetic of whole numbers, common fractions and decimals, has, therefore, been brought out to meet the needs of men whose early training on these subjects may not have been as complete as desirable, or who would like a book on arithmetic to refresh their memory. In addition to the treatment of whole numbers, fractions and decimals, a chapter on proportion and on the use of formulas in ordinary arithmetical work is included. The method by which the whole subject is presented is such as to particularly adapt this book to the student who has no teacher, but it is also well suited for use in apprentice and trade schools, as it covers the essentials only. The apprentice and trade schools usually can devote but little time to this subject, and the larger text books, including much extraneous matter, are, therefore, not so well adapted for use in this class of schools.

Planing and Milling. By Franklin D. Jones. 306 pages, 6 by 9 inches. 234 illustrations. Published by the Industrial Press, New York City. Price, $2.50.

This book deals with the practical problems met with in the operation of planers, shapers, slotters and milling machines of standard and special designs. Each of the subjects taken up is treated from the standpoint of the man in the shop, and a special effort has been made to present such information as pertains more particularly to problems which the shop man often finds difficult to solve. The examples of operation included have been selected with a view to showing not only how a specific result is obtained, but to illustrate fundamental principles and thus serve as a general guide. Descriptions of methods involving arithmetical calculations contain the necessary rules or formulas, and examples are given illustrating the problems which arise in practice. The illustrations in the book constitute an important feature and have received particular attention. Practically all of the drawings are original and most of them are of simple type so that they can be easily understood even by those who are not accustomed to "reading drawings." In preparing the book, the author has made use of much of the material published in MACHINERY'S Reference Books Nos. 94, 96 and 97, which material appears in this book together with a great deal of additional information on modern planing and milling practice. The book is one which can be thoroughly recommended to anyone who wishes to make a study of the most modern methods relating to planer, shaper, slotter and milling machine work and the types of machines used.

Machine Drawing. By Charles L. Griffin and C. C. Adams. 271 pages, 5¼ by 8¼ inches. Illustrated. Published by the American Technical Society, Chicago, Ill. Price, $1.50.

This work is a revision and an extension of an earlier work by Mr. Griffin which attracted much attention at the time of publication because of its practical, common-sense treatment of the subject. The revised and extended work is, of course, better than the original, as it contains more matter and has been brought up to date. It defines a working drawing as "a drawing which completely instructs the workman so that he is able actually to make in the shop whatever the drawing represents." In other words, the working drawing conveys to the mechanic all the information necessary to make the object. This is a comprehensive definition, and any work on drawing which instructs its readers to make drawings truly complete in every respect deserves general attention. The contents comprise the following: Lines, Arrangement of Views, Sectional Views, Shade Lines, Dimensions, Specifications for Screw Threads, Specifications for Bolts and Nuts, Specifications for Pipes and Pipe Threads, Scale Drawings, Details of Preparation, Pencil Drawing, Tracing, Blueprinting, Illustrative Drawings (with large number of parts); Working Drawings; Mechanism Drawing; Duplex Pump Plates; Electrical Shop Drawings; Design of Direct-current Generator (in all its details, including a final assembly drawing). The work is one that can be recommended to all wanting a first-class work on mechanical drawing with many good examples for practice.

Graphic Methods for Presenting Facts. By Willard C. Brinton. 371 pages, 7 by 10 inches. 255 illustrations. Published by the Engineering Magazine Co., New York City. Price, $4.

The graphical method of presenting data and making comparisons of same is too well known among the engineering fraternity to need any explanation. But notwithstanding the conceded value of this method of presenting facts, not only to the engineer but to the layman as well, it has not been employed as much as it could have been with profit to all concerned. The work by Mr. Brinton has been presented to suit the point of view of the business man, the social worker and the legislator, and mathematics have been eliminated. The effort has been made to produce a work that would serve as a handbook for anyone having occasional charts from data presented to them in tabulated figures. The work is too extensive for us to give more of a general idea of its contents than by quoting chapter heads, which are as follows: Component Parts; Simple Comparisons; Simple Comparisons Involving Time; Time Charts; Curve Plotting; Curve Plotting Continued; Comparison of Curves; Component Parts Shown by Curves; Cumulative or Mass Curves; Frequency Curves; Correlation; Map Presentations; Maps and Pins; Curves for the Executive; Records for the Executive; Corporation Financial Reports; General Methods; A Few Cautions. The 7- by 10-inch page favors the presentation of comparatively large diagrams to illustrate the examples chosen. The many examples, and the clear presentation of the subject matter make a work that can be recommended to general managers, superintendents, draftsmen and business men to whom the graphic presentation of facts appeals.

NEW CATALOGUES AND CIRCULARS

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Circular on Cutler-Hammer automatic starters for electric motors.

H. D. Smith & Co., Plantsville, Conn. Leaflet advertising the "Perfect Handle" valve spring lifter for automobile engines.

Richard W. Jefferis Co., Camden, N. J. Folder advertising Jefferis pressed steel fire-proof lockers, wardrobes, bins and shelving.

New York Public Library, New York City. List of works in the library relating to oxy-acetylene welding. 34 pages, 6 by 9 inches.

Huther Bros. Saw Mfg. Co., 1108 University Ave., Rochester, N. Y. Circular descriptive of Huther Bros. "Dado" head for cutting grooves of any width in wood.

Morrison Co., Inc., Richmond, Va. Leaflet giving tables of sizes and prices for plain right-hand pipe nipples, plain right- and left-hand pipe nipples, and galvanized right hand pipe nipples.

Wright Mfg. Co., Lisbon, Ohio. Catalogue on Wright standard chain hoist, giving sizes, capacities and prices of high-speed steel hoists, screw hoists, steel trolleys and hand traveling cranes.

Standard Mfg. Co., Bridgeport, Conn. Circular of No. 3 special automatic manufacturing milling machine for slabbing, radial, center and straddle milling, and various manufacturing milling operations.

General Electric Co., Schenectady, N. Y. Bulletin 46018, describing portable voltmeter, known as Type P-8. This is an unusually small instrument, suitable for use on both alternating and direct current.

American Blower Co., Detroit, Mich., is issuing a book illustrating the installation of the "Sirocco" heating, ventilating and cooling system in the plant of the Ford Motor Co. at Detroit. This is the largest "Sirocco" system ever installed.

Builders Iron Foundry, Providence, R. I. Bulletin 85 of the "Venturi" hot water meter for boiler feeds, etc. This type of meter is peculiarly adapted for measuring hot water, a service that is extremely hard on meters in general.

General Electric Co., Schenectady, N. Y. Bulletin 44300, illustrating and describing some of the gas-electric motor cars and locomotives built by this company. These cars and locomotives are adapted for branch line service on steam roads and also for interurban service.

Foundry & Machine Exhibition Co., Chicago, Ill. Registration list at the 1914 annual exhibition in the International Amphitheater, Chicago, September 5-11. The announcement is made that the 1915 convention will be held in the East, either at New York, Philadelphia or Atlantic City.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Leaflet 3749 describing Westinghouse synchronous booster rotary converters. This bulletin outlines the advantages of this type of machine and gives a detailed account of its method of operation and construction details.

David Lupton's Sons Co., Allegheny Ave. and Janney St., Philadelphia, Pa. Catalogue 8, listing the line of Lupton products for light and ventilation, which comprise steel sash, steel partition, steel tube doors and jams, continuous sash, trusses, operating devices and skylights.

Agnew Electric Welder Co., Detroit, Mich. Circulars of No. 5-C butt electric welder; No. 10-D spot welder; No 20-D spot welder; and No. 40-C butt welder. The welding capacity of the latter is ⅞ to 2 inches round or 5/16 by 10 inches flat. The transformer capacity is 50 K. W.

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletin 1018-A, superseding Bulletin 1018, on E. C. & M. motor field rheostats and field rheostat relays for adjustable speed direct-current motors. Bulletin 1029-A, superseding Bulletin 1029, on Type Q, Form FM brakes for direct-current mill type motors.

Eck Dynamo & Motor Co., Belleville, N. J. Sectional catalogue consisting of bulletins 39, 40, 41, 46, 47 and 55 of protected type direct-connected dynamos, worm-geared motors for slow speeds, back-geared motors, motor generators, and suggestions for installing and operating.

General Electric Co., Schenectady, N. Y., has just issued Bulletins 44403 and 44405, describing that company's ventilated commutating-pole railway motors for 600 and 600-1200 volt service. Bulletin 44403 is devoted to the GE-222-G railway motor, and Bulletin 44405 describes the GE-233-A motor for operating two in series on 1200 volts.

Electric Welder Co. of America, 1523-31 Fort St., W., Detroit, Mich. Circular of type C duplex convertible electric welders which may be used for butt welding and spot welding. The machine is fitted with heat control apparatus, by means of which it is claimed that objects of unequal size may be readily welded by an ordinary operator.

Golden-Anderson Valve Specialty Co., Fulton Bldg., Pittsburg, Pa. Bulletin of double-cushioned, triple-acting, non-return valves that effectually prevent accidents in boilers and steam-pipe lines. These valves automatically shut off the steam flow from every boiler the instant the pipe ruptures, and immediately cut out a boiler when a tube bursts.

Hess-Bright Mfg. Co., Front St. and Erie Ave., Philadelphia, Pa. Data sheets illustrating ball bearings and their correct use in machinery as follows: vertical mountings on shafts without shoulders; standard mountings for horizontal and ball bearing electric motors; turbine pump; ball bearing live tail centers; and ball bearing lathe head.

Boston Gear Works, Norfolk Downs, Mass. Circular showing Boston gears that are kept in stock for immediate delivery. These gears, being made in large quantities, can be furnished at correspondingly low prices. Circular showing standard racks made to mesh with stock gears. These racks are made in any pitch up to 1 diametral pitch, 12 inches face.

Bridgeport Hardware Mfg. Corp., Bridgeport, Conn. 1914 supplement to catalogue 18, describing the new tools that have been added to the line of hardware and cutlery specialties made by this company. Some of the tools listed are pocket knife tool kit, comprising a file, reamer, cork puller, screw driver and chisel; coping saw; ticket punchers; crate opener, screw-drivers; pliers; scrapers, etc.

General Electric Co., Schenectady, N. Y. Bulletin 44003 devoted to modern electric railway apparatus. The book describes briefly the Curtis steam turbine for railway service, railway generator, transformers, switchboards, synchronous converters, motor-generator sets, G E ventilated railway motors and electric locomotives. It also contains illustrations of the G E locomotives in use at the locks of the Panama Canal.

Poole Engineering & Machine Co., Baltimore, Md. Leaflet descriptive of the gun iron castings made by this company, which consists of charcoal gun iron mixtures of cast iron for which a tensile strength of 30,000 pounds per square inch in the castings is claimed. It is said that gears made from this material compare favorably with those made from steel, and have no tendency to "flow" under heavy loads.

Beaudry & Co., Inc., Boston, Mass. Leaflet on the Beaudry hammer, a power hammer built in two types; the "Champion" for light and heavy railroad, machine and general forging, and the "Peerless," for plating, drawing, swaging, collaring, spindle making and general manufacturing. The "Champion" power hammer is built in sizes from 50 to 500 pounds weight of ram and the "Peerless" hammer is built in sizes from 25 to 200 pounds weight of ram.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Catalogue 3002-A entitled "Westinghouse Electric Motors for Machine Tool Service," showing the application of electric drive to all classes of machine tools. The features of both direct and alternating current motors are described and hints on the selection of motors for machine tool service are given. There are also included a number of tables showing the relation between feeds, cutting speeds, diameters of work, etc.; the relation between area of cut in square inches and cutting speed in feet per minute; also horsepower required for various machines.

MACHINERY
JANUARY, 1915

Fixtures for Continuous Milling

by Alwin B. Bachmann

IN all lines of mechanical work there has always been an incentive to use labor-saving devices to perform operations automatically, or at least in such a way that the loss of time caused by changing the work or tools is reduced to a minimum. The automobile industry has made wonderful progress in this direction, the use of a great variety of special tools and machines having been made necessary to meet the problems which have arisen in handling their work. The accompanying illustrations show a vertical milling machine and some of the fixtures with which it has been equipped to provide for the uninterrupted finishing of various classes of castings. The revolving table provides for passing the work continuously under the cutter so that the operator is only required to remove the finished pieces and substitute rough castings in their place. It will be evident that the output obtained in this way must be very satisfactory, as non-productive time resulting from the necessity of starting and stopping the machine, from the return movement of the table to the starting position, and from the exchange of finished work for fresh castings while the machine is at a standstill, is avoided.

The machine on which these fixtures are used is shown in Fig. 1; this is a special type of the Model C, high-power vertical milling machine made by the Becker Milling Machine Co., Hyde Park, Mass. The change made from the standard machine of this type consists of the elimination of the cross-feed and the provision of direct connection of the rotary table with the knee, thus insuring the utmost rigidity. Fig. 2 shows five different automobile parts which are to be milled on the faces marked *f*. Before entering upon a discussion of the method of machining these parts, it will be of interest to know the rate at which they were machined in continuous rotary milling fixtures used on the machine shown in Fig. 1. In a ten-hour day, this rate amounted to 1400 pieces of part No. I; 1200 pieces of part No. II; 2400 pieces of part No. III; 1800 pieces of part No. IV; and 2000 pieces of part No. V. These figures serve to emphasize the advantage of the continuous rotary milling process for handling work of this character, as the rigidity of the machine and fixtures insures the required degree of accuracy, while the rapidity with which the work can be handled enables a very satisfactory rate of production to be obtained. In most cases, the rate of production depends upon how fast the operator is able to replace the finished work by fresh castings, and as a result, care should be taken to make the action of the clamping mechanisms as rapid as possible. In addition to rapidity of operation, the design of the clamps must be such that they grip the work securely without any tendency to cramp or twist it; otherwise accurate results cannot be hoped for.

Fig. 3 shows the milling fixture for machining part No. I, set up on the rotary table of the milling machine, and Fig. 5 shows the design of this fixture. The L-shaped base *A* has fourteen equally spaced holes in its upright wall to receive the studs *B* on which the pieces to be milled are mounted. These pieces have previously had a hole bored in them and one side has also been faced square with the hole. Seven equally spaced uprights *C* are cast solid with the base and a hardened stop *D* against which the work rests is carried at the top of each of the uprights. There are also seven equally spaced brackets *E* which are screwed to the base of the fixture and carry the clamps which hold the work. By referring to Figs. 3 and 5, it will be evident that each clamp holds two pieces of work which are located between the clamp and the stops *D*. Provision is made to allow the clamps *F* to slide in order to compensate for variation in the castings, the slots in the clamps being covered by large headed bolts *H* which prevent chips from entering the slots. The clamps *F* and binder bolts *H* are held back from the work by springs *Q*, and in order to secure the work in the fixture, the swivel bolt *K* is swung up over the binder lever *I*, after which the nut *L* is turned down. This draws the clamp *F* down onto the two adjacent pieces of work which are located against the stops *D* in the correct position for milling. It will be seen that nuts *M* are threaded onto the ends of the studs *B* which carry the work, these nuts being employed to bring the finished face of the castings back against the locating faces *P* of the fixture. A split washer *O* holds the work in place, while the nut *M* is small enough so that the work can be drawn over it, thus making it necessary to merely loosen the nut in order to remove the work from the fixture. The engaging faces of the nut *M* and washer *N* are turned concave and convex respectively, the adjustment provided in this way taking care of any unevenness on the rough side of the casting.

The nut *M* and the wrench used for tightening it are one of the features of this fixture. This wrench is shown in the foreground in Fig. 3 and a better idea of its construction will be obtained by referring to Fig. 6, where it will be seen that three hardened pins are pressed into the body of the wrench. Half of each of these pins is sunk into the sleeve, which serves to back up the pins, while the other half of each pin enters the semi-cylindrical grooves formed in the nut. The ends of the studs *B* form pilots for the wrench so that it will slip

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For additional information on rotary milling, see "Milling Sad Irons," in the November, 1912, number of MACHINERY.
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on easily. This form of nut and wrench makes it possible for engagement to be made in nine different positions so that the turning of the nut *M* can be effected very rapidly. When the fast movement of the rotary table is taken into consideration, this is a feature of great importance. In order to set the milling cutter at exactly the required distance from the center of the studs *B*, one of the stops *D* was adjusted on its top face to allow a 1/8-inch gage block to be used for this purpose. The fixture for machining part No. 11 is very similar in construction to the one which has just been described for machining part No. 1. This fixture is shown in Figs. 4 and 6 and will be readily understood by referring to those illustrations in connection with the preceding description.

Very close limits were required on the distance from the center of the hole in the work to the face finished by the milling operation, and this made it necessary to take particular care to have all of the studs located in the fixture at exactly the same height. This result was obtained in the following manner: When finishing the stud holes, the base *A* of the fixture was set up on an auxiliary circular table which, in turn, was mounted on the table of a boring mill. Care was taken to have the circular table run absolutely true with the boring-bar and when this result had been obtained, the base *A* of the fixture was fastened to the auxiliary table and not removed until it had been completely finished. The auxiliary table was used for indexing, and the boring and facing operations were performed at one setting.

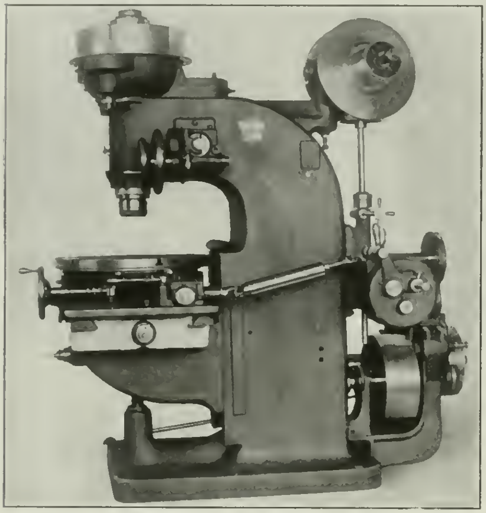


Fig. 1. Special Type of Model C Becker Vertical Milling Machine on which the Fixtures are used

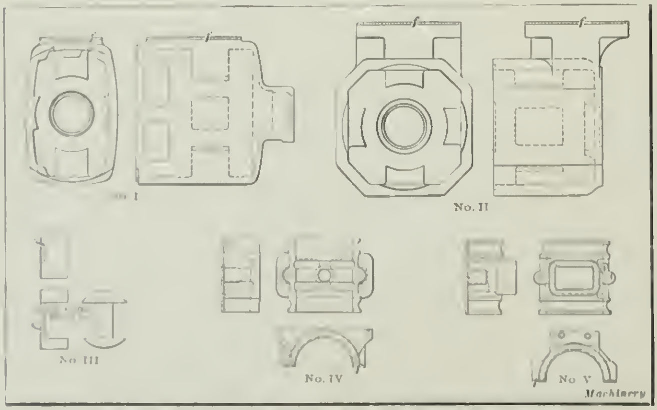


Fig. 2. Examples of Automobile Parts that have the Surfaces marked f machined on the Rotary Milling Fixtures

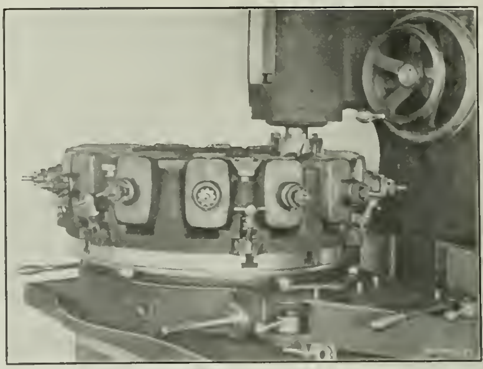


Fig. 3. Type of Fixture used for milling Part No. I in Fig. 2

A very delicate piece of work, so far as the provision of a clamping mechanism for holding it in the fixture is concerned, is part No. III in Fig. 2. It will be seen that the small center web is only 3/16 inch in thickness, and a comparatively light pressure such as might be brought to bear by squeezing the piece between the thumb and finger, is sufficient to spring it. Although the inside of the web remains rough, limits of ± 0.005 inch were required on the thickness; and in addition, the parallelism of the web is essential. Owing to these features of the work, the clamping mechanism had to be designed with provision for floating the work. The fixture used for machining these parts is shown in Figs. 7 and 8. Referring to these illustrations, it will be seen that there are two jaws *E* mounted in each of the rear blocks *F* and that two similar jaws are carried in the binder straps *G*, these jaws being loosely mounted in their seats. Springs *H* support the jaws, and this design enables them not only to adjust themselves to the shape of the work, but also to pull the work down into contact with the supporting block *I* when the clamps are tightened. In this way the parallelism of the web is assured. To provide the movement of the binder straps *G*, which is necessary to allow them to compensate automatically for variations in the width of the work, the binder straps rest on studs *K* which have semi-cylindrical upper ends. The holes in which these studs fit and also the holes for the binder screws *L* are large enough to provide the necessary play. The holes in the straps are concave and the convex washers *M* fit into them. In this way the tightening of the nuts *O* on the binder screws *L* enables the straps *G* to compensate for variations in the work. Two

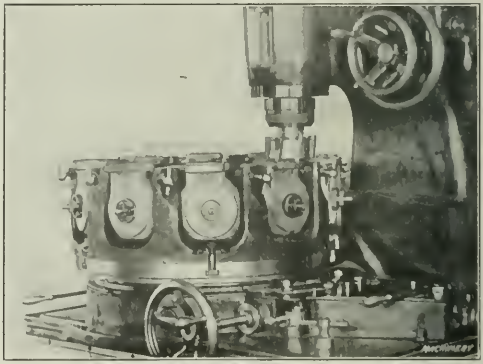


Fig. 4. Fixture used for milling Work of Form shown at No. II in Fig. 2

spring plungers *N* support each binder strap when the clamp is released, to provide for removing a finished piece of work and substituting a fresh casting. The stop-pins *P* locate the work and take the end thrust when milling, thus relieving the floating parts of the clamping mechanism from strain.

The preceding paragraph described how the work was clamped without twisting it and how the desired parallelism of the center web was obtained at the same time. Another point which had to be taken into consideration was setting the pieces square. As the web has a convex surface on which it rests, a special attachment had to be provided for locating the work squarely in the fixture. This attachment is shown in Fig. 10. The baseplate *Q* which is fastened at the center of the rotary table carries a stud *R* on which the arm *S* is pivoted. The plunger *T* has two ⅜-inch slots, the lower one of which receives the piece *U* which has three points that engage the work, while the lever *V* which operates the plunger passes through the upper slot. The member *U* cooperates with the jaws of the fixture in pulling the work down into contact with the supporting block *I* (Fig. 8) and when the work is set ready for clamping, the plunger *T* is pressed down by means of the lever *V* which is pivoted on the pin *W*. This serves to locate the work squarely in the fixture, after which the clamps are adjusted to hold it in position. To obtain just the right position of the plunger *T* over the work while the rotary table is in continuous movement, the rear end of the lever *V* enters slots in a dial *Z* which has the same number of slots as the number of pieces of work held in the fixture. The dial *Z* is set in such a relation to the clamps of the fixture, that the member *U* is brought down in the proper position to square the work preparatory to clamping. After the work has been properly squared up, the spring *Y* releases the lever *V* from the dial *Z* and lifts the plunger *T*, thus leaving the attachment free to be revolved to square up the next piece of work.

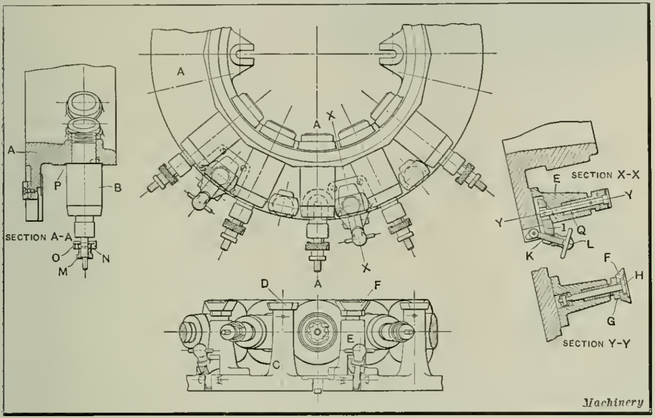


Fig. 5. Design of Rotary Milling Fixture shown in Fig. 3

Figs. 11 and 12 show a fixture which may be adapted for machining the pieces Nos. IV and V in Fig. 2. Parts of the form referred to, but of two different sizes, had to be milled, and to provide for this work a single fixture was arranged for handling both sizes. Referring first to the sectional view through the fixture for part No. IV, it will be seen that V-blocks *D* made of hardened steel are provided in which the work is supported. These V-blocks are made interchangeable with V-blocks of the proper size for holding the smaller pieces at a higher level in the fixture, so that the binder strap *E* can secure both sizes of work. The rocker *F* which is carried by the binder strap adjusts itself to the work and avoids any cramping action which would otherwise occur when fastening the work down. The thrust is taken up by the binder strap, the small pin *I* on which the rocker is pivoted merely serving to hold the rocker in the strap. Spring plungers *G* and studs *H* locate the work in the correct position for milling. When changing the work, the binder nut *K* carried by the swivel bolt *L* is swung out from the binder strap, after which the strap is swung back against the stop *M* so that the work can be removed from the fixture. The entire clamping mechanism is carried by a bracket *N*, there being eighteen of these brackets equally spaced around the base *O* of the fixture.

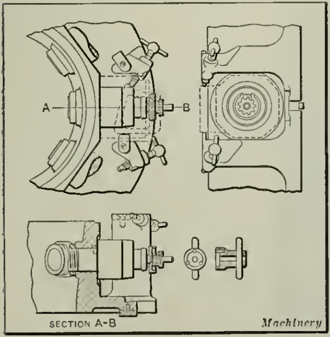


Fig. 6. Details of Fixture illustrated in Fig. 4

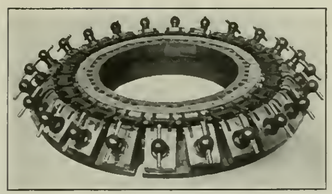


Fig. 7. Form of Fixture used for milling Piece No. III

Both sizes of part No. IV were the same shape so that the same form of locating members *G* and *H* could be employed. This is not the case with the two sizes of part No. V, and as a result a different arrangement had to be provided for locating the two sizes of work in the fixture ready for the milling operation. The binder nut, swivel bolt and binder strap are the same as in the fixture for machining part IV, but instead of using interchangeable steel V-blocks, interchangeable cast-iron blocks *P* were screwed to brackets *Q* as shown in the cross-sectional view in Fig. 11. Each of the blocks *P* carries its own locating members; those for the smaller work are not shown,

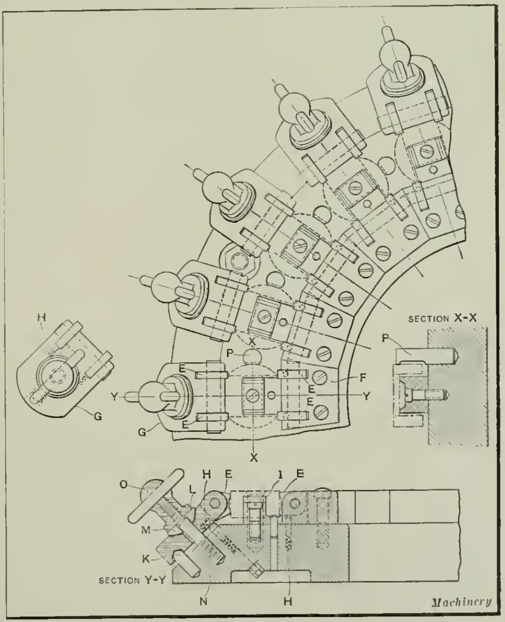


Fig. 8. Details of the Fixture shown in Fig. 7, illustrating Provision for supporting Thin Work

but consist of a spring plunger *G* and locating pin *H* as shown in the cross-section of the fixture for part IV. Those for the larger work are clearly shown in the cross-section on the line *Z-Z*, where it will be seen that two studs *R* and *S* are mounted in the block *P*. The stud *S* is slotted and carries a small rocker *V* which locates the work against the stud *R* through the action of a spring plunger. The blocks *P* are made of cast iron and the V-shaped recess in which the work is held is lined with hardened steel strips *U* to provide a durable bearing for the work.

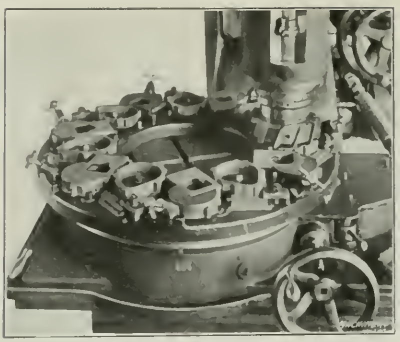


Fig. 9. Fixture for Use in milling more than One Face on the Work

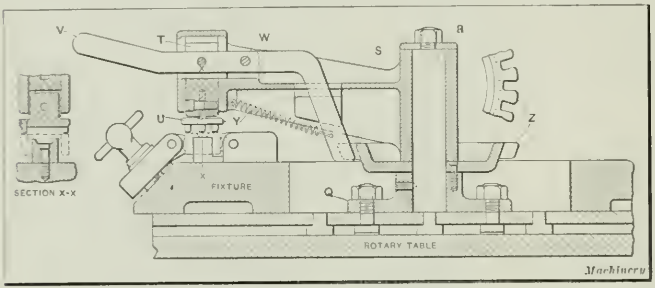
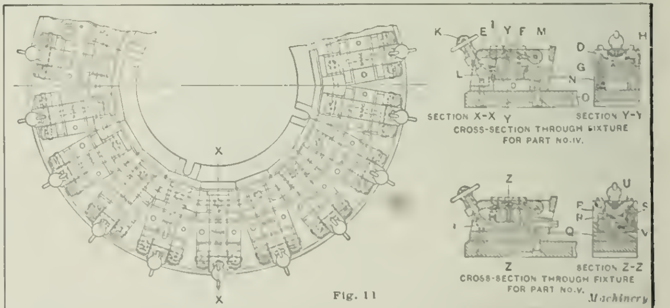


Fig. 10. Attachment for squaring up Work held in Fixture shown in Figs. 7 and 8

In order to design efficient and durable fixtures for continuous rotary milling, the following points are worthy of particular attention. The pieces to be milled should be placed as close together as possible to avoid time lost in traversing the cutter from piece to piece. When the shape of the work permits of it, the circle in which the pieces are arranged should be as small as possible, as the output is not dependent upon the number of pieces which the fixture holds but upon the rate at which the work is fed to the cutter, which is independent of the diameter of the fixture. It will be obvious, however, that the cost of the fixture will be reduced in proportion to the diameter of the circle on which the work is arranged. Fixtures should never be designed along lines which make it impossible for the operator to change the work as rapidly as the table revolves. They should be designed to take all the different sizes in which a part of a given form is made or even different parts of similar shape.


K
E
Y
F
M
H
D
G
L
N
O
SECTION X-X
Y
SECTION Y-Y
CROSS-SECTION THROUGH FIXTURE FOR PART NO. IV.
X
X
Z
U
P
R
S
Q
V
Z
SECTION Z-Z
CROSS-SECTION THROUGH FIXTURE FOR PART NO. V.
Fig. 11
Machinery
Fig. 11. Design of Fixture shown in Fig. 12 and Jaws for holding Work IV and V

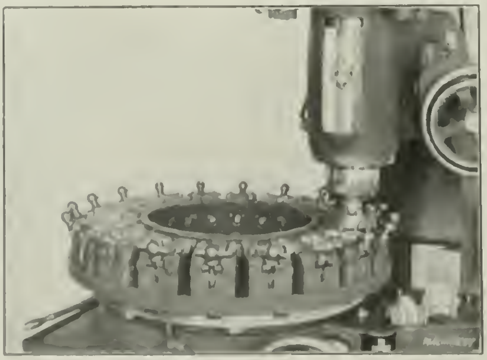


Fig. 12. Fixture of Type used for milling Parts Nos. IV and V in Fig. 2

Fixtures for handling work which has to be milled on more than one side can often be arranged to take care of all of the different milling operations, an excellent example of a simple and efficient fixture of this kind being shown in Fig. 9. The gear housings for a certain automobile starter have to be finished on two sides and the fixture shown in this illustration holds fourteen pieces, seven of which are arranged in equally spaced stations where the first operation is performed, this operation consisting of milling the square base. In performing this operation, the rough casting rests on three hardened pins. The other seven castings on which the second operation is to be performed are set between those on which the first milling is done. The second set of castings is located by a finished spot which is the same distance above the pins that support the rough castings as the depth of the cut taken on the second operation. The work is changed in the following manner: A casting which has been finished on both sides is removed and replaced by the adjacent casting on which the first operation has been performed; and the partially finished piece is replaced by a rough casting. The advantage of this arrangement consists not only of having two fixtures combined in one, but also of being able to finish seven pieces on both sides for each revolution of the rotary table. When machined in this way, the amount of handling required by the work is reduced to a minimum. In connection with this fixture the advantage of having the work located close together in order to reduce time lost in traversing from piece to piece is clearly demonstrated. When machining parts in large quantities, continuous rotary milling will be found the method of maximum efficiency in practically all cases where it can be employed, and as a result it should be adopted wherever possible. The advantages of handling work by this method are so great, however, that it will often be found worth while in cases where the quantity of work to be machined is not very large.

* * *

It has been known for several years that liquid oxygen mixed with a substance like cotton-wool forms a powerful explosive. In the past, however, there have been serious difficulties encountered in its practical use, but it is claimed that a new method has been discovered for handling oxygen so that it can be used commercially as an explosive. It is stated that bags which are filled with a special form of lamp black soaked in liquid oxygen for a few minutes just before they are required for use will, if detonated, explode with the force of dynamite at a cost much less than that of the latter explosive. There is no danger from a mis-fire, as the oxygen will evaporate in a short time, and a lighted match may be put to the charge and cause only a quiet, slow burning of the charge.

COMPENSATING AND QUICK-ACTING CLAMPING DEVICES*

DEVICES USED IN UP-TO-DATE MANUFACTURING TO INSURE RAPID PRODUCTION AND COMMERCIAL ACCURACY

BY ALBERT A. DOWD†

THE manufacturer of the present day is looking for maximum efficiency in his methods of production, and with this in view he endeavors to take advantage of every improvement in machine tools that will help to increase his output. In the work of the factory, modern improvements of all kinds are used to facilitate the rapid handling of parts and their transfer from one department to another. The "tooling" for the various machine tools is much more carefully studied than it was a few years ago, so that the greatest possible output of the machine can be attained, and fixtures for holding the work during the process of machining are much more carefully designed, so that as little time as possible will be lost in locating and clamping the work.

In horizontal and vertical turret lathe work the development of fixtures and holding devices is very noticeable. In the design and construction of quick-acting clamping devices for turret lathe fixtures, there are several important points to be considered:

1. Quick and accurate location for the work that will not be subject to variations caused by the presence of dirt or chips.
2. Arrangement of fixture in such a way that locating points or surfaces can be kept in their proper relation, so that the desired accuracy may be maintained at all times. Provision should be made for wear or breakage, either by a construction that will permit replacement, or a method that will allow the adjustment of the points in question.

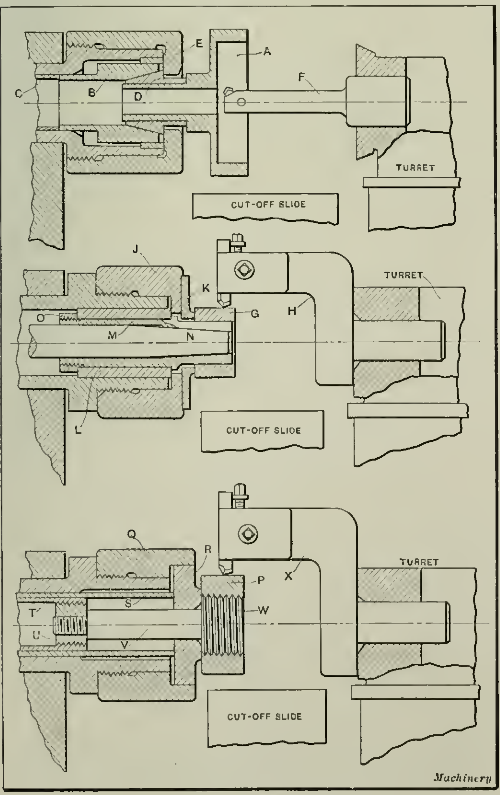


Fig. 1. Collet Mechanisms

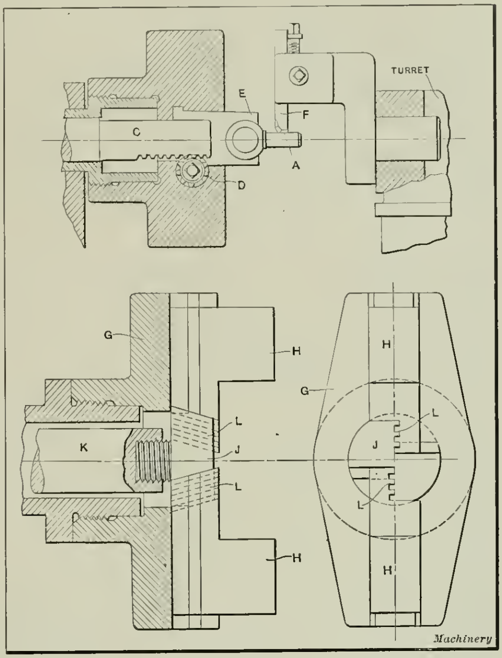


Fig. 2. Quick-acting Two-jaw Chucks

3. Precaution in designing so that distortion of the work will not take place because of improper clamping or faulty locating. Care must be taken so that too much force will not be applied to the screws or other devices used in securing the work, and attention must also be given to the possibility of "cocking" the casting by a faulty application of the clamps.
4. Provision for compensating for unequal pressures that might result when several clamps are to be operated from a common point, for unless this matter is properly taken into consideration the clamps will not hold securely. When clamps are to be set up on a rough casting, special attention must be given to this feature of the design, so that the holding action will be positive and secure.
5. Provision for incorporating a "driver" whenever possible, as the strains incident to the cutting action of the tools are taken by it to a great extent so that the clamps are relieved. Chances for distortion are minimized, and the clamps need not be set up so tightly if a driver is provided.

A number of examples of quick-acting clamps and compensating devices for horizontal and vertical turret lathe fixtures are described in the following and important points in construction and design will be noted.

Quick-acting Clamping Devices

The three-jawed universal chuck is undoubtedly the most familiar form of rapid clamping device. Its use, however, is limited to cylindrical work or that of a semi-cylindrical nature, when used with the standard equipment of jaws. For second-operation work soft jaws are frequently used, these being bored out on the machine to the size of the finished work. The step-chuck is another example of a quick-clamping device.

Various forms of collet mechanisms may also be classed among the examples of quick-clamping devices. Some of the variations and developments of these devices are of sufficient importance to be included with the other forms described here. The majority of collet mechanisms on the horizontal type of turret lathes are operated from the rear end of the spindle by means of a hand lever which controls the longitudinal movement of an internal sliding sleeve. This sleeve operates the closing mechanism when arranged for normal work.

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* For supplementary material on clamping devices, see "Clamping Work in Jigs," MACHINERY, December, 1913.

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Fig. 1 illustrates three developments of collet closing mechanisms adapted to several classes of work. The upper view represents the device when used under normal conditions, the work *A* having been partially machined in a previous operation. The regular collet chuck or nose-piece *E* is screwed to the spindle and serves to keep the parts in position and also to prevent longitudinal movement of the jaws *D* when the closer *B* is forced forward by the operating sleeve *C*. This type of mechanism is supplied with Pratt & Whitney turret lathes, and is especially desirable for second-operation work, as the longitudinal location of the work is positive on account of the absence of a longitudinal movement of the jaws. A boring-bar *F* is shown in the turret.

The central figure in the illustration shows an expanding collet made by the Garvin Machine Co. for use with turret lathes. The work *G* is to be turned and faced by the turning tool *H* and a facing tool mounted on the cut-off slide. A special nose-piece *J* is screwed onto the spindle and holds the locating sleeve *L* in position. Through this locating sleeve the split collet *M* passes, held securely by the nut *O* at the inner end. The operating rod *N* is connected to the regular operating sleeve and is tapered at the forward end to fit the taper of the expanding collet. The action of the device is very satisfactory for second-operation work, and it may be manipulated rapidly. There is no end movement of the mechanism.

The lower figure shows an adaptation of the collet mechanism to a piece of threaded work *P* which is to be turned by the turning tool *X* and faced by the cut-off slide, square with the threaded portion. The nose-piece *Q* is screwed to the end of the spindle. A movable collar *R* is fitted to the end of the nose-piece and is controlled longitudinally by operating sleeve *S*. The threaded arbor *W* is screwed into a fixed internal sleeve *T*, the connection being made through the threaded collar *U*, the stem *V* of the arbor being a running fit in the movable collar *R*. It will be noted that the clamping action takes place when the sleeve is moved forward, and the release is effected by a reversal of the operation, no end movement of the work being evident. An arrangement of this sort is very useful for threaded work and its operation is sufficiently rapid to satisfy the most exacting requirements.

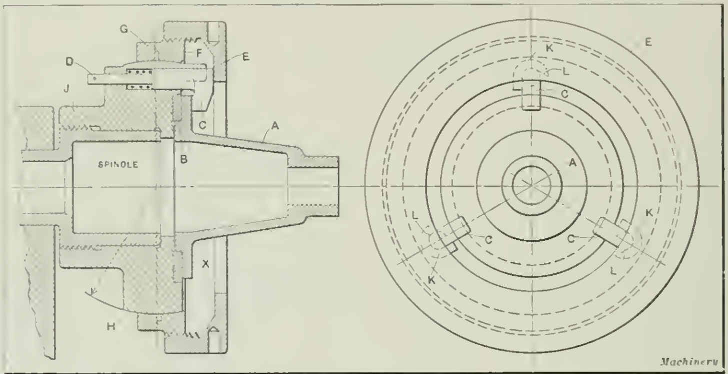

Fig. 3. Quick-acting Compensating Holding Device for Automobile Hub

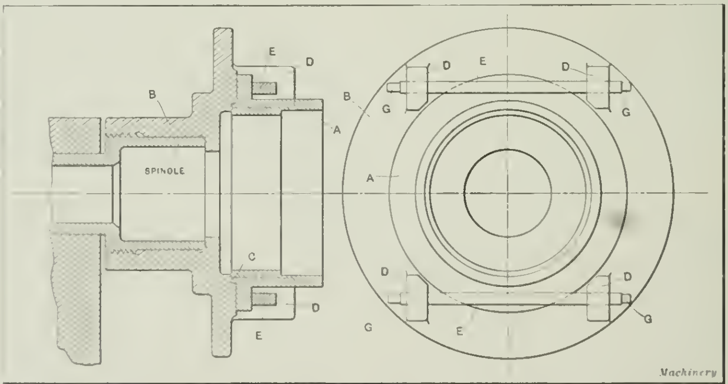

Fig. 4. Quick-acting Clamping Fixture in which Wedges are used

Quick-operating Two-jawed Chucks

Chucks of the two-jawed variety are occasionally fitted with devices for rapidly opening and closing the jaws, two of these mechanisms being shown in Fig. 2. The upper illustration shows a Pratt & Whitney two-jawed chuck in which the jaws *E* have been formed to receive the brass key *A*, the turning operation on the work being performed by the tool *F*. The jaws of this chuck are normally operated by a right- and left-hand screw on the shaft *D*, which passes through the chuck. In this instance, the shaft is fitted with a piston in the center, between the two jaws. This pinion is revolved by a rack cut on the operating rod *C*, the longitudinal movement of which is obtained by a special arrangement of the collet closing mechanism at the rear end of the spindle. The regular sleeve and the fingers that operate it are removed, and a collar is placed on the rod which allows a coupling to be made with the lever that normally operates the mechanism. As the pinion is revolved, the jaws open or close according to the movement of the rod.

The Garvin Machine Co. manufactures a two-jawed chuck designed especially for rapid operation through the collet mechanism. The lower view in the illustration shows the arrangement used. The chuck body is screwed onto the spindle in the usual manner, and in it are mounted the two jaws *H*. These jaws are manufactured in several styles for either external or internal work and with or without inserts. Either compressed air or spring pressure may be used to operate the mechanism, and the movements are controlled by the foot of the operator on a treadle beneath the machine, so that his hands are left free to handle the work to the best advantage. The jaws are provided with multiple wedge surfaces *L* that mesh with corresponding angular grooves in the central plug *J*, this plug being screwed into the operating rod *K* which is spring-controlled in one direction and treadle-controlled in the other. The maximum movement obtainable is about 3/16 inch on each side, which is ample to take care of practically any condition that may be encountered. When reversible jaws are used, the change from external to internal holding only requires a reversal of the jaws and an extra center wedge plug, the change from one type to the other being accomplished in a few minutes.

Quick-acting Compensating Holding Device for Automobile Hub

The automobile hub *A* in Fig. 3 had been partially machined in a previous operation. The outside taper and the end of the hub were to be machined in the setting shown, the tapered surface being machined by a taper attachment. There were a large number of these pieces, so that the expense of the fixtures was a minor item when compared with the output desired. Six machines were needed to produce the required quantity, these machines being horizontal turret lathes with special tooling and holding devices of the type shown in the illustration.

Both tooling and fixtures were designed with a view to increasing the production. The usual method of clamping the work by means of three or more straps or hook-bolts and setting up each one of these separately with a wrench was considered too slow, so it became necessary to devise a method by which all clamps could be tightened simultaneously and with a uniform pressure.

The work *A* was located at *B* on a hardened and ground steel locating ring and was clamped in position by three hook-bolts *C*, bearing against flange *X*, which had been finished in the previous setting of the work. These hook-bolts were backed up by lugs *K* on the body casting, and the lugs themselves were cut away on one side as shown at *L*, so that the hook-bolts could be turned around part way in order to insert the work. A portion of the body *H* was turned spherical, and the steel pieces *G* and *F* were machined to a running fit on the spherical surface. Before machining the spherical portion of these two pieces, they were "papered up" with several thicknesses of paper so as to provide a "take-up" for wear. Piece *F* was provided with a thread that engaged with the threaded portion of the adjusting collar *E*. This collar was furnished with a series of holes around its periphery, in which a piece of drill-rod was inserted when clamping or releasing the work. It will be noted that the hook-bolts extend entirely through the body casting *J* and are forced outward by the coil springs, while the pins *D* limit the movement and prevent their falling out. A compensating action is obtained by the spherical bearing *H* on which the floating collar composed of the two pieces *G* and *F* is free to swivel. Slight inequalities and variations in machining are therefore equalized; the pressure of the hook-bolts is uniform, and there is no tendency to "cock" or distort the work. The operation of the device was satisfactory and its action as rapid as could be desired. The provision for "take-up" in the spherical ring and the ease with which a new locating ring *B* can be fitted are valuable features.

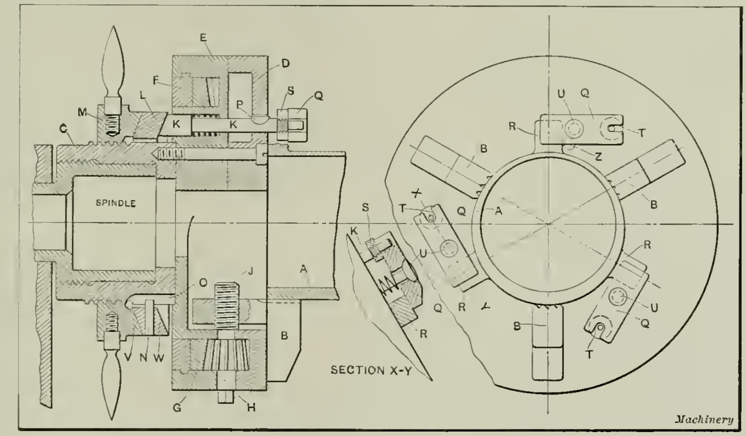

Fig. 5. Combination Chucking and Clamping Device used in making Piston Rings

Quick-acting Clamping Fixture Using Wedges

Another quick-acting clamping fixture for the horizontal type of turret lathe is shown in Fig. 4, but this fixture is open to several objections which will be noted later. As in the former instance, the work has been partially machined in a previous setting and is located in the fixture by surface *C*. No provision has been made for replacement in case of wear on the locating surface, it being the theory of the designer that when the surface became so worn as to produce inaccuracies in the product, it would be a very easy matter to cut a recess in the body casting at *C* and insert a steel ring. It was the expectation of the designer that the locating surface would remain in good condition long enough to complete the output required. This is questionable practice and should be discouraged unless the production is so small that there is little likelihood of inaccuracies resulting from it.

The body of the fixture is screwed to the spindle in the usual manner and is provided with four lugs *D*, slotted to receive the tapered clamping wedges *E*. These wedges bear against the flanged portion of the casting *A*, and are driven into their positions by a babbitt hammer. The ends *G* are relieved so that they will not become battered up in case the operator uses a steel hammer in place of a babbitt one. The wedges on this fixture are loose pieces and must be taken out when the work is completed. Care is necessary in replacing them to see that the proper side of the wedges bears against the work, and in addition to this, they must be driven in with about the same amount of force. Both of these features show a lack of care in the design, so that although the fixture may be rapidly operated, it should be considered an example of faulty construction. The lack of any method of compensating for or equalizing the pressure of the wedges may produce faulty locating and a possible tendency to "cock" the casting.

Combination Chucking and Clamping Device for an Eccentric Ring Pot

The arrangement shown in Fig. 5 is exceptional and appears complicated at first glance; but in reality it is comparatively simple, as it is merely an adaptation of a standard chuck to a somewhat unusual condition. There were approximately 10,000 pots of this kind to be turned eccentric, bored and cut off into narrow piston rings. No change in the design of the pot was permissible, as there were a great many castings on hand. An eccentric turning device operated simultaneously with the boring tool, and the rings were cut off by a gang of tools on the cut-off slide. Three machines were equipped for this work and the production of 4-inch rings averaged about 80 per hour, turned eccentric, bored and cut off.

The type of chuck used was a Pratt & Whitney combination, and the machine a horizontal turret lathe. This may be used as a universal or independent chuck, and for either concentric or eccentric work. When used as a universal chuck for eccentric work, as in the instance here given, the plate *F* at the back is unscrewed until the gear ring *G* is out of mesh with the operating pinions *H*. The jaws are then set independently by means of the screws *J* to conform to the eccentricity of the casting *A*, after which the back-plate is returned to its original position and the operating gear again meshed with the pinions. The chuck jaws will now operate universally, but the jaws *B* will be eccentric so that they will center the work properly. It will be readily seen that it would be impracticable to use the jaws for gripping the work with sufficient pressure to drive and hold it securely, so a method of clamping in addition to the jaws was found necessary. A pin driver *Z* was set in the face of the chuck plate *D*, and proved sufficient for this purpose.

The chuck is mounted on a special faceplate *C*, screwed to the spindle, and is threaded to fit the operating spider collar *M*. The front surface of this collar has a spherical seat *V* to fit the rear of the floating collar *L*. A pin *N* enters the slot *O* in the faceplate and prevents the floating collar from revolving. The surface *W* at the front of the collar bears against the ends of the three pins *K* that pass entirely through the chuck and are keyed at *P* to prevent turning. These pins are kept firmly against the floating collar by coil springs, and their outer ends are furnished with thrust collars *S* that lift the ends of clamps *Q*, thus causing them to pivot on the ball-

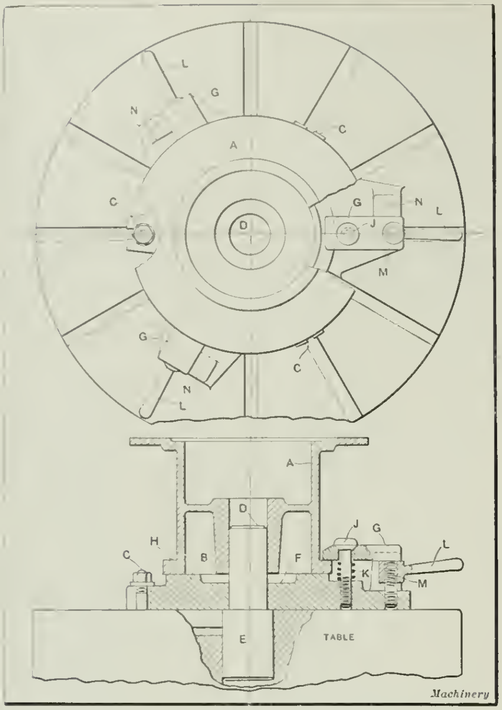

Fig. 6. Quick-acting Clamping Device for Vertical Turret Lathe

headed screws *U* and therefore depressing the other ends which grip the three lugs *R* on the pot casting. The slots *T* at the ends of the clamps prevent them from becoming displaced during their operation. The small section *X–Y* clearly shows the construction of this portion of the clamping arrangement. It will be noted that when the spider collar *M* is revolved, the spherical bearings *V* and *W* allow a compensating action of the pins *K*, which thereby equalizes the pressure on all three of the clamps *Q*. The action of this entire device was rapid and the work obtained by its use satisfactory.

Fixtures for the Vertical Turret Lathe

In the design of fixtures for the vertical turret lathe more power is usually required in the clamping devices, the amount of stock to be removed usually being greater and the feeds employed considerably heavier. For these reasons it is always well to make use of a driver whenever this is possible. If the construction does not permit the use of a driver, the area of clamping surface should be as large as is consistent with the design, and the clamps should be especially powerful so as to obtain as great a degree of friction as possible without distorting the work.

The work *A* shown in Fig. 6 has been previously machined both in the small hole and on the face of the smaller frame and hub. In this instance, on account of the comparatively small number of pieces to be machined, it was not considered advisable to go to the expense of making a fixture with a compensating device for clamping. Rapidity of operation, however, being highly desirable, it was decided to make quick-acting clamps without the compensating features. No driver could be employed.

In the fixture, the work is located on the central stud *D* which extends down through the fixture nad centers it on the table by the larger end *E* fitting into the center hole. The fixture itself is clamped in position by three bolts *C*. The finished face of the flange *H* rests on the annular pad *B*. Three clamps *G* are arranged around the flange and are set up tight against it by the action of the lever *L* which is threaded with a double thread at *M*. The ball-ended stud *J* allows the clamp to tip or rock sufficiently to gain a good bearing on the flange. The lugs *N* take the thrust of the tail of the clamp. It will be noted that the operator can readily tighten two of the clamps at once, one with each hand, so that the action of the device is very rapid.

Internal Equalizing Device with Hook-bolts

The work *A* in Fig. 7 has been partially machined in the previous operation and is located for this setting on a hardened and ground steel ring by the shoulder *E*. The fixture *B* is located on the table by the center stud *J* and held down by three bolts *H*. Before the work comes to the vertical turret lathe for this setting, the flange is jig-drilled with the six holes shown; one of these holes is used to assist in driving the work, the pin *G* being used as a driver. There are three hook-bolts *L*, spaced at equal distances around the inside of the flange, and kept away from it when they are not in use by the coil springs indicated. These hook-bolts are well backed up by the body of the fixture *M*. A reference to the upper view will show the manner in which the body is cut away at *R* to allow the hook-bolts to swing clear of the work. The upper end of stud *J* is threaded with a coarse thread at *K*. The nut *O* has a spherical bearing on the clamping collar *N* and the latter also has a spherical bearing on the ends of the hook-bolts. The pin *S* prevents the collar *N* from revolving when nut *O* is tightened. A special socket wrench *P* is provided with this fixture, the handle *Q* being long enough to give a good leverage. It will be noted that the pressure required on the hook-bolts in this fixture is not as great as it would be were there no driver, as pin *G* takes most of the strain. When nut *O* is tightened by means of the socket wrench, the spherical bearings, both on the nut and collar, permit the hook-bolts to adjust themselves to the variations in the casting, so that a positive compensating action is assured and the pressure is equalized.

Compensating Clamping Device for a Large Flange

The work *A* in Fig. 8 has been partially machined in a

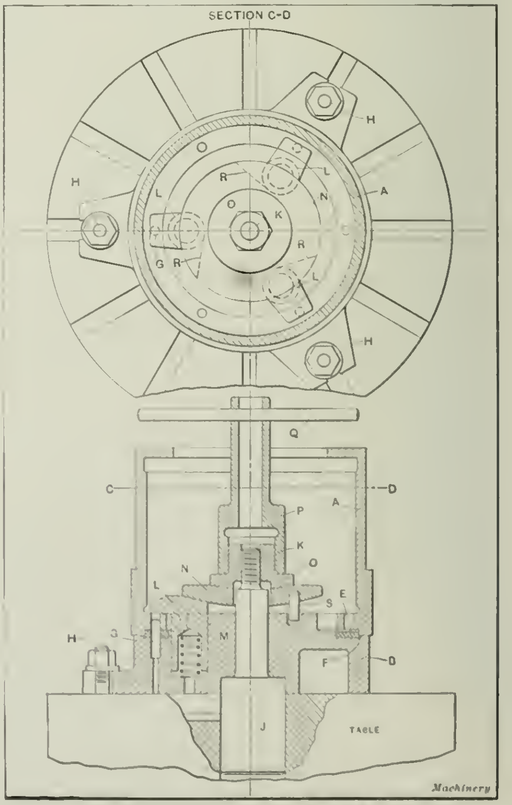

Fig. 7. Equalizing Clamping Device used on Vertical Turret Lathe

previous setting and the shoulder *B* is used to locate from, in the setting shown. After the first setting, and previous to that illustrated, the flange is drilled at *X* for a driver. The amount of stock to be removed during this operation is considerable, and unless a driver were provided, some difficulty might be experienced in holding the piece securely against the pressure of the cut. The fixture body *H* is centered on the table by the stud *F* which enters the center hole in the table at *G*. Three screws *C*, provided with shoes *D* at their lower end, enter the table T-slots. There are three clamps *E* spaced equidistantly around the flange and held clear of it when not in action by the coil springs below. The ball-ended screws *P* permit a rocking action to the clamps, so that they will adapt themselves readily to the surface.

Ring *L* is spherical on its lower side to correspond with the clamping ring *K* and is prevented from revolving by pin-driver *N* in the body of the fixture. This pin enters a slot *O* in the annular ring, the slot being large enough to permit of a slight rocking action without interference. The outside of the fixture is threaded at *J* and on it is mounted the clamping ring *K*. There are twelve holes *M* around the periphery of this ring for a long piece of drill rod by which the ring is revolved. This ring forces the ring *L* against the under side of clamps *E* and these swivel on the ball-ended screws *P* until they bear against the upper side of the flange and draw the work down firmly onto the fixture. As ring *L* is free to float on its spherical lower surface, it follows that an equalizing action is set up between the ring and the clamps, so that the pressure is distributed equally.

Equalizing Clamping Fixture for Steel Sprocket Gear

The steel sprocket gear *A* in Fig. 9 has been machined on one side and the hole bored in a previous operation. The shoulder *B*, the important locating surface, is used to set up the piece for this operation. The fixture *C* is provided with a center stud *E* that fits the center hole in the table at *F*. The fixture is clamped in position on the table by bolts *D*. As in a previous instance, clamps *G* are allowed to swivel on the ball-ended screws *H* and a coil spring underneath the clamps keeps them out of contact with the work when not in use. The large screw plug *M* is threaded into the body of the fixture with a coarse left-hand thread, and has a stem that extends upward through the collar *L*, and is squared at its upper end to receive a wrench. Collar *L* is formed spherically on its lower surface to fit a corresponding part on the screw plug *M*, and it has a bearing against the under sides of the three clamps shown. In order to prevent its revolution, a driving pin *J* is driven into one side of the collar and enters the slot *K* provided for it in the body of the fixture, sufficient freedom being given so that no interferences will take place on account of the rocking action of the collar.

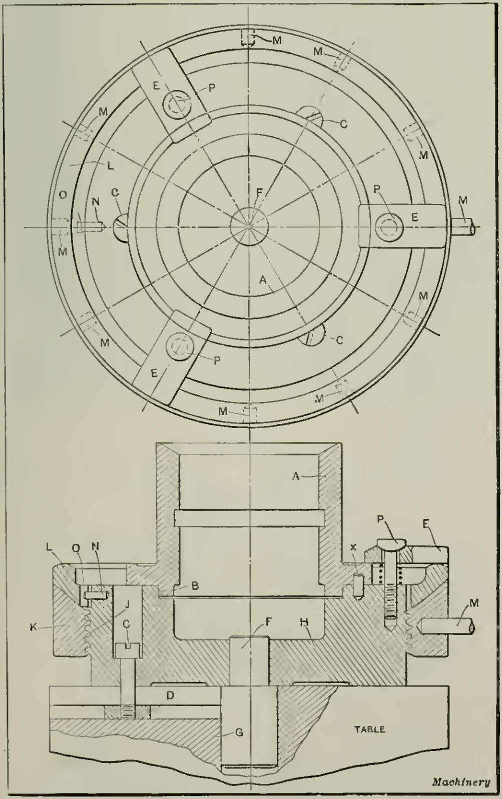

Fig. 8. Another Example of Equalizing Clamping Fixture used on Vertical Turret Lathe

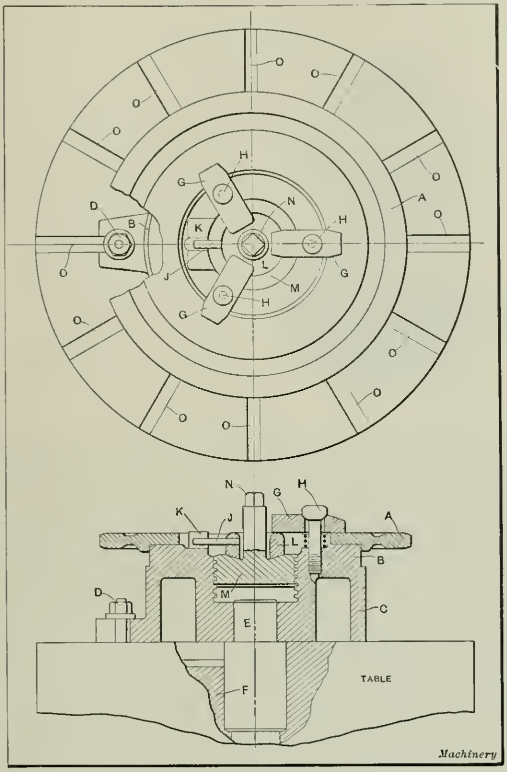

Fig. 9. Compensating Clamping Fixture for Steel Sprocket Gear

After the work had been set in place on its locating shoulder *B*, the clamps are swung around in the position shown and a wrench applied to stud *N*. As the screw rises in the threaded pocket, collar *L* rocks on its spherical bearing and forces clamp *G* down onto the work with an equal pressure.

* * *

Small geared grinding machines have come into general use during the past few years on the farm, in small shops, in the kitchen and on repair work for sharpening tools. These machines, provided with artificial or natural abrasive wheels, are capable of sharpening tools quickly and effectively. The workman can hold the tool in one hand while he turns the crank with the other, and thus these portable machines economize time and labor, making unnecessary frequent trips to a stationary grinder or the employment of another workman to turn a grindstone. The classes of workmen benefited by these small grinding conveniences are legion, comprising practically every type of worker, such as carpenters, plumbers, blacksmiths, stone workers, masons, machinists, farmers, miners, garage workers, section men, etc.

STORY OF THE COMBINATION SQUARE

BY L. S. STARRETT*†

L. S. Starrett

In 1876, while making patterns, I was impressed with the need of improvements in try-squares to fill the place of a kit with different lengths of fixed blades for patternmakers' and carpenters' use on various grades of work. The idea of a sliding blade struck me as the right principle to work on. After I conceived the design I made patterns, got castings and a blade and had the first sample made by a good machinist, who, not believing in an adjustable square blade, said he "wouldn't give a damn for it." But that did not discourage me. I showed it to Samuel Colt of Hartford, the noted revolver manufacturer. He grabbed it out of my hands and exclaimed: "That is a good thing. That will sell. Did you get it up? I want one."

He being a man after my own heart this was encouraging. I made a contract with a Connecticut company who made old-style try-squares, etc., to make 5000 as a starter. After awhile I got the first lot and showed them to the hardware men, all of whom admitted it to be a good thing, but said that as it was not introduced there was no demand. They said: "If you will get them introduced, we will buy them." I saw the point. So I employed agents, giving them a generous commission to canvass the manufacturers and sell direct to employes, in many cases taking orders to be delivered after the next pay-day. The squares sold like hot cakes, and so my agents did well for themselves and well for me. But I could not get them made fast enough to fill orders.

My first one-sheet circular headed by a cut of the combination square gave the following description: "The old-style try-square superseded by an instrument that is more than a substitute for a whole kit, from the shortest to the full length of blade, and more convenient than a whole kit can be. It is also a miter square, a plumb and level, a depth and mortise gage, a steel rule and straightedge, a scriber or scratch gage, and a gage for transferring measurements." When this circular was shown to the manager of the concern I had contracted with he exclaimed: "No, you don't! No, you don't!" meaning superseding the old-fashioned try-square, being somewhat jealous, you see. How much this had to do with my not getting the squares as fast as I wanted I don't know, but being a good friend to the foreman I interested him in pushing things to get out a lot on time. The management could not understand why their foreman was so intensely interested in getting the work along as fast as he did.

However, as the work was not as good as I wanted, I fitted up a small shop in Athol and started to make them myself, hiring the best workmen I could find. But to get the blades graduated was what bothered me most. I tried to place a contract with a firm making scales but was turned down. I could not buy a graduating machine for love nor money. So after deciding on the best method of graduating I got hold of an idea and perfected my own machines and system, and not only made and graduated my square blades, but put on the market an improved line of spring-tempered steel rules that are now acknowledged and accepted as standard the world over. Among the first scales I made was a "very-thin scale." I christened this "flexible" to distinguish it from the heavier spring-tempered scale. This has since been copied by all of our competitors who make scales.

Soon after I put out my squares I added a center head to slip off and onto the same blade to use in finding the center of circular work; also a bevel protractor to use with the same blade, all of which have added much to the value of the tool, and since my patents have expired these tools have been copied at home and abroad by many of our competitors who no doubt think imitation is no crime.

It may be of interest to state that it was not long after my introducing agents got to work that the hardware dealers made inquiries with the intention of placing orders. As my agents at that time were selling all I could produce they were informed that I was not ready to sell to the trade yet and would not be until I got them thoroughly introduced. Some of our good hardware men did not like it. I told them that as soon as the hardware men were ready to put in a sufficient stock to warrant it I would call off my agents and let them handle the squares. This has long since been done and now we are selling all of the productions of the L. S. Starrett Co. (the largest fine tool company in the world) through the hardware trade exclusively. Not only this, but we are helping them through our traveling men who are introducing the many new tools we are constantly bringing out, turning all orders over to the trade in the locality in which they operate.

* * *

VALUE OF ADVERTISING IN TRADE PAPERS

The value of advertising in trade papers is indicated by a letter recently received, requesting the names of trade papers covering the automobile and motorcycle manufacturers and the manufacturers of their accessories. The writer stated that he was desirous of making up a good mailing list of these manufacturers and that while he knew such lists could be had from mailing houses who make a business of compiling them, he preferred to make up his own list and thus eliminate many useless names. He had found that trade papers were very valuable for this purpose, the inference being that live concerns advertise and thus are worth including in a mailing list. Firms that do not advertise are "dead wood," and many are in such an advanced state of decay that it is a waste of paper and postage to send them circulars.

* * *

MACHINE SHOP TERMS ILLUSTRATED

Backing Off

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* President, L. S. Starrett Co., Athol, Mass.

† Laroy S. Starrett was born in China, Me., April 25, 1836. He was the sixth child of Daniel D. and Anna Starrett, and was one of twelve children. He was brought up on a large farm under the hard, primitive conditions existing in America seventy-five years ago. All the clothes of the family were made from wool and flax raised on the farm and prepared by the mother and sisters, who carded, spun, wove, cut and fitted them to the members of the family. Mr. Starrett's father was handy with tools. He made ox yokes, carts and sleds, not only for himself but for his neighbors. In fact both father and mother were ingenious and Mr. Starrett inherited a common-sense way of doing things and a love for working with tools. Working from five in the morning until nine at night, as was necessary under the hard conditions of life, begot habits of industry but prevented his getting more than a short term of schooling in the common district school. At seventeen he left home to earn money to help pay off a large mortgage on the farm. For ten years he turned in all of his wages not actually needed for clothes and other necessaries. When the farm was cleared of debt and his parents relieved from this anxiety, Mr. Starrett had saved about $1000 and then he married Lydia W. Bartlett, a high school graduate of Newburyport, Mass. In 1862 he rented a 600-acre farm with a large stock of cattle and horses and during Civil War days he ran the farm very successfully. He bought and used one of the first mowing machines seen in that part of the country. During this period, Mr. Starrett invented a washing machine, a butter worker and a meat chopper, all of which were patented. In the spring of 1865 he sold out his farming interests and hired a shop in Newburyport where he began manufacturing, making a specialty of the meat chopper. In 1868 he removed to Athol, Mass., and incorporated the Athol Mfg. Co. to manufacture the meat chopper and some other inventions, but after seven years he lost controlling interest in the concern and left to begin the manufacture of the combination square, as told in the accompanying article. Mr. Starrett's wife died in 1879, leaving one son and three daughters.

THE PRACTICAL SIDE OF SHERARDIZING[*]

THE PROCESS, THE APPARATUS AND METHODS EMPLOYED

BY CHESTER L. LUCAS[†]

NUMEROUS processes are employed for rust-proofing metal articles. Of these one general class is based on the application of a coating of zinc to the work. Of the zinc-coating processes, the oldest in common use is undoubtedly hot galvanizing. This is essentially a dipping operation in which the work, after being properly cleaned, is immersed in a tank of molten zinc. Another method of rust-proofing is the electro-galvanizing process which had its inception before hot galvanizing, but only until within the last few decades has it come into use. This is an electro-plating process, in which zinc is deposited from an anode onto the work. In addition to these two processes, there are others based on the immersion of the work in solutions of different kinds, and at least one in which the zinc dust is sprayed on the work while hot. Another zinc-coating process is sherardizing and it is the purpose of this article to outline the practical side of this interesting process.

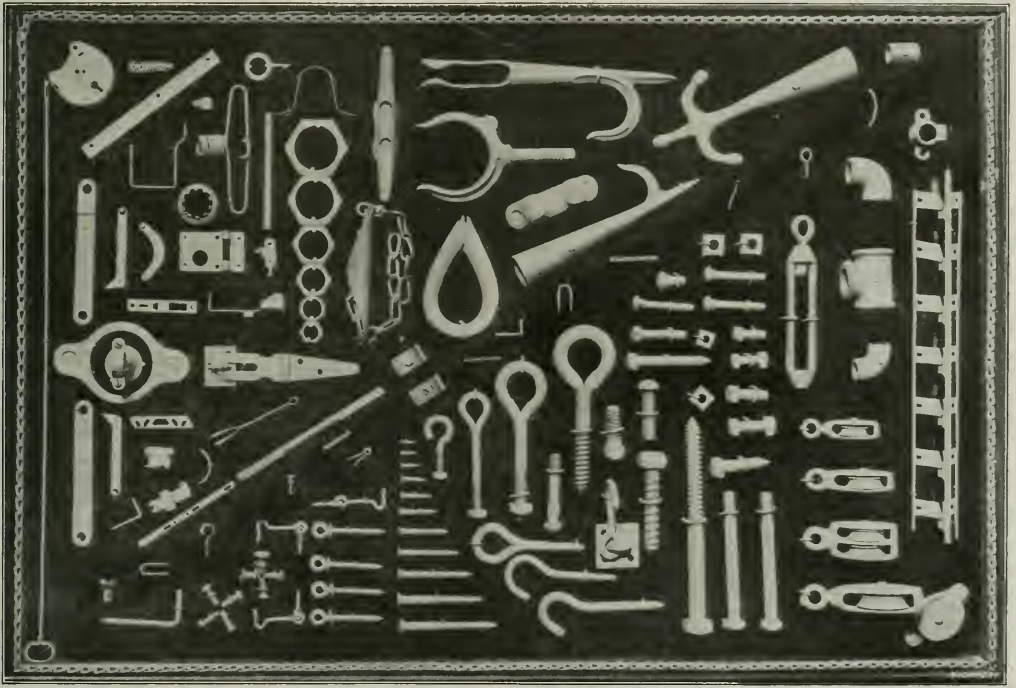

Fig. 1. Specimens of Sherardized Work

The Sherardizing Process

The sherardizing process was originated in England by Sherard Cowper-Coles about twelve years ago. Briefly, the process consists in sealing the work to be sherardized in metal retorts in conjunction with metallic zinc dust. The retorts are then heated until the work at the center has reached a temperature of from 500 to 700 degrees F., depending upon the nature of the work; at the same time the retorts are turned intermittently so as to give the zinc dust access to all parts of the work. After holding this heat for several hours, the time depending on the thickness of the coating desired, the drums are taken from the furnace and allowed to cool. When cool the work is finished. Fig. 1 shows specimens of sherardized work and gives an idea of the variety of articles that can be sherardized. These range from a watch screw to a roll of wire fencing. A sherardized surface is light gray in color, and the finish imparted is a fine matted surface resembling that obtained by sand-blasting. Fig. 2 shows a sherardized surface magnified seventy times which accounts for the rough appearance.

The action that takes place in sherardizing consists in forming both a zinc-iron alloy and a coating of zinc upon the material to be treated. The zinc dust becomes partially vaporized under the influence of the heat applied, and the vapor thus produced in condensing upon the hot iron forms the protecting coating, the inner layers of which alloy with the iron, while the outer layers provide additional surface protection of nearly pure zinc. Fig. 3 will perhaps make this point clear. This shows a section through a piece of low-carbon steel that has been sherardized. This has been magnified thirteen hundred times and plainly shows the body of the steel, the zinc-iron alloy section and the pure zinc coating above. It should be explained that this photograph was taken of a section formed by cutting through the stock and polishing the surface.

Advantages of the Sherardizing Process

Sherardizing has advantages over other methods of zinc coating, which may be classed under two heads; first, the superiority of the product and second, the economy of the process. The fact that the zinc coating penetrates unlike any other method of zinc coating, and amalgamates with the iron, makes a finish that cannot be worn or eaten away. In addition, the coating is so evenly applied and so thoroughly driven into the surface of the metal that it does not alter the exterior of the article to any appreciable extent. In fact, sherardizing is perfectly practical for the protection of threaded screws of fine pitch and it is not necessary to recut them after the coating has been applied if a slight clearance

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[*] For additional information on sherardizing and other galvanizing processes previously published in MACHINERY see "A New Process for the Protection of Iron and Steel from Corrosion," November, 1904; "Cowper-Coles Galvanizing Process," December, 1905; "The Art of Galvanizing," February, 1908; "Sherardizing or Dry-galvanizing," August, 1908; "Machines for Sherardizing or Dry-galvanizing," December, 1909.

[†] Associate Editor of MACHINERY.

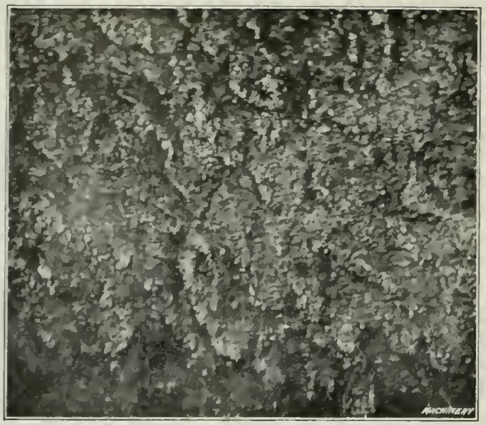

Fig. 2. Appearance of a Sherardized Coating magnified Seventy Times

is made when cutting the thread. Because of the nature of the process every part of the article treated is reached, the insides of tubes or sharp corners are coated just as thoroughly as the more exposed places. The depth of the coating may be controlled by the metallic percentage of the zinc dust, the length of time the heat is applied and by the temperature to which the retorts are subjected. There is no distortion of slender pieces or thin objects such as might occur when using the hot dip, because in sherardizing the heat is applied gradually and the work just as slowly cooled off.

The economy of the process is at once evident by the low heat required, the temperature of 500 to 600 degrees F. being far below the melting point of zinc, with is 786 F. Less zinc is required because none is wasted. The thin but thorough coating that is applied is just as effective as the thick rough coating that the hot galvanizing process gives. A sherardized coat of one-half ounce to the square foot affords more protection than a galvanized coating of one-and-a-half ounce to the square foot. No flux is necessary and the presence on the work of non-fatty oil in a moderate degree does not interfere with the sherardizing.

There is practically no limit to the metallic products that may be sherardized; in fact any articles that may be placed in the drum may be so treated. Oftentimes drums of special shape may be made to accommodate certain products. Screening, wire, etc., may be handled just as effectively as inflexible material by coiling it and placing it in that state in the drum. After sherardizing, the wire or screen may be straightened without injury to the coat of sherardizing.

Practically the only limitation to the sherardizing process is the fact that on very small tempered steel articles such as springs, the heat of six hundred degrees or thereabouts will draw the temper, leaving the metal in an annealed condition. On most work, however, this is not objectionable.

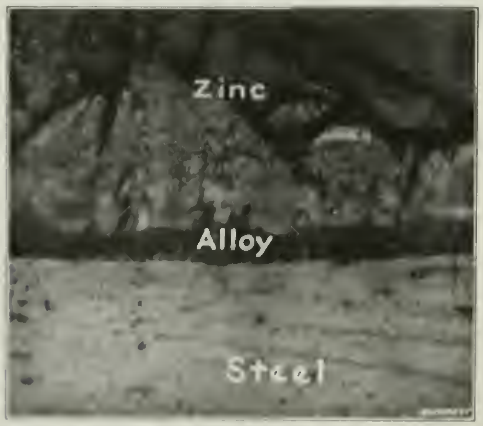

Fig. 3. Enlarged Cross-section Photograph through a Piece of Sherardized Steel magnified 1300 Times

The process of sherardizing is not confined to the coating of the product with zinc alone, but aluminum, tin, etc., are also used for sherardizing to good advantage. Zinc, however, is the leading metal on account of its ability to resist corrosion, due to its being electro-positive to iron.

Zinc for Sherardizing

The zinc dust used in the process of sherardizing is commercial zinc dust, of which at this time about ninety per cent is imported. On an average, the composition of this material runs about ninety per cent metallic zinc and ten per cent zinc oxide. Zinc dross is sometimes used, but not very successfully, as it will not alloy with the work being treated as intimately as the finely powdered zinc dust, although when the two are combined in equal parts they show good results. The best results are obtained when the zinc dust has been reduced to about fifty per cent metallic by the addition of spent zinc; therefore, new zinc should be reduced to that percentage as rapidly as possible.

Sherardized material requires a deposit of four pounds of zinc per hundred pounds of material treated, as an average. After the zinc has been reduced to the right percentage it may be held at that strength by simply replacing four pounds of new zinc for every hundred pounds of material treated, taking care that it is thoroughly mixed with the spent zinc dust. A chemical analysis of the dust in use once a month is recommended.

The Operation of Sherardizing

The basic patents for sherardizing are controlled in the United States by the United States Sherardizing Co. of New Castle, Pa. This company licenses subsidiary companies who, in turn, may license and instruct manufacturing companies in the art of sherardizing upon the payment of a royalty per ton of work treated by the process. Through the courtesy of one of these licensing companies, the New Haven Sherardizing Co., under the direction of A. F. Schoen, we are able to present an account of the operation of a sherardizing plant. The work illustrated in Fig. 1 was sherardized by this company.

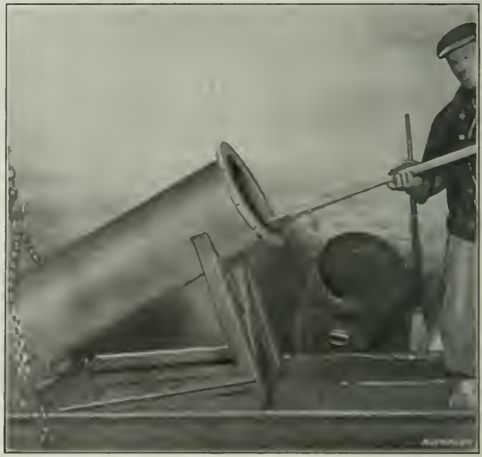

Fig. 4. Loading a Sherardizing Drum

Cleaning the Work

Sherardizing, like other zinc-coating processes, should have a clean surface to work upon. The presence of scale, rust or dirt greatly interferes with the sherardizing action. Machine products like screws and bolts require no cleaning other than an alkali dip. Sand-blasting is employed for cleaning relatively large pieces and an acid pickle is the common medium for removing scale. After cleaning with acid by the pickling process, the work should be thoroughly neutralized by placing it in a boiling solution of cyanide (mixture, one pound cyanide crystals to twenty gallons of water). A bright coating of zinc is assured, by taking these precautions.

The claim has been made that articles coming direct from the machine covered with oil can be sherardized without cleaning. This is true where no fats are used with the oil, and the zinc dust is new and of sufficient metallic strength to force itself through the oil. However, experiments along these lines have proved that after several operations, the material will come out very dark; therefore, considering the small cost of cleaning it should not be neglected.

Packing the Drums

The drums in which the work is packed with the zinc dust may be of any convenient shape and size to fit the furnace in which the work is to be done. The one shown in the illustration Fig. 4 is four and a half feet long and fifteen inches inside diameter. These are made of boiler plate with flanges at each end, upon which the end caps are bolted. In the event of the work being too long for the drum, two of these drums may be bolted together making an extra long drum. The operator shown in Fig. 4 is loading the drum with chains which he takes from the barrel that may be seen at the right. In the drum shown, about three hundred and fifty pounds of chain may be accommodated. The drums are filled in the same manner that a casehardening heat is prepared, first a shovelful of the zinc dust and then a shovelful of work is placed in the drum, and so on until the retort is filled to within about two inches of the top. This space is left to provide for expansion of the contents.

After the heads have been bolted on the drums, they are ready for the furnace. Fig. 5 gives an adequate idea of the way a sherardizing furnace is charged for firing. The laborer who fills the retorts, loads them upon a skeleton truck, the top of which has a cross track from which the drums may be rolled into the furnace by means of wheels slipped over their ends. It will be noticed that the drums are spaced and held by an angle iron frame. This view shows the square sockets in the drum-caps, by means of which the drums may be turned while the sherardizing is going on.

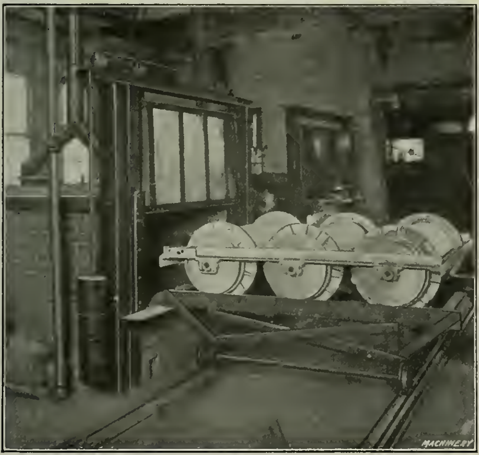

Fig. 5. Charging one of the Furnaces

The Sherardizing Furnace

The requirements of a furnace for sherardizing are not severe. On account of the fact that the maximum heat required to be imparted to the work is only from 500 to 700 degrees F., illuminating gas, natural gas, oil, coal or even coke may be used. The New Haven Sherardizing Co. is paying special attention to coke furnaces. In other lines of work coke furnaces have not been in general favor on account of the low amount of heat to be derived from this fuel, but as coke will give a sufficient heat for sherardizing, the economy of the coke furnace is apparent.

Figs. 6 and 7 show a new coke furnace made by the New Haven Sherardizing Co., for the purpose of sherardizing. This is a coke-burning furnace, although it can be used for soft coal or, in fact, any other fuel. It is especially valuable in urban districts where no liquid or gaseous fuel is available. The operating cost of this furnace is practically the same as for natural gas or producer gas. As Fig. 7 shows, it is made on the arch construction plan, employing a double arch. One of these arches is over the work chamber or oven and the second arch, which is larger, embraces the first arch and also the coke burning pocket at the side. Near the center of the arch over the work chamber, there are a number of rectangular openings. The heat passes up from the coke pocket to the top of the large arch, and is drawn downward through the rectangular openings into the furnace and onto the work. Each of these several openings is controlled by a separate damper whose handles may be seen at the left-hand side of the furnace in Fig. 6.

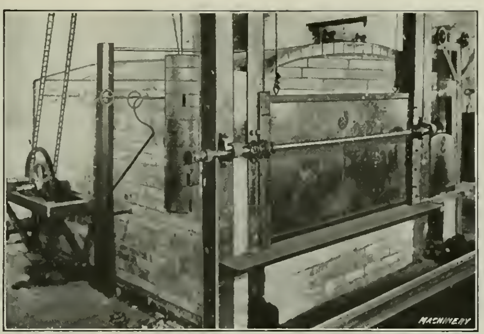

Fig. 6. A Coke-burning Furnace made by the New Haven Sherardizing Co.

The furnace has an automatic drum turning feature which provides for the turning of the sherardizing drums at stated intervals. Intermittent turning of the sherardizing drum gives better results than the continuous rotation practice that has been advocated by some authorities. The work is much cleaner and brighter if not continuously rotated during the sherardizing process. In those plants where continuous rotation is practiced, the drums are turned one revolution every two minutes. When turned by hand intermittently, the operation is performed as shown in Fig. 8. Short squared shafts extend through the furnace wall and into the sockets in the ends of the drums. Every fifteen minutes the drums are given a half turn to mix the contents thoroughly and allow the heat and zinc to have access to all parts of the work. From the above, it will be seen that there are three methods in vogue for turning the sherardizing drums while under heat: *viz.*, continuous rotation, automatic intermittent turning and intermittent turning by hand. Above the squared shafts shown in Fig. 8 may be seen the pyrometer that indicates the furnace heat.

The temperature at which the furnace is kept varies according to the size of work being sherardized. From five hundred to seven hundred degrees F. marks the range limits, large work requiring the higher heat. The drums are kept heated for a period varying from four and one-half to five hours, ac-

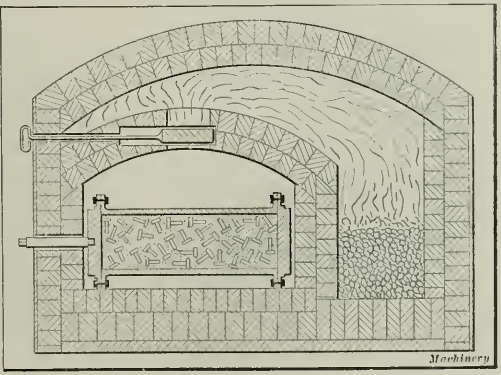

Fig. 7. Section through the Coke Burning Furnace

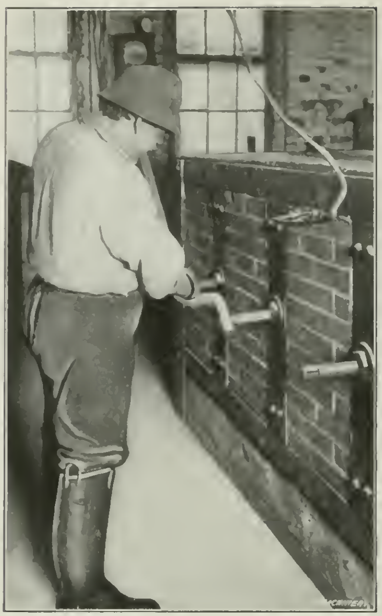

Fig. 8. Turning the Drums

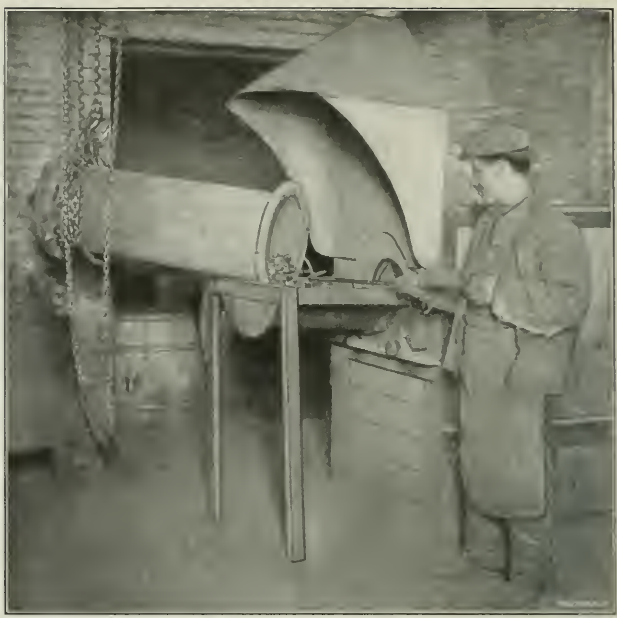

Fig. 9. Removing the Sherardized Work from the Drum

cording to the depth of the sherardizing coat that it is desired to give the work.

Removing the Work

At the end of the prescribed time that the drums are kept under heat, they are rolled out of the furnace and allowed to cool slowly until they may be handled without inconvenience. The unloading operation is shown in Fig. 9. For this operation, the drum is hoisted to the mouth of a rotary screen and there emptied, the contents passing through the rotary screen. The work emerges at the outer end, while the zinc dust drops through the screen and out of the way. From the illustration it will be seen that the mouth of the screen leads out of a forge-like structure that catches the work as it is pulled from the drum and allows the floating dust to be carried away in the exhaust overhead. The work emerging from the farther end of the screen is caught in a second screen and the process repeated until at the end it is perfectly clean and free from all zinc dust.

The Cost of Sherardizing

There are four charges that enter into the cost of sherardizing. First is the royalty that must be paid to the owners of the process, second the labor cost, third the cost of the zinc dust and fourth the fuel charge. The royalty is in all cases approximately $2.50 per ton of material sherardized. The cost of the zinc dust required for a ton of work varies with the size of the work but is approximately $5, based on the use of eighty pounds of dust at 6¼ cents per pound. The labor cost for handling a ton of average work would be about $3. The fuel cost varies, being for producer gas $1.75 per ton, for illuminating gas $4 per ton, for natural gas 75 cents per ton, for crude oil 90 cents per ton and for coke 75 cents per ton. From these figures it will be seen that expense is no barrier to the use of this most efficient of rust-proofing processes.

* * *

COMPARISON OF HARDNESS TESTING APPARATUS

In experiments undertaken by M. Portevin, for the purpose of investigating the effect of heating steel for hardening in salt baths, an interesting characteristic of the Shore scleroscope test, as compared with the Brinell hardness test, was brought out. As is well known, the Brinell test consists in pressing a ball into the object the hardness of which is to be tested, the size of the depression under a standard pressure being a measure of the hardness. The Shore test consists of dropping a weight provided with a hard point upon the surface and the amount of rebound of the weight, as measured on a scale provided with the instrument, is the indication of the hardness. For many purposes, the Brinell test is considered the standard, and is generally acknowledged as being based on a more scientific principle than that of the Shore scleroscope, but for measuring surface hardness, as it was necessary to do in the experiments referred to, the Brinell method proved entirely inefficient and the scleroscope only gave reliable readings. The surface of the steel had been decarbonized for a depth varying from 0.07 to 0.060 inch. The Brinell test with a ball of 0.400 inch diameter gave practically the same readings for steel decarbonized only 0.07 inch as it gave for steel decarbonized for a depth of 0.060 inch, but the Shore scleroscope, which measures specifically the surface hardness, that is, the hardness of the layer of decarbonized material as considered apart from the total hardness of the whole specimen, showed very distinctly the soft condition of the surface. When the decarbonized surface was only 0.07 inch it showed a hardness of 80, while with a decarbonized surface of 0.060 inch the hardness on the scleroscope scale was only 32.

Two very important conclusions as regards the value of the scleroscope and the Brinell test for hardness testing can be drawn from these tests. In the first place, the scleroscope indicates primarily the surface hardness, and in a case where one is concerned with the total hardness of the material rather than with that of the thin layer on the surface, as, for instance, in testing ordinary structural material, the Brinell test is more accurate and dependable. On the other hand, when one is primarily concerned with surface hardness and less with the hardness of the main portion of the body being tested, as is the case with cutting tools or hardened objects generally, then the scleroscope appears to give a more reliable result. This conclusion agrees with the statements made many times by scientists and those that have occasion to test the hardness of materials, that both the scleroscope and the Brinell systems have their distinct fields of usefulness and that neither is likely to supersede the other.

* * *

One of the most expensive woods used regularly in an established industry in the United States is boxwood, the favorite material for wood engraving. It has been quoted at four cents a cubic inch, and at about $1300 by the thousand board feet.

DIE-CASTING MOLD FOR BALL BEARING SEPARATORS

There is one annular ball bearing on the market that differs from the general run of bearings in that the balls are closely spaced, being within 0.010 inch of each other in some sizes. This, of course, is an advantage to the bearing, as the load is distributed over a larger number of balls. To keep the balls in their correct running positions, a cast alloy separator is used, and a group of these separators for different sized ball bearings is shown in Fig. 1. These are made by the die-casting process by the German Bronze Co. of Erie, Pa., through whose courtesy the photographs of the molds shown in Figs. 2 and 3 are illustrated.

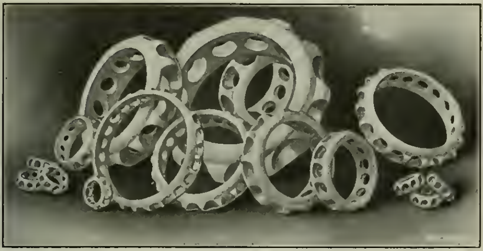
Fig. 1. Die-cast Ball Separators

In common with most die-casting molds, the molds for these separators consist of two halves. The parting line on the casting comes in the exact center, bisecting the casting at the center line of the holes for the balls. In order to form the cavities for the balls, it is necessary to have a set of cores that may be thrown into an inner position while the casting is being made. Provision must also be made for removing these cores quickly so that the casting can be taken from the mold. Fig. 2 shows the two halves of the mold with the core-pins withdrawn to permit the casting to be taken from the mold, while Fig. 3 shows the lower die half with the core-pins in the casting position. Aside from the core-pins and the operating mechanism, the two halves of the casting mold each resemble the upper half shown at the right of the illustration, Fig. 2. In this illustration it will be seen that there are semicircular openings in the outer ring, and these, in conjunction with similar openings on the lower half, form the circular openings in which the cores work.

As this particular mold is for a separator for a twenty-five ball bearing, there are twenty-five core-pins *A*. These core-pins are operated by core-slides *B* that work in a cast-iron body seen at *C* through the slots. The core-slides are each fitted with roller studs *D* that engage in the slots in the core operating plate *E*. The long handle shown at the top is used for swiveling the core operating plate, and as the slots are inclined their action on the roller studs causes the core-pins to be thrown in or out in accordance with the direction in which the handle is moved. It will be appreciated that these core-pins and their operation are the important part of the mold. They must fit accurately in their bearings, but, most important of all, they must advance positively to the same limit each time the mold is closed; otherwise the cavities in which the balls operate would be of different depths. This is taken care of by having flanged ends to the core-pin slides, which act as stops and limit positively the advance of the core-pins. There is a chance for adjustment of the core-pins to increase or decrease the lengths to which they work into the molds. In making the mold, the inner ends of the core-pin were formed with a special forming tool that made them exactly alike and of the proper shape.

The making of one of these molds complete represents a total of approximately 350 hours' time. The operation of the mold is very successful, and the operator is able to turn out a substantial quantity per day. C. L. L.

* * *

ONE WAY OF LOSING THE STANDARD SIZE

BY A

Manufacturers of small tools very often receive orders for taps to duplicate a sample tap which is sent for the purpose. In itself, this is nothing unusual and little difficulty is encountered so far as the tap manufacturer is concerned, a possible exception being in the case of a sample tap which has an odd number of flutes or some such feature which makes it hard to obtain the correct dimensions. But when a repeat or duplicate order comes in, trouble begins. Another sample tap is sent with the order, and this would be all right provided the *same* tap were sent for both the original and the repeat orders. Such, however, is seldom the case, as it generally happens that the sample accompanying the second order is one of the taps made on the original order. In ninety-nine cases out of a hundred the taps made on the first order are of a different size from the sample, usually being larger.

After this performance has been repeated a few times, it is obvious that the last lot of taps will be several thousandths inch larger than the first sample, although the taps made on each separate order were well within commercial limits of accuracy, as compared with the sample sent, so that there is no just cause for complaint. The trouble caused by sending taps as samples to work from and thus losing the original standard is due to the fact that no matter what the tap maker is working to—either figures or samples—he always makes his limit *larger* than the specified dimensions. If a tap is made under size from a sample, it will invariably be rejected because a piece that is threaded standard size will not enter the tapped hole. If, on the other hand, the tap is made 0.001 inch larger than the specified dimensions, the tap will be accepted, as a standard threaded piece will go into the tapped hole with the same apparent amount of play as it entered a hole machined with one of the original taps. This emphasizes the importance of sending gages or specified dimensions for the tap maker to work from instead of sample taps.

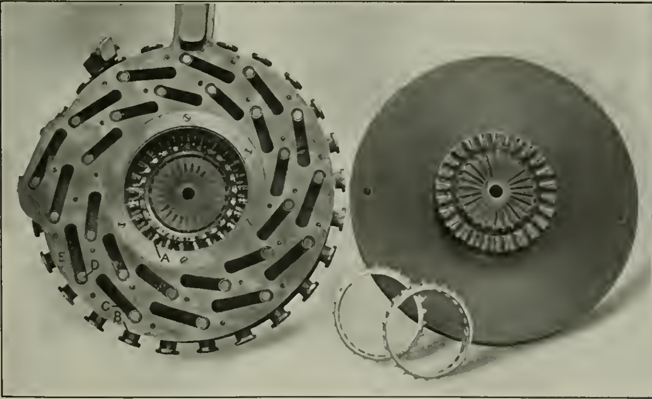

Fig. 2. Two Halves of Mold showing Cores withdrawn

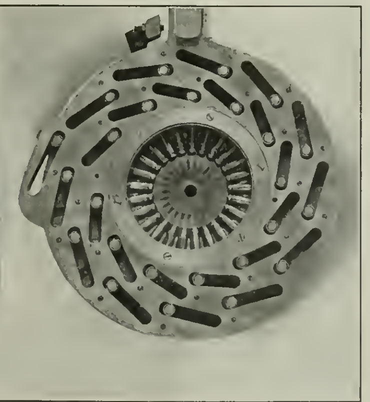
Fig. 3. Lower Half with Cores in Position for Casting

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JANUARY, 1915

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WORKING FOREIGN PATENTS

The war which has paralyzed commerce with Germany and other European countries has directed attention to a grave defect in the United States patent laws. Patents granted to inventors by most European countries require the manufacture in that country of the article covered by the patent within a specified time; but no such clause appears in the United States patents, so that many foreigners whose works are located in Europe enjoy patent protection in the United States without the necessity of manufacturing here.

Some of our industries were in consequence nearly paralyzed with the cessation of over-sea commerce, because the materials necessary for carrying them on are controlled by foreign manufacturing concerns holding United States patents but not working them in this country. Our patent laws were enacted for the purpose of stimulating invention and manufacturing, and are based on the theory that the public will benefit from the unrestricted rights to manufacture or use at the expiration of the patent term. If, however, our people are barred from all participation in the benefits of manufacture within our borders during the term of a patent because it was granted to a foreigner, and in times of stress like these we can neither buy the patented product from abroad nor make it here, the injustice is apparent. Congressional action should be taken without delay to remedy this condition.

* * *

THE MEANS OF DESCRIPTION

The faculty of speech enables men to communicate ideas to one another. The knowledge acquired by one is imparted to others through the medium of language, and no individual is dependent for what he knows on what he can personally observe in his own lifetime. On the contrary, he can draw freely from the store of knowledge common to all mankind. The faculty of language is the most potent factor of uplift in the evolution of man.

One of the most important services rendered by a technical journal like MACHINERY is in affording readers the means of description. To be able to intelligently discuss a machine and its parts, to describe each part accurately in terms commonly accepted, marks the difference between the well-read and the uneducated mechanic. The uneducated mechanic resorts to similes and comparisons that are often vulgar and grotesque, but the well-read mechanic can speak in correct descriptive terms, and illustrate what he means by drawing, which is a graphic method of description.

If the average reader gained nothing else from perusing MACHINERY's pages than the faculty of accurate expression and concise description, he would be well repaid for his trouble. Stop and think what it means to be able to name every part of a machine, to describe its function and its relation to the function of the machine as a whole. It is a great accomplishment and one that every man interested in any phase of mechanical work should endeavor early to acquire. One of the best ways of developing the faculty is writing, for we never know a subject even superficially until we try to put it on paper. Then we find how little we know about it; we discover the gaps in our knowledge that must be filled before a complete and accurate description can be written.

* * *

VALUE OF ORGANIZED SAFETY WORK

What organized effort can accomplish in eliminating accidents in rolling mills is indicated in a bulletin issued by the Illinois Steel Co., one of the constituent plants of the United States Steel Corporation. The effective work of the safety committee in the slabbing mill is reflected in the fact that this mill had no "lost time accidents" in the first seven months of 1914, although more than 125,000 tons of product were rolled. Accidents in the two plate mills were reduced approximately 65 per cent in the same period, as compared with the previous year.

Humanity learns its lessons chiefly by experience, and vicarious sacrifices have always seemed necessary to change ways that were wrong or dangerous, but cooperation and intelligent application of the lessons learned should materially reduce the accident toll of the future. Acting on this theory, the bulletin briefly describes accidents and calls attention to the errors of practice that caused them. The value of this is twofold. In the first place it warns men, foremen and superintendents of unsuspected dangers, and in the second place it stimulates them to avoid accidents for fear of being made the subject of a stinging sermonette in the next number of the bulletin. Organized safety work educates the men to avoid dangers, and it stimulates those responsible for production to develop discipline tending to lessen accidents throughout the plant.

* * *

CONSERVATISM IN REDESIGNING MACHINE TOOLS

One of the difficult questions for a manufacturing concern to decide is to what extent its product should be changed and improved from year to year. Changes of models and improvements are costly, not only in the first development, but in the manufacture. Manufacturing cost can be reduced to the lowest terms only when the equipment is devised solely with the view of specialization on one product. Even when a manufacturer is building one product, if he has a variety of models complication and loss of efficiency may ensue.

In the machine tool field, the temptation is strong to constantly improve and change existing models with the idea of attracting new customers. A concern that always has something new coming along is interesting and progressive, but in the light of hard, common sense it may not always be working for profit. One of the most successful automobile manufacturers has stuck closely to one model of machine, although hundreds of thousands have been built and the suggestions for changes have been many. This manufacturer had the backbone and the good business sense to stick to his model and improve his manufacturing methods rather than the product.

While conditions are of course different in the machine tool field, there is no doubt that many machine tool builders should devote more of their energies to the improvement of manufacturing methods rather than to the improvement of the product. The fact is that many so-called improvements are of doubtful value. Many devices applied to machine tools with the alleged purpose of facilitating output are rarely or never used by the operator. They are talking points used mainly by persuasive salesmen to influence a decision in favor of his company's product. If the same manufacturer had improved his manufacturing methods so as to put his machine on the market at a lower cost, and at the same time use the very best materials available in its construction, he would be in a stronger position. Even though his selling price were lower, his reduced manufacturing cost would provide a margin between that and the selling price liberal enough to employ the best salesmen available. It is unfortunate that selling expense is so large a percentage of the price, but the successful manufacturer recognizes the conditions and adapts himself to them.

* * *

CAR COUPLINGS IN INDUSTRIAL PLANTS

Great improvements have been made in large industrial plants in promoting the safety of life and limb of employes, but much still remains to be done. One important improvement which would prevent the crippling of employes of industrial railroads is the adoption of some form of automatic coupler for industrial cars. The use of automatic couplers for railway cars has resulted in a greater saving of life and limb than any other improvement in railway operation except the air brake.

In steel plants, especially, are automatic couplings required for ingot and other small cars. The coupling and uncoupling of these cars is repeated many times a day, and the operation is always fraught with danger to some employe. There is no reason except that of initial cost for neglecting to make this improvement, for the time saved would alone make the change a paying one. It is generally conceded that the greatest loss of life and limb in coupling railway cars was in switching, and in industrial plants this class of service preponderates. In fact, it may be said to be practically 100 per cent of the service. Many of the state legislatures have passed laws intended to protect the lives and limbs of workers, and they should take this condition of large plants under consideration. Many thousands of small cars are used that are fitted with the old link-and-pin coupler, and this dangerous device—a veritable man-killer—should be replaced by automatic couplers, which would make unnecessary the entry of the employe between the cars to couple or uncouple.

* * *

SELLING PATENT RIGHTS

Often we are asked to recommend some individual or concern supposed to be in a position to sell a patent on an invention; but it is impossible to give definite information because no agency exists that can render such a service for patentees generally.

Selling patents is very different from selling machines or real estate. The range of things covered by patents is almost unlimited, and capitalists, manufacturers and others interested in promoting inventions for profit are widely distributed in enterprises of every description or attached to none at all. The work calls for innumerable experts. A person qualified to sell patents on shoe machinery would hardly be able to handle machine tool improvements or agricultural implements successfully. The technical side of a patent selling business would alone require encyclopedic knowledge in a person qualified to sell all kinds of patents, and the commercial side would demand a practical acquaintance with commercial conditions in almost every trade.

An inventor with ability enough to work out a practical and valuable invention should be able to apply his powers with equal energy to effecting such relations with others as will result in making his invention profitable. That such a combination of the inventive and commercial faculty rarely exists is not equivalent to saying that it cannot be developed. It can be; and a man who finds himself in possession of the inventive faculty should carefully study the commercial prospects and conditions and learn how to secure financial cooperation for his ventures. To merely invent is not sufficient; the inventor should be able to produce the children of his brain in shape for others to enjoy. The one who brings an idea into commercial form and places it within the reach of all is worthy of more recognition from every point of view than he who simply conceives the idea.

HINTS ON SELLING MACHINE TOOLS

BY C. H. S.

Although the bulk of the machine tools manufactured in this country is sold through dealers who sell iron working tools exclusively, a goodly portion is disposed of by jobbing houses who handle a general line of railway, mill and factory supplies. This article is intended particularly for the dealer who has not sufficient business of this nature to warrant him to employ a man exclusively on this work, but it is hoped that others engaged in the sale of machine tools may find a few suggestions that will help them increase their sales.

Possibly the first suggestion to the small dealer should be to select a line of tools that is best suited to the majority of the trade he expects to deal with. In other words, a line of cheap tools should not be considered in a manufacturing territory any more than a high priced line should be offered where the dealer has only small repair shops and garages to sell to. This selection should be made very carefully, in fact it might be well to tabulate a list of the possible customers in the territory. If this tabulation showed that 75 per cent were the kind that could not afford to buy the high grade tools it would appear advisable to take on a low or medium priced line. On the other hand, if a third of one's hoped-for customers were manufacturers, by all means take on the line of tools adapted to manufacturing purposes. Remember that shops engaged in manufacturing naturally grow in size and their tool purchases increase correspondingly, while the average repair shop after once being fitted out may not buy additional equipment for years.

After having sized up your territory and satisfied yourself that a certain class of tools will meet with favor in your particular trade, then take on tools in that line that are universally advertised. The fact that they are extensively advertised will not only help you in your sales, but it is pretty good proof that the tools are just what the manufacturers claim for them. The reason for this is that honesty in advertising machinery has been brought up to a higher standard than it ever has before, and it would now be considered very poor business to claim more for a tool than it can properly perform. After making the right selection stick to it through thick and thin. Do not offer a competing tool just because a customer prefers it or because the price is lower. Success in marketing machinery is dependable to a great extent on how closely the head of the business adheres to this policy. By so doing he secures not only the confidence of the manufacturer he represents but the customer's confidence as well. The manufacturer knows he is getting the representation he expected and the customer soon learns to respect the dealer who believes in the machines and tools he is selling, and is conscientious enough to offer his particular line regardless of whether he secures the order or not.

Assuming that the dealer has selected a line of tools that is extensively advertised, he should at once subscribe to the magazines or trade journals that carry most of the advertising that he is interested in. A copy for each salesman and a couple of office copies is not an extravagance by any means. The salesman should be instructed to read all of the advertisements carefully, not only of the tools he is selling but of competitors' tools as well. Thus he learns what his competitors are offering and he is better able to meet their competition. One thing to remember in the selling game is that it is just as important to know your competitor's product as it is to know your own, for in no other way can a salesman offer his wares intelligently.

Frequently the salesman's knowledge of a competitor's line will keep him from stating facts concerning his own that he would not mention if he knew what the other fellow was offering. This is not the only reason for suggesting that each salesman peruse the advertising pages of the machinery journals. He not only keeps informed of the progress of the different manufacturers in this way, but the suggestions continually appearing in the advertisements concerning improved methods of jigging and handling work, proper feeds and speeds, numerous testimonials, pictures of recent installations and names of large users all go to make up the most important selling information that can be put in a salesman's hands. All advertisements of any importance should be cut out, carefully indexed and filed away. The office copies should be used for this. In a year or two the salesman will be surprised at the fund of valuable information accumulated.

It is a good thing for the small dealer to keep his principals informed concerning any important deals in his territory. If competition is keen on a certain prospect get the manufacturer to send you comparative data on his tools and the other fellow's. Frequently there is information in such data that cannot very well appear in the catalogues or advertisements because of its semi-confidential nature, but if offered judiciously by the salesman it may help him to "cinch" a sale. Now that most manufacturers of machine tools have service departments which will gladly go over a prospective customer's blueprints or samples and make time estimates and offer suggestions as to the best methods for handling the work, do not be afraid to call upon your manufacturers for this information. Remember they are specialists in their respective lines while you, on account of the varied nature of your work, cannot hope to be.

* * *

AN EIGHT DOLLAR STRADDLE MILLING FIXTURE

The accompanying illustrations show a straddle milling fixture that was built for the operation of squaring the ends of short lengths of brass rod stock. The diameter of the bar was one-half inch and the finished squared section was $\frac{3}{8}$ inch diameter and squared to a depth of $\frac{1}{4}$ inch. The fixture and method of operating are shown in Figs. 1 and 2. A base block is bolted to the table of the hand miller, and in its top face a square bottomed recess is bored $\frac{1}{8}$ inch deep and of the same diameter as the part to be milled. A $\frac{3}{8}$-inch slot $\frac{1}{4}$ inch deep is milled into this depression from the side of the block. A gripping jaw is fitted into this slot, so that, when the handle is pulled upward, the jaw is forced inward and downward at the same time, thus gripping the piece and holding it against the bottom of the depression.

The gripping handle also serves as a means of changing the position of the fixture and work with relation to the cutters. One of these positions is shown in the illustrations and the fixture is swiveled against a pin and held there while the milling is being done, operating the table with the left hand lever. As soon as one cut is taken, the operator draws the table from the milling cutters and swivels the fixture with his right hand into a position at right angles to that formerly occupied. The second cut is then taken, and after again drawing the fixture from the cutters, he depresses his right hand thus releasing the grip on the work. It is thus thrown out and a new piece held. The milling is done on a Carter & Hakes hand milling machine. The operator is allowed to make $1.75 per day, and he gets four cents per gross for doing the work. Therefore it will be seen that approximately forty-four gross or over 6300 pieces represents a day's work, and the fixture cost less than eight dollars to build! C. L. L.

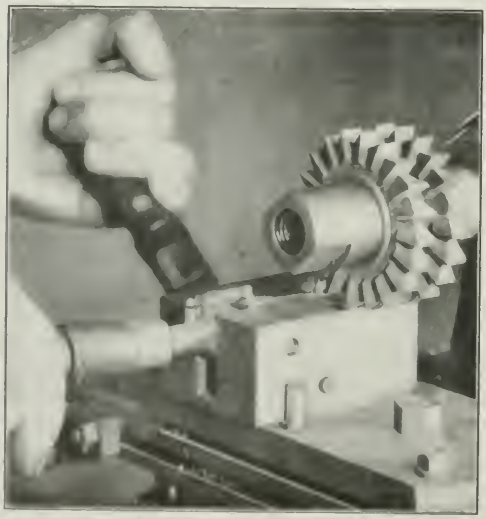

Fig. 1. Rapidly Operated Straddle Milling Fixture

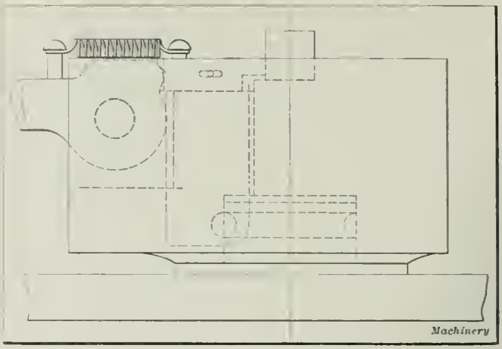

Fig. 2. Construction of Straddle Milling Fixture

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SELECTION OF WHEELS FOR CYLINDRICAL GRINDING

BY C. H. NORTON*

I have read with interest an article by F. B. Jacobs in the October number on the selection of wheels for grinding. It would be interesting to some of us who are following for our life's work, and have been at it for thirty years, the grinding of cylindrical and other kinds of grinding wheel work to know just what Mr. Jacobs' connection with grinding is.

I am aware that many times—perhaps always—it is very difficult to make clear to the novice certain truths in regard to any specialty, and I will refrain from starting an argument in MACHINERY in regard to this, for the reason that the subject is so deep and has connected with it so many things that must be understood by both parties in the discussion before any good can come from such a discussion. I will, however, state as positively as Mr. Jacobs has that the depth of cut, work speed, width of wheel, etc., do have a very marked effect upon the grade and grain of wheel for any kind of grinding—both in finishing and production.

In another place Mr. Jacobs seems to discredit nearly all grinding wheel makers and grinding machine makers because one grinding wheel maker says you should finish with a fast work speed and another says that you should finish with a slow speed. I do not know where he got the idea that the Norton Grinding Co. said you should finish with a slow speed. I never said so, but did say and will say now that in a great many cases grinding with a slow work speed is a very good way to finish, and in order that the readers may not be confused about this, I will state that it is an absolute truth that you can finish work both ways if you want to. The reasons for selecting a slow or a fast speed at different times can be understood by no one except those who are thoroughly familiar with the art of grinding, and there probably is not space enough in one issue of MACHINERY to contain a thorough description of the art of grinding.

These discussions I consider fruitless and misleading, and it is questionable whether your readers are benefited by them, simply because no one writer can understand everything; and that is one great reason why I, even after thirty years of experience, have refrained from writing oftentimes upon this subject. I realize that I learn something every day and also that your readers, looking from different viewpoints, will be very likely to misconstrue what is written. The art of grinding is broader in its scope than the art of turning, planing, boring or almost any of the machine operations, and it has not yet been reduced to a science. But there are certain truths which are settled probably forever, and one of these is that the depth of cut and surface speed of work do affect the grade and grain of the wheel.

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* Mechanical Engineer with the Norton Grinding Co., Worcester, Mass.

AUTOGENOUS SOLDERING OR WELDING OF ALUMINUM*

FLUXES FOR WELDING—MAKING WELDS WITH OXY-ACETYLENE TORCH—WELDING ALUMINUM-ZINC ALLOYS

BY FOREMAN JOINTER

THE term "autogenous" used in soldering or welding is one which is largely misapplied, except in the case of jointing lead, iron and steel. When the process is applied to aluminum a flux is absolutely necessary (a flux is also commonly used with iron); hence the use of the word "autogenous" is not quite accurate, although it has come to be generally accepted. The terms "autogenous soldering" and "autogenous welding" are somewhat similar, and variously applied; hence the need of a modern mechanical dictionary. Autogenous soldering or welding is sometimes spoken of as something modern, but as a matter of fact, the Romans used it a century or two B. C. for the jointing of lead pipes. However, the process of autogenous soldering or welding by means of the oxy-acetylene blowpipe only dates back to the year 1900.

Autogenous soldering, in the writer's opinion, is a form of welding in which the surfaces to be united are actually fused or melted, thereby causing them to flow together so as to form a strong union. The process is thus more akin to welding than to soldering proper; hence, in this article it will be defined as welding. Until the method of jointing aluminum by autogenous welding was perfected, its use was more or less restricted to those cases where jointing was of no great importance, or, not needed, but with the introduction of the oxy-acetylene system of blowpipe welding, the industrial applications of aluminum have received an enormous impetus, and it has not only supplanted other metals but various other materials in many branches of modern industries. The welding of aluminum joints, obviously, makes a much stronger and more intimate union than soft soldering, no interposition of any foreign metal being employed; hence the expansion and contraction of the finished part is uniform. This method is now extensively employed, as satisfactory welded joints are obtainable readily. It had long been recognized that this was the most hopeful direction in which to experiment, because such joints, containing as they do nothing but aluminum, would be as free from subsequent galvanic action as the metal itself; but the difficulty met with was in removing the oxide with which the metal is normally coated. However, this has now been overcome by the employment of suitable fluxes which have been put on the market. These vary considerably in quality, but several good fluxes now obtainable are capable of dissolving the film of oxide and permit the parts of the metal to flow satisfactorily together. The credit of having first welded aluminum must be conceded to the firm of Heraeus in Hanau, Germany, who exhibited at the Paris International Exposition in 1900 a number of aluminum articles which had been welded by means of a special process (German patent 118,868).

Fluxes for Welding Aluminum

In welding aluminum the most important factor in the process is the flux which performs the function of dissolving the oxide at the low melting point of the metal and, at the same time, protects the hot metal from contact with the air. To produce a flux that will remove the oxide film has not been a simple problem to the chemist and engineer, and only during the last few years have such fluxes been obtainable. When it is explained that while the melting point of metallic aluminum is 657 degrees C., that of the oxide is nearly 3000 degrees C., the difficulty of this problem no doubt will be appreciated. As in the case of soft soldering, the rapidity with which the flux acts is an important factor in its utility.

Many fluxes for welding aluminum are employed with satisfactory results, consisting chiefly of the following ingredients in varying proportions: aluminum chloride, lithium chloride, potassium chloride, sodium chloride, and calcium chloride; also aluminum fluoride, calcium fluoride, potassium fluoride, etc.

Welding Aluminum with Oxy-acetylene Torch

In welding aluminum with the oxy-acetylene blowpipe, it is essential that the acetylene and the oxygen used must be in a state of high purity, as at the great temperature of the welding flame, aluminum tends to absorb nitrogen, and if this impurity exists in the oxygen it will render the work brittle and unreliable. It is known to those who have attempted to weld aluminum by means of the oxy-acetylene flame, that when two pieces of the metal are to be welded together at their edges, the melted parts do not flow together properly, as in the case of iron where the melting point of the oxide is lower than that of the metal. The molten aluminum spreads in spherical form under the influence of the welding flame. These metallic pellets consist of pure aluminum within a coating of alumina (oxide of aluminum) which has great power of resistance to the flame, and on cooling, the edges of the metal remain unjoined; hence the need of a flux to remove the oxide film and permit the fused metal to flow satisfactorily together.

When welding aluminum, it is essential to guard against undue expansion and contraction by preheating and annealing effectively. The low temperatures dealt with when welding aluminum make the preheating easy, but care must be taken not to exceed the fusion temperature, as the fluidity of aluminum necessitates the employment of great dexterity to prevent the deformation of the metal under the blowpipe. When melting new metal for filling the joint, on aluminum 1/8 inch in thickness or more, one end of the feeder should be constantly submerged in the molten metal in the welding groove. By this method, an experienced welder, by judicious and rapid movement of the blowpipe flame, can completely prevent burning and, at the same time, effect a perfect weld. It must be remembered, however, that the fusion point of this metal is very low; hence the welding flame should be kept further away from the metal than is usually the case when welding iron or steel. The flame should be so adjusted as to furnish a slight excess of acetylene.

When welding small articles by the oxy-acetylene welding flame, the operator is confronted with several difficulties, especially if the articles are manufactured of sheet aluminum, as the expansion and contraction due to temperature changes is very rapid; therefore, the operator must guard against distortion of the work. Holes are also liable to be made in thin metal, particularly if due care is not taken, although an experienced aluminum welder can effect satisfactory welds in sheet aluminum 0.008 inch in thickness.

Some specimens of sheet aluminum which have been joined by autogenous welding are shown in Fig. 1. The aluminum sheet *A* is 0.064 inch thick and was welded by a beginner, with the oxy-acetylene torch. The weld *B* has a good appearance on the top surface, but thorough fusion has not occurred. Good fusion welds are shown at *C* and *D*; the aluminum sheet *C* is 0.048 inch thick, and *D*, 0.116 inch thick. The flanged weld *E* was improperly made; thickness of aluminum, 0.048 inch. The flanged weld *F* was properly made and afterward hammered.

When making a butt-weld on thin sheet aluminum it will be found advantageous, if the position of the work is suitable, before abutting and jointing the two pieces, to turn the edges up at right angles so as to form sufficient excess of metal for filling in the joint. By this method it will clearly be seen that heterogeneous metal does not enter the weld, the joint being entirely composed of metal identical with the surfaces to be joined. Feeders of doubtful quality should be avoided.

Tests of welds effected by the oxy-acetylene process on commercial sheet aluminum 0.094 inch thick have recently been made. These welds were very brittle, although they had been made by an expert in welding sheet aluminum. The feeder used as added metal was pure aluminum, and the de-oxidizing flux employed had never given rise to such a difficulty previously. The abnormal brittleness found in the welded test-pieces, it was concluded, was attributable to the impurities in the metal. This brittleness is also found in pure sheet aluminum, although in a somewhat lesser degree. It is known that in the process of welding, internal strains are inevitably set up, the physical and mechanical properties of the metal being altered; therefore, in order to obtain a perfect and homogeneous weld it is desirable to reheat the metal from 450 to 500 degrees C. This causes molecular rearrangement to take place within the metal and sets up greater homogeneity in the weld zone, thus eliminating the effect of the excessively rapid heating undergone during the welding process, and, consequently, improving the quality of the metal.

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* For articles on this and kindred subjects, see "Soldering and Brazing Aluminum," December, 1914; "Electrical Soldering," June, 1914; "Autogenous Welding or Autogenous Soldering," April, 1914; "Manufacture of Tubing by Autogenous Welding" and articles referred to, January, 1912.

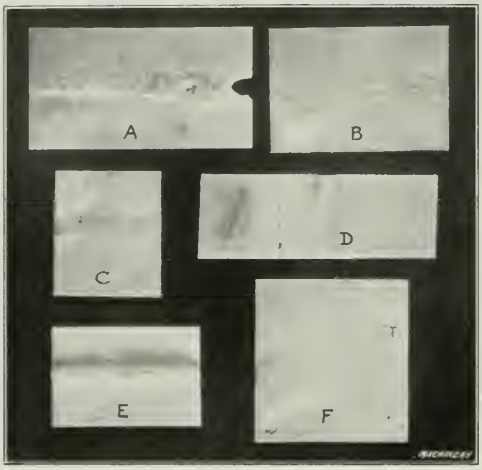

Fig. 1. (A) Weld made by Beginner. (B) Fusion not Thorough. (C) A Good Weld on 0.048-inch Stock. (D) A Good Weld on 0.116-inch Stock. (E) Flanged Weld improperly done. (F) A Hammered Flanged Weld

The success of welding aluminum autogenously depends to a great extent on the intelligence and ability of the operator. It is possible for a competent welder, at his own discretion, to give a greater or less strength to the welded part, and for this reason it is impossible to draw conclusions from the work of one operator as to the work of another. An expert in aluminum welding is distinguishable by his tact in the preparation of the surfaces to be welded; judgment in preheating and reheating (or annealing) of the work; the choice of a well constructed blowpipe; the determination and maintenance of the correct proportions of oxygen and acetylene issuing from the nozzle of the blowpipe; in the entire application of the system; the estimation of the area to be fused in each partial operation; the manipulation of the welding flame at the right moment when fusion has proceeded so far that complete welding is assured; the dexterity in preventing the deformation of the metal under the blowpipe; and lastly, the rapidity and ease of the operation, thereby preventing the overheating of the metal and the avoidance of burnt welds.

The writer has often seen oxy-acetylene welding carried out efficiently on iron and steel by expert workmen, who, when transferred to the welding of aluminum, produced unsatisfactory work until they became proficient with the metal. Welding operators frequently undertake work on aluminum and its alloys without sufficient experience and fail in consequence.

Welding Aluminum-Zinc Alloys

Alloys of aluminum and zinc present much the same difficulties as are encountered in welding the pure metal. These alloys are now extensively used in the automobile, aeronautical and kindred industries where strength combined with lightness is a necessity. As with the pure metal, preheating and effective annealing are essential. A typical automobile repair job is shown in Fig. 2, which illustrates the crank-chamber or gear-case. The upper view shows the fractured gear-case, whereas the lower view shows the same case repaired by autogenous welding. In actual operation, the correct method is to preheat the article before welding, to about 400 or 450 degrees C., but the heating should be done slowly so as to obviate ruptures from unequal expansion.

Breakages during heating and cooling must be avoided, more so than in the case of pure aluminum, for between 500 and 550 degrees C. the alloys become friable and their tenacity practically disappears; without proper support a portion may easily break off during the heating process. Another advantage of preheating is that oily and fatty matters are expelled; these are often retained by the metal in considerable quantity owing to its porosity. When a repair is carried out too soon, the oil carbonizes and adheres to the edges of the metal to be welded, thus impeding proper coherence of the two surfaces to be joined.

During the welding process a special flux should be used, which breaks down the oxide, and prevents oxidation of the metal when under fusion. A compound containing the chlorides of potassium, lithium, sodium and other elements performs this function with success; many good fluxes are on the market. A typical patent flux consists of 60 parts potassium chloride, 6 parts cryolite (an aluminum sodium double fluoride), and 30 parts calcium chloride, but the proportions might be varied within considerable limits.

The added metal should have practically the same composition as the material being welded. The necessary alloys of aluminum and zinc are not always readily obtainable as feeders, especially in the form of strips, which are preferable, so that many operators use pure aluminum during the welding process. However, the adding of molten metal from feeders of pure aluminum should be strictly avoided; thus if an alloy containing, say 25 per cent of zinc, is being welded its melting point will be approximately 50 degrees C lower than that of the aluminum added, the result being increased difficulty in working, and incoherency of the parts rather than a true autogenous weld. Moreover, if pure aluminum is used the weld-zone will be softer and more flexible than the rest of the work, and this lesser resistance is a defect which should be avoided. In addition, the weld-zone, if too soft, will be almost certain to break out again, and it is essential that the added metal should contain a percentage of zinc, so that the weld-zone will have a hardness approximately equal to that of the rest of the article. The conditions as stated should be observed as nearly as possible if one wishes to obtain a true autogenous weld. It will be gath-

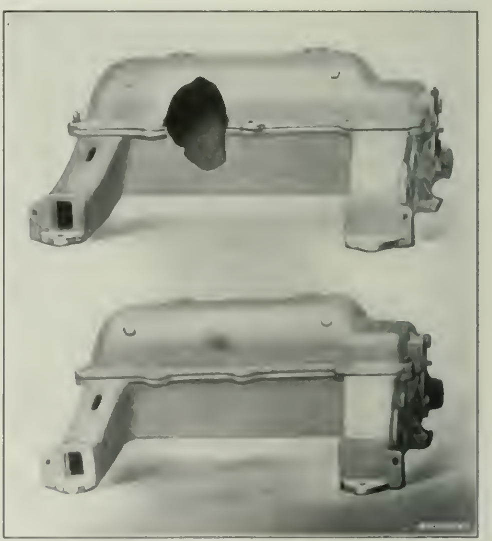

Fig. 2. Fractured Aluminum Gear Case before and after being welded with Oxy-acetylene Blowpipe

ered from the foregoing that perfect welds are thus readily attained in aluminum and the aluminum-zinc alloys by those having adequate knowledge of how to employ this new art correctly.

Practical Hints on Autogenous Welding of Aluminum

1. To weld aluminum properly and to make a thoroughly sound and homogeneous joint, requires skill and training and a knowledge of how to design and prepare the work for being welded, as well as to make the weld.

2. In order to obtain the best results in welding aluminum, it is essential that the acetylene and the oxygen should be in a state of high purity. Acetylene obtained from practically all small generators is impure.

3. Before attempting to weld, see that the blowpipe is in good order, and that the tubing is sound and securely fixed; also that the regulator on the oxygen cylinder is in proper working order and passing gas without fluctuation.

4. Be sure to have an ample supply of acetylene and oxygen before beginning to weld, as it is injurious to the weld to stop in the middle of the operation.

5. Remember that the melting-point of the oxide of aluminum is not only much higher than that of the metal, but it is also heavier than the molten aluminum.

6. Wear suitable glasses (smoked or colored) when welding, in order to avoid serious injury to the eyesight.

7. In order to relieve the metal from internal strains due to welding, preheating and reheating (or annealing) should be properly effected. These operations should be carried out in the absence of air, and where possible in a special furnace. When preheating and reheating, take the necessary precautions to avoid melting the metal; when heated above 500 degrees C. aluminum becomes fragile and is very easily deformed under its own weight.

8. Thoroughly clean the surface and edges of the metal where the welding is to be done, to avoid the impurities which set up automatic disintegration in the line of welding.

9. It should not be assumed that a blowpipe of any size is suitable for all thicknesses of aluminum; it is most essential to select a blowpipe of the right size. A blowpipe consuming 50 liters (1.76 cubic foot) or even 25 liters (0.88 cubic foot) of acetylene per hour can be employed satisfactorily on sheets 1/16 inch in thickness, whereas aluminum 1/4 inch thick requires a blowpipe consuming 700 to 800 liters (24.7 to 28.2 cubic feet) per hour.

10. Do not attempt to weld without a flux; in spite of all precautions that may be taken, a weld made without a flux is never perfectly homogeneous. It is only by employing a suitable flux which will cause the oxide to dissolve at the same temperature as the aluminum becomes molten, that a perfect weld can be obtained.

11. When making up powders to be used for fluxes, thoroughly dry the ingredients, so as to avoid their combination with each other and their shriveling up under the action of the blowpipe. (Unfortunately the best fluxes are hygroscopic and should be powdered before use as they are liable to become granulated).

12. The flux should not be thrown on the weld in excess, as the brazier does when brazing copper or brass; it should be added from the welding rod, by first warming the rod with the blowpipe flame, then dipping it into the vessel containing the flux, which readily adheres to the rod. It will then flow ahead of the blowpipe flame and "prepare" the metal.

13. Aluminum is not as readily welded as iron. In aluminum welding it is essential to remove the refractory oxide with which the metal is normally coated. The fluidity of melted aluminum is very great.

14. Do not be discouraged if you have successfully welded iron and have attempted to weld aluminum and failed; in order to obtain autogenous welds on aluminum a different mode of procedure is necessary. An iron welder generally finds it difficult to learn aluminum welding, since aluminum is to him a strange metal.

15. In a perfect weld the junction of the two pieces should have the same chemical composition and the same physical properties as the joined pieces. No line of demarkation should be visible under the microscope.

16. When preparing sheets or plates 1/8 inch in thickness or more, bevel the edges. The width of the V formed, when the edges are together, should be at least as great as the thickness of the work; the beveling should be done right to the bottom edge, so as to enable the metal to be melted throughout its entire thickness.

17. The diameter of a welding rod should, preferably, be about equal to the thickness of the metal. In practice, feeders above 1/4 inch in diameter are not advisable. A very useful form of feeder is an aluminum rod with a core of the welding flux down the center, making the welding metal self-fluxing.

18. The welding of thin sheets is facilitated by flanging the edges; the depth of the flange formed should slightly exceed the thickness of the metal, so as to form an excess of metal at the joint to serve for filling in without any additional metal.

19. When using feeders on thin welds it is preferable to hold the feeder in front of the blowpipe in the direction of the edges to be welded; it is also essential for the flame to be held practically perpendicular to the work, pointing slightly in the direction of travel. The apex, or outer extremity, of the white jet of the flame should be kept some distance from the work, depending on the thickness to be welded.

20. When welding aluminum 1/8 inch in thickness or more, the feeder and the edges to be joined should be melted simultaneously. On no account must globules from the feeder fall onto the surface of the work.

21. Never use a steel tool to clear the hole in the nozzle of the blowpipe should it be obstructed at any time, because it is likely to damage it; copper wire should be employed.

22. The experienced operator, when welding thin sections of aluminum, displays his skill by raising the flame just at the moment when fusion has proceeded so far that complete welding is assured.

23. Thoroughly cleanse by brushing, the lines of the welding and adjacent surfaces in clean warm water, so as to remove completely the effects of the flux, which otherwise would set up corrosion of the metal.

24. When possible, cold hammering and annealing improve the line of welding. Do not allow cavities to form in the weld, as they diminish the strength of the joint considerably. A good fusion weld seldom breaks at the point of welding.

25. The alloys of aluminum and zinc present the same difficulties as pure aluminum; the operator must use the same flux, and take precautions against the effect of expansion and contraction in carrying out welds on articles made of these materials. After welding very little zinc is left in the vicinity of the weld.

26. Pure aluminum should not be used for welding aluminum and zinc alloys, as the pure metal does not give a perfect weld, the welded zone being more flexible, but much softer than the rest of the material.

27. Good results cannot be obtained if the metal is welded in a dilatory manner; welds on aluminum should be expeditiously executed from the moment the first fusion is obtained, *i. e.*, the rate of travel should be a fast uniform one.

* * *

TALC AS A LUBRICANT

A German chemical journal contains an article relating to the use of talc for lubricating purposes. Talc does not behave like graphite when treated with tannin solutions, but it may be brought into a fine molecular state by heating it with ammonium carbonate or by exposing it for several hours to a current of dry ammonia. The talc is afterward dried in a vacuum. The treated material can be suspended in water so that it is very difficult to filter it, and subsides exceedingly slow in lubricating oils of medium density. When once suspended in a neutral oil, the talc does not subside on heating. The change in the character of the talc is attributed to the absorption of a minute quantity of ammonia. From 40 to 60 per cent of ordinary talc may be introduced into heavy mineral oil, provided the oil be added to the talc and the operation not carried on in the reverse manner.

PITCH DIAMETERS OF BALL BEARINGS

BY GEORGE C. HANNEMANN*

The tables presented in this connection give the pitch diameters to the next highest 0.001 inch of the ball circles of ball bearings with the balls touching. To use these tables in the design of ball bearings of the "noiseless" type, an allowance of from 0.0003 to 0.001 inch per ball should be added to the diameters here given, depending on the size of bearing balls to be used.

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* Address: Care of Auburn Ball Bearing Co., Rochester, N. Y.

TABLE I. PITCH DIAMETERS WITH BALLS TOUCHING

No. of Balls	Diameter of Balls in Inches					
	1/8	5/32	3/16	7/32	1/4	9/32
5	0.213	0.266	0.319	0.373	0.426	0.479
6	0.250	0.313	0.375	0.438	0.500	0.563
7	0.289	0.361	0.433	0.505	0.577	0.649
8	0.327	0.409	0.490	0.572	0.654	0.735
9	0.366	0.457	0.549	0.640	0.731	0.823
10	0.405	0.506	0.607	0.708	0.810	0.911
11	0.444	0.555	0.666	0.777	0.888	0.999
12	0.483	0.604	0.725	0.846	0.966	1.087
13	0.523	0.653	0.784	0.915	1.045	1.176
14	0.562	0.703	0.843	0.984	1.124	1.264
15	0.602	0.752	0.902	1.053	1.203	1.353
16	0.641	0.801	0.962	1.122	1.282	1.442
17	0.681	0.851	1.021	1.191	1.361	1.531
18	0.720	0.900	1.080	1.260	1.440	1.620
19	0.760	0.950	1.140	1.330	1.519	1.709
20	0.800	0.999	1.199	1.399	1.599	1.798
21	0.839	1.049	1.259	1.468	1.678	1.888
22	0.879	1.098	1.318	1.538	1.757	1.977
23	0.918	1.148	1.377	1.607	1.836	2.066
24	0.958	1.198	1.437	1.676	1.916	2.155
25	0.998	1.247	1.497	1.746	1.995	2.245
26	1.038	1.297	1.556	1.815	2.075	2.334
27	1.077	1.346	1.616	1.885	2.154	2.423
28	1.117	1.396	1.675	1.954	2.233	2.512
29	1.157	1.446	1.735	2.024	2.313	2.602
30	1.196	1.495	1.794	2.093	2.392	2.691
31	1.236	1.545	1.854	2.163	2.472	2.781
32	1.276	1.595	1.913	2.232	2.551	2.870
33	1.316	1.644	1.973	2.302	2.631	2.959
34	1.355	1.694	2.033	2.371	2.710	3.049
35	1.395	1.744	2.092	2.441	2.789	3.138
36	1.435	1.793	2.152	2.510	2.869	3.227
37	1.474	1.843	2.211	2.580	2.948	3.317
38	1.514	1.893	2.271	2.649	3.028	3.406
39	1.554	1.942	2.331	2.719	3.107	3.496
40	1.594	1.992	2.390	2.789	3.187	3.585

Machinery

TABLE II. PITCH DIAMETERS WITH BALLS TOUCHING

No. of Balls	Diameter of Balls in Inches					
	5/16	11/32	3/8	7/16	1/2	9/16
5	0.532	0.585	0.638	0.715	0.851	0.957
6	0.625	0.688	0.750	0.875	1.000	1.125
7	0.721	0.793	0.865	1.009	1.153	1.297
8	0.817	0.899	0.980	1.144	1.307	1.470
9	0.914	1.006	1.097	1.280	1.462	1.645
10	1.012	1.113	1.214	1.416	1.619	1.821
11	1.110	1.221	1.332	1.553	1.775	1.997
12	1.208	1.329	1.449	1.691	1.932	2.174
13	1.306	1.437	1.567	1.829	2.090	2.351
14	1.405	1.545	1.686	1.967	2.247	2.528
15	1.504	1.654	1.804	2.105	2.405	2.706
16	1.602	1.763	1.923	2.243	2.563	2.884
17	1.701	1.871	2.041	2.381	2.722	3.062
18	1.800	1.980	2.160	2.520	2.880	3.240
19	1.899	2.089	2.279	2.659	3.038	3.418
20	1.998	2.198	2.398	2.797	3.197	3.596
21	2.097	2.307	2.517	2.936	3.355	3.775
22	2.196	2.416	2.636	3.075	3.514	3.953
23	2.295	2.525	2.754	3.213	3.672	4.131
24	2.395	2.634	2.873	3.352	3.831	4.310
25	2.494	2.743	2.993	3.491	3.990	4.489
26	2.593	2.852	3.112	3.630	4.149	4.667
27	2.692	2.961	3.231	3.769	4.307	4.846
28	2.792	3.071	3.350	3.908	4.466	5.024
29	2.891	3.181	3.470	4.048	4.626	5.204
30	2.990	3.289	3.588	4.186	4.784	5.382
31	3.089	3.398	3.707	4.325	4.943	5.561
32	3.189	3.508	3.826	4.464	5.102	5.739
33	3.288	3.617	3.946	4.603	5.261	5.918
34	3.387	3.726	4.065	4.742	5.419	6.097
35	3.487	3.835	4.184	4.881	5.578	6.276
36	3.586	3.945	4.303	5.020	5.737	6.454
37	3.685	4.054	4.422	5.159	5.896	6.633
38	3.785	4.163	4.542	5.298	6.055	6.812
39	3.884	4.272	4.661	5.438	6.214	6.991
40	3.983	4.382	4.780	5.577	6.373	7.170

Machinery

TABLE III. PITCH DIAMETERS WITH BALLS TOUCHING

No. of Balls	Diameter of Balls in Inches				
	5/8	11/16	3/4	13/16	7/8
5	1.064	1.170	1.276	1.383	1.489
6	1.250	1.375	1.500	1.625	1.750
7	1.441	1.585	1.729	1.873	2.017
8	1.634	1.797	1.960	2.124	2.287
9	1.828	2.011	2.193	2.376	2.559
10	2.023	2.225	2.428	2.630	2.832
11	2.219	2.441	2.663	2.884	3.106
12	2.415	2.657	2.898	3.140	3.382
13	2.612	2.873	3.134	3.396	3.657
14	2.809	3.090	3.371	3.652	3.933
15	3.007	3.307	3.608	3.908	4.209
16	3.204	3.525	3.845	4.165	4.486
17	3.402	3.742	4.082	4.422	4.762
18	3.600	3.960	4.320	4.680	5.039
19	3.798	4.177	4.557	4.937	5.317
20	3.996	4.395	4.795	5.194	5.594
21	4.194	4.613	5.033	5.452	5.871
22	4.392	4.831	5.271	5.710	6.149
23	4.590	5.049	5.508	5.967	6.426
24	4.789	5.268	5.746	6.225	6.704
25	4.987	5.486	5.985	6.483	6.982
26	5.186	5.704	6.223	6.741	7.260
27	5.384	5.922	6.461	6.999	7.538
28	5.583	6.141	6.699	7.257	7.815
29	5.782	6.361	6.939	7.517	8.095
30	5.980	6.578	7.176	7.773	8.371
31	6.178	6.796	7.414	8.032	8.649
32	6.377	7.015	7.652	8.290	8.928
33	6.576	7.233	7.891	8.548	9.206
34	6.774	7.452	8.129	8.806	9.484
35	6.973	7.670	8.367	9.065	9.762
36	7.172	7.889	8.606	9.323	10.040
37	7.370	8.107	8.844	9.581	10.318
38	7.569	8.326	9.083	9.840	10.596
39	7.768	8.544	9.321	10.098	10.875
40	7.966	8.763	9.560	10.356	11.153

Machinery

TABLE IV. PITCH DIAMETERS WITH BALLS TOUCHING

No. of Balls	Diameter of Balls in Inches				
	15/16	1	1⅛	1¼	1½
5	1.595	1.702	1.914	2.127	2.551
6	1.875	2.000	2.250	2.500	3.000
7	2.161	2.305	2.593	2.881	3.458
8	2.450	2.614	2.940	3.267	3.920
9	2.742	2.924	3.290	3.655	4.387
10	3.034	3.237	3.641	4.046	4.855
11	3.328	3.550	3.994	4.437	5.325
12	3.623	3.864	4.347	4.830	5.796
13	3.918	4.179	4.701	5.224	6.268
14	4.214	4.494	5.056	5.618	6.741
15	4.510	4.810	5.411	6.013	7.215
16	4.806	5.126	5.767	6.408	7.689
17	5.103	5.443	6.123	6.803	8.164
18	5.399	5.759	6.479	7.200	8.639
19	5.696	6.076	6.835	7.595	9.114
20	5.993	6.393	7.192	7.991	9.589
21	6.291	6.710	7.549	8.387	10.065
22	6.588	7.027	7.906	8.784	10.541
23	6.885	7.311	8.262	9.180	11.016
24	7.183	7.662	8.619	9.577	11.492
25	7.481	7.979	8.977	9.974	11.969
26	7.778	8.207	9.334	10.371	12.445
27	8.076	8.611	9.691	10.768	12.921
28	8.371	8.932	10.048	11.165	13.398
29	8.673	9.252	10.408	11.564	13.877
30	8.969	9.567	10.763	11.960	14.351
31	9.267	9.885	11.121	12.356	14.827
32	9.565	10.203	11.478	12.753	15.304
33	9.863	10.521	11.836	13.151	15.781
34	10.161	10.838	12.193	13.548	16.257
35	10.459	11.156	12.551	13.945	16.734
36	10.757	11.474	12.908	14.313	17.211
37	11.055	11.792	13.266	14.740	17.688
38	11.353	12.110	13.621	15.137	18.165
39	11.651	12.428	13.981	15.535	18.642
40	11.919	12.746	14.339	15.932	19.119

Machinery

THICKNESS OF CYLINDER WALL

BY THOMAS N. HAFFNER[*]

The chart here presented gives the value of the quantity $\sqrt{\frac{S+P}{S-P}}-1$ from the well-known formula of Lamé:

$$T = R\left(\sqrt{\frac{S+P}{S-P}}-1\right)$$

where T = thickness of cylinder wall in inches;
R = inside radius of cylinder in inches;
S = safe stress in pounds per square inch;
P = pressure in cylinder in pounds per square inch.

The figures at the left-hand side of the chart represent the pressure P in pounds per square inch, and the figures at the right-hand side represent the working stress S in the material in pounds per square inch. The figures at the bottom of the chart are constants for these two factors. In using the chart to determine the constant, the horizontal line through the proper pressure value is located, and the curve starting from the desired value of the stress is next found; this curve is then followed to the point where it intersects the horizontal pressure line, after which the vertical line is followed to the bottom of the chart to determine the constant. This constant multiplied by the inside radius R of the cylinder—which is a simple slide-rule operation—gives the required thickness T of the cylinder wall.

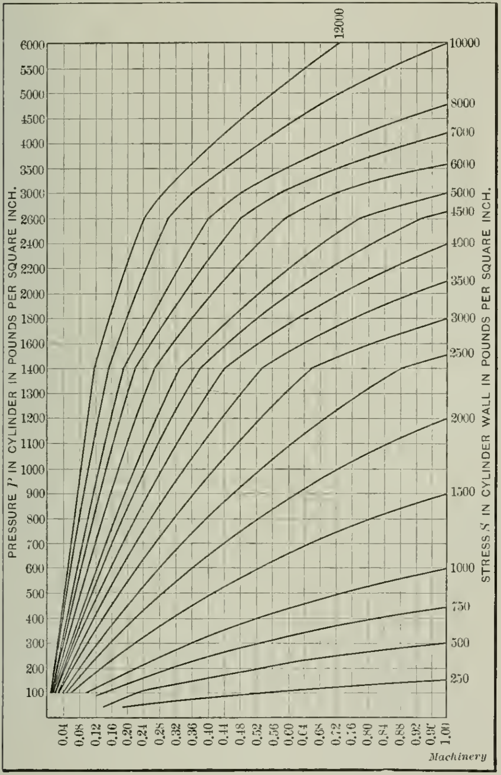

Chart for determining Thickness of Cylinder Wall

* * *

A process for preventing corrosion of iron and steel has been patented by H. Hanemann in England. The method makes use of dry ammonia gas. The objects to be treated are heated to about 1380 degrees F. and subjected to the action of a rapid stream of dry ammonia gas for about one and one-half hour, after which the furnace is allowed to cool slowly. By this means a protective layer of iron nitride (Fe_2N) is formed. It is stated that the nitrified iron is proof against atmospheric oxidation.

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[*] Address: Fullerton, Pa.

FORMULAS FOR BLANK DIAMETERS OF DRAWN SHELLS

BY FRITZ J. W. SPARKUHL[*]

In the process of manufacturing drawing dies for round articles of fancy shape, the problem of finding the proper blank dimensions is of vital importance, and under ordinary conditions this is not the easiest task the diemaker or tool-designer has to face. As much time and labor are often spent in obtaining a satisfactory result, the writer has worked out a number of blank-formulas for the most common shapes, the vertical sections of which are shown in cases 1 to 28 in the accompanying tables.

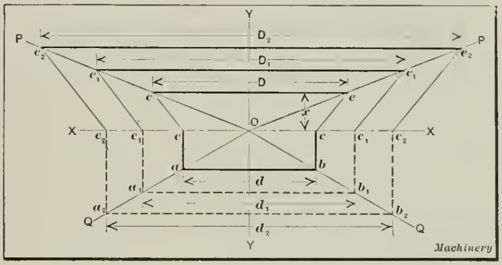

Fig. 1. Diagram illustrating Graphical Method of determining Blank Diameters for Shells of Proportional Sizes

These formulas are based upon the well-known and long-established rule that the area of the blank equals the area of the shell, or mathematically expressed:

$$\frac{\pi D^2}{4} = A$$

$$D = \sqrt{\frac{4}{\pi} \times A.}$$

where D = diameter of blank, and A = area of shell.

It is also assumed that the metal, which is comparatively thin, does not undergo any remarkable change of thickness while the flat blank is converted into a shell. In the third column of the tables the diameter of the blank is expressed in its most reduced and convenient form, and by substituting the proper dimensions these formulas will give the right results. All corners at the bottom are shown sharp, which is a condition that it is practically impossible to obtain in drawing dies, as the metal will not stand the strain. The radius of these corners should not be less than six to ten times the metal-thickness for tin plate and four to five times for copper plate, according to the quality. Otherwise, the tables are self-explanatory and no further comment is necessary.

In addition to these formulas an easy method is demonstrated for graphically determining the blank-dimensions of shells of different contents but similar forms, *i. e.*, shells whose lines are all proportional to each other, as shown in Figs. 1 and 2. The method consists of laying out the known shell section of diameter d, and by drawing the lines OQ through a and b we have the new shell sections $c_1a_1b_1c_1$ and $c_2a_2b_2c_2$, respectively, which are directly proportional to $cabc$. The method for determining the diameters of the

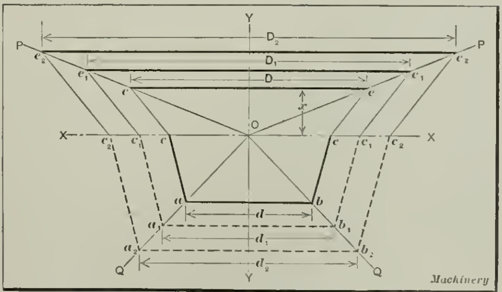

Fig. 2. Method illustrated in Fig. 1, applied to another Form of Shell

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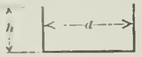
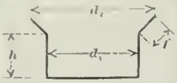
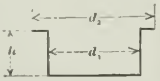
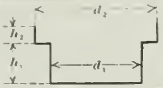
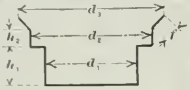
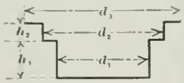
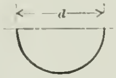
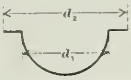
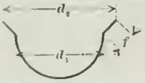
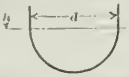
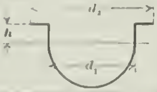
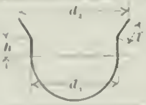
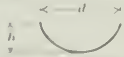
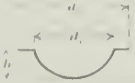
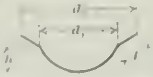
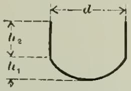
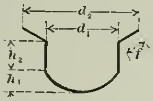
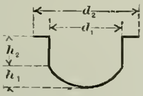
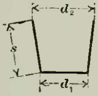
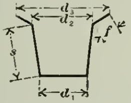
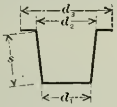
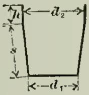
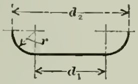
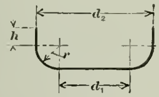
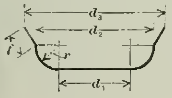
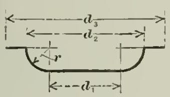
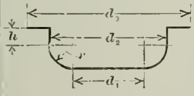
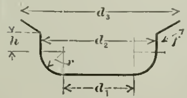
AREAS AND DIAMETERS OF BLANKS FOR DRAWN SHELLS

Fig.	Shape of Body	Area of Body A =	Diameter of Blank D =
1		$\frac{\pi d^2}{4} + \pi dh$	$\sqrt{d^2 + 4dh}$
2		$\frac{\pi d_1^2}{4} + \pi d_1 h + \pi f \frac{d_1 + d_2}{2}$	$\sqrt{d_1^2 + 4d_1 h + 2f(d_1 + d_2)}$
3		$\frac{\pi d_1^2}{4} + \pi d_1 h + \frac{\pi}{4}(d_2^2 - d_1^2)$	$\sqrt{d_1^2 + 4d_1 h + d_2^2 - d_1^2} = \sqrt{d_2^2 + 4d_1 h}$
4		$\frac{\pi d_1^2}{4} + \pi d_1 h_1 + \frac{\pi}{4}(d_2^2 - d_1^2) + \pi d_2 h_2$	$\sqrt{d_2^2 + 4(d_1 h_1 + d_2 h_2)}$
5		$\frac{\pi d_1^2}{4} + \pi d_1 h_1 + \frac{\pi}{4}(d_2^2 - d_1^2) + \pi d_2 h_2 + \pi f \frac{d_2 + d_3}{2}$	$\sqrt{d_2^2 + 4(d_1 h_1 + d_2 h_2) + 2f(d_2 + d_3)}$
6		$\frac{\pi d_1^2}{4} + \pi d_1 h_1 + \frac{\pi}{4}(d_2^2 - d_1^2) + \pi d_2 h_2 + \frac{\pi}{4}(d_3^2 - d_2^2)$	$\sqrt{d_3^2 + 4(d_1 h_1 + d_2 h_2)}$
7		$\frac{\pi d^2}{2}$	$\sqrt{2d^2} = 1.414d$
8		$\frac{\pi d_1^2}{2} + \frac{\pi}{4}(d_2^2 - d_1^2)$	$\sqrt{d_1^2 + d_2^2}$
9		$\frac{\pi d_1^2}{2} + \pi f \frac{d_2 + d_1}{2}$	$1.414\sqrt{d_1^2 + f(d_2 + d_1)}$
10		$\frac{\pi d^2}{2} + \pi dh$	$1.414\sqrt{d^2 + 2dh}$
11		$\frac{\pi d_1^2}{2} + \pi d_1 h + \frac{\pi}{4}(d_2^2 - d_1^2)$	$\sqrt{d_1^2 + d_2^2 + 4d_1 h}$
12		$\frac{\pi d_1^2}{2} + \pi d_1 h + \pi f \frac{d_1 + d_2}{2}$	$1.414\sqrt{d_1^2 + 2d_1 h + f(d_1 + d_2)}$
13		$\frac{\pi}{4}(d^2 + 4h^2)$	$\sqrt{d^2 + 4h^2}$
14		$\frac{\pi}{4}(d_1^2 + 4h^2) + \frac{\pi}{4}(d_2^2 - d_1^2)$	$\sqrt{d_2^2 + 4h^2}$
15		$\frac{\pi}{4}(d_1^2 + 4h^2) + \pi f \frac{d_1 + d_2}{2}$	$\sqrt{d_1^2 + 4h^2 + 2f(d_1 + d_2)}$

Machinery

AREAS AND DIAMETERS OF BLANKS FOR DRAWN SHELLS

Fig.	Shape of Body	Area of Body A=	Diameter of Blank D=
16		$\frac{\pi}{4}(d^2+4h_1^2)+\pi d h_2$	$\sqrt{d^2+4(h_1^2+dh_2)}$
17		$\frac{\pi}{4}(d_1^2+4h_1^2)+\pi d_1 h_2+\pi f\frac{d_1+d_2}{2}$	$\sqrt{d_1^2+4\left[h_1^2+d_1h_2+\frac{f}{2}(d_1+d_2)\right]}$
18		$\frac{\pi}{4}(d_1^2+4h_1^2)+\pi d_1 h_2+\frac{\pi}{4}(d_2^2-d_1^2)$	$\sqrt{d_2^2+4(h_1^2+d_1h_2)}$
19		$\frac{\pi d_1^2}{4}+\pi s\frac{d_1+d_2}{2}$	$\sqrt{d_1^2+2s(d_1+d_2)}$
20		$\frac{\pi d_1^2}{4}+\pi s\frac{d_1+d_2}{2}+\pi f\frac{d_2+d_3}{2}$	$\sqrt{d_1^2+2[s(d_1+d_2)+f(d_2+d_3)]}$
21		$\frac{\pi d_1^2}{4}+\pi s\frac{d_1+d_2}{2}+\frac{\pi}{4}(d_3^2-d_2^2)$	$\sqrt{d_1^2+2s(d_1+d_2)+d_3^2-d_2^2}$
22		$\frac{\pi d_1^2}{4}+\pi s\frac{d_1+d_2}{2}+\pi d_2 h$	$\sqrt{d_1^2+2[s(d_1+d_2)+2d_2h]}$
23		$\frac{\pi d_1^2}{4}+\frac{\pi^2 r}{2}(d_1+1.274r)$; or $\frac{\pi}{4}(d_2-2r)^2+\frac{\pi^2 r}{2}(d_2-0.726r)$	$\sqrt{d_1^2+6.28rd_1+8r^2}$; or $\sqrt{d_2^2+2.28rd_2-0.56r^2}$
24		$\frac{\pi d_1^2}{4}+\frac{\pi^2 r}{2}(d_1+1.274r)+\pi hd_2$; or $\frac{\pi}{4}(d_2-2r)^2+\frac{\pi^2 r}{2}(d_2-0.726r)+\pi hd_2$	$\sqrt{d_1^2+4(1.57rd_1+2r^2+hd_2)}$; or $\sqrt{d_2^2+4d_2(h+0.57r)-0.56r^2}$
25		$\frac{\pi}{4}d_1^2+\frac{\pi^2 r}{2}(d_1+1.274r)+\pi f\frac{d_2+d_3}{2}$; or $\frac{\pi}{4}(d_2-2r)^2+\frac{\pi^2 r}{2}(d_2-0.726r)+\pi f\frac{d_2+d_3}{2}$	$\sqrt{d_1^2+6.28rd_1+8r^2+2f(d_2+d_3)}$; or $\sqrt{d_2^2+2.28rd_2+2f(d_2+d_3)-0.56r^2}$
26		$\frac{\pi d_1^2}{4}+\frac{\pi^2 r}{2}(d_1+1.274r)+\frac{\pi}{4}(d_3^2-d_2^2)$; or $\frac{\pi}{4}(d_2-2r)^2+\frac{\pi^2 r}{2}(d_2-0.726r)+\frac{\pi}{4}(d_3^2-d_2^2)$	$\sqrt{d_1^2+6.28rd_1+8r^2+d_3^2-d_2^2}$; or $\sqrt{d_3^2+2.28rd_2-0.56r^2}$
27		$\frac{\pi d_1^2}{4}+\frac{\pi^2 r}{2}(d_1+1.274r)+\pi d_2h+\frac{\pi}{4}(d_3^2-d_2^2)$; or $\frac{\pi}{4}(d_2-2r)^2+\frac{\pi^2 r}{2}(d_2-0.726r)+\pi d_2h+\frac{\pi}{4}(d_3^2-d_2^2)$	$\sqrt{d_1^2+6.28rd_1+8r^2+4d_2h+d_3^2-d_2^2}$; or $\sqrt{d_3^2+4d_2(0.57r+h)-0.56r^2}$
28		$\frac{\pi d_1^2}{4}+\frac{\pi^2 r}{2}(d_1+1.274r)+\pi d_2h+\pi f\frac{d_3+d_2}{2}$; or $\frac{\pi}{4}(d_2-2r)^2+\frac{\pi^2 r}{2}(d_2-0.726r)+\pi d_2h+\pi f\frac{d_3+d_2}{2}$	$\sqrt{d_1^2+6.28rd_1+8r^2+4d_2h+2f(d_2+d_3)}$; or $\sqrt{d_2^2+4d_2\left(0.57r+h+\frac{f}{2}\right)+2d_3f-0.56r^2}$

Machinery

blanks D_1 and D_2 is based on the geometrical theorem that the areas of similar bodies are proportional to the square of corresponding lines of these bodies.

Let A = area of given shell;

d = diameter of given shell;

D = blank diameter of this shell;

d_1, d_2, etc., = diameters of unknown shells;

A_1, A_2, etc., = areas of these shells;

D_1, D_2, etc., = blank diameters of unknown shells.

The preceding theorem for determining the required blank diameters may be expressed:

$$\frac{A}{A_1} = \frac{d^2}{d_1^2}, \quad \frac{A}{A_2} = \frac{d^2}{d_2^2}, \text{ etc., or}$$

$$\sqrt{\frac{A}{A_1}} = \frac{d}{d_1}, \quad \sqrt{\frac{A}{A_2}} = \frac{d}{d_2}, \text{ etc.}$$

We know that the area of the blank equals the area of the shell. Expressed in the form of equations:

$$D = \sqrt{\frac{4}{\pi} \times A}, \quad D_1 = \sqrt{\frac{4}{\pi} \times A_1}, \quad D_2 = \sqrt{\frac{4}{\pi} \times A_2}, \text{ etc.}$$

Therefore $\sqrt{\frac{\pi/4 \times A}{\pi/4 \times A_1}} = \frac{d}{d_1} = \frac{D}{D_1}$, $\sqrt{\frac{\pi/4 \times A}{\pi/4 \times A_2}} = \frac{d}{d_2} = \frac{D}{D_2}$, etc.

In plain words, the blank diameters of similar shells are proportional to any corresponding diameters of these shells. To find D_1, D_2, etc., graphically, we proceed as follows: The known blank diameter *ee* of shell *d* is laid out parallel to the horizontal axis *X-X* at any distance *x*, and bisected by the vertical axis *Y-Y*. We next draw lines *OP* from *O* through the points *c* and connect points *c* with points *e*. We then draw parallels to lines *ce* from points c_1, c_2, etc., to lines *OP* which intersect at e_1, e_2, etc. By connecting points c_1c_1, e_2e_2, etc., we have the desired diameters D_1, D_2, etc., for shells of diameters d_1, d_2, etc.

Another idea which might be appreciated is the following: In case a full set of shells has to be drawn and all dimensions have to be in direct proportion to each other, when one shell is given and its blank diameter and cubic contents are known, we use the stereometrical theorem:

The contents of similar bodies are proportional to the cubes of their corresponding lines, *i. e.*:

$$\frac{V}{V_1} = \frac{d^3}{d_1^3}, \quad \frac{V}{V_2} = \frac{d^3}{d_2^3}, \text{ etc., or } \sqrt[3]{\frac{V}{V_1}} = \frac{d}{d_1}, \quad \sqrt[3]{\frac{V}{V_2}} = \frac{d}{d_2}, \text{ etc.}$$

We saw that $\frac{d}{d_1} = \frac{D}{D_1}$; therefore $\frac{D}{D_1} = \sqrt[3]{\frac{V}{V_1}}$.

As D_1 has to be found:

$$D_1 = D \times \sqrt[3]{\frac{V_1}{V}} \quad D_2 = D \times \sqrt[3]{\frac{V_2}{V}}, \text{ etc.}$$

The preceding is a formula which I found useful when I had to design tools for a set of eight round tomato boxes of different contents but similar form, and I think that anybody using these methods will find them most valuable time- and trouble-savers.

* * *

DECLARATION OF SANITARY PRINCIPLES

The Board of Sanitary Control of the Cloak and Suit Industry in New York City has formulated a set of principles which mark a radical departure from the recognized and accepted standards that have prevailed in industrial life since the rise and growth of the modern factory system. They apply generally to conditions of factory life, and are reproduced herewith.

1. An industry is responsible for the conditions existing in its establishment.
2. It is the duty of an industry to control, supervise and improve the sanitary conditions of its industrial establishments without compulsion from outside sources.
3. The general public is directly and intensely interested in the sanitary conditions existing in industry.
4. Decent sanitary conditions of the workshops are the first requisites and a debt which manufacturers in the industry owe to the public and to the workers.
5. An efficient and permanent improvement in the conditions of industrial establishments can only be brought about by the efforts and by the cooperation of the manufacturers, of the public and of the workers themselves.

* * *

A peculiar characteristic of metal alloys is that the electrical conductivity of a metal is often very much decreased by alloying it with another metal. As an example it may be mentioned that an alloy of gold and silver will have less electrical conductivity than either of the metals from which it is formed. Another peculiar property of alloys is that when a pure metal is cooled to a very low temperature, its electrical conductivity is greatly increased, but this is not the case with an alloy.

EXPERIENCES OF AN APPRENTICE

BY APPRENTICE

Gee, but I got a real call-down this morning from the boss, and for a time I didn't know whether to throw up the job or stick. Now, as I look back on it, I realize that it was only because he wanted to show me where I was wrong. But it certainly hurt my pride to be called down in front of the whole room.

The trouble came from a job the boss gave me several days ago—a jig having seventeen holes unequally spaced. After machining the casting, I strapped it to an angle-plate on the milling machine and spotted all the holes, then drilled and bored them. The job was done in pretty good time, and I turned it over to the boss for inspection with a touch of pride, thinking that I had managed to finish this particular job without leaving a "trade-mark" of any kind on it.

On inspection, the boss soon discovered errors of 0.002 to 0.003 inch in center distances between some of the holes and 0.037 inch error between the last two holes. He called me to the milling machine and said:

"I want you to start from the center of the jig, or from whatever point you did start from, and show me just how you moved the table and knee when you bored those holes."

There was something about the way he talked and acted that made me suspect that all was not well. But I showed him how I started the job and began to explain how I bored the hole and so on. But he interrupted me with:

"Just take hold of the handle and let me see you go through the actual operation from one hole to the next."

I started from an imaginary point, set the dials on the feed-screws, moved the table along to the last hole, and went through the seemingly foolish operation of feeding the table crosswise to bore an imaginary hole. Then the table was moved in the opposite direction 1¼ inch, which was the distance to the next hole and it happened to be one complete revolution of the dial. The boss stopped me right there and said:

"You have worked at this business over three years and yet you don't know enough to take up the backlash in the screw. You moved the table in one direction, bored a hole and then started right back and bored the next hole. Don't you know that the screw has a certain amount of backlash that allows the dial to rotate 0.030 or 0.040 inch before the table starts to move?"

I knew it all right but through lack of care and foresight it never entered my mind when doing the job. Well, after the boss got a lot of unprintable words out of his system, he became thoughtful and said:

"What puzzles me is how you made a mistake of 0.003 and 0.004 inch between the holes, because the screws in that milling machine were especially made for jig work and we use them for nothing else. Let me see you move the table to bore the next hole."

Now it happened that the next hole was at an odd dimension from the other and the dial stopped at 75. I moved the table the required distance and then loosened the dial and swung it around until the zeros lined up and right there I received another call-down. I will not repeat it word for word, but the substance of it was never to move the dials from the time they are first set to the finish of the job, and to go far enough beyond the required reading on the dial in each case to take up the backlash before the required reading on the dial coincides with the zero on the machine.

I could not understand why there would be discrepancies in the center distances of the holes because of moving the dial, as long as the desired line on the dial was set exactly with the line on the machine. Tom stopped his shaper and took the time to show me how easy it was to move the handle while loosening the dial. The fellow that said "experience is a bitter teacher" knew what he was talking about, and while I'll never make that mistake again, I wish that I had learned it either by reading or by being told in a quiet way instead of being called down before all the boys.

* * *

It is said that among the various materials used for cleaning files, a piece of coke gives as good results as any.

MACHINING MOTOR CYCLE PARTS*

MISCELLANEOUS MACHINING OPERATIONS ON MOTOR CYCLE CYLINDERS, PISTONS, PISTON RINGS AND FLYWHEELS

BY DOUGLAS T. HAMILTON†

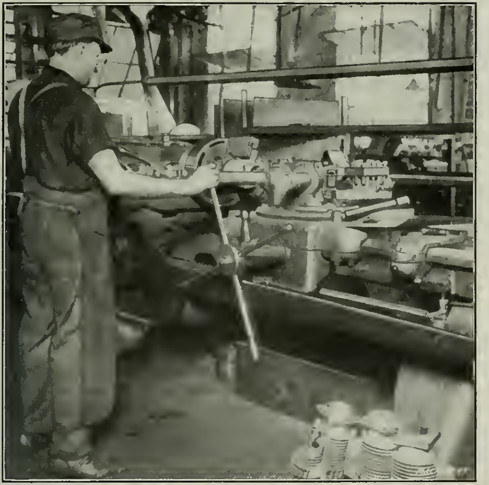


Fig. 1. First Machining Operation on a Motor Cycle Cylinder Casting—Boring the Cylinder and turning the Neck

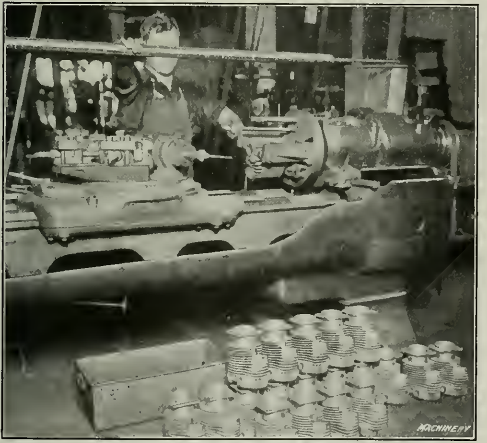


Fig. 2. Second Operation on a Motor Cycle Cylinder Casting—Machining the Inlet and Exhaust Valve Holes

IN machining motor cycle cylinder castings, pistons, piston rings and flywheels, the Harley-Davidson Motor Co., Milwaukee, Wis., makes good use of the Jones & Lamson flat turret lathe. This type of machine is particularly adapted to work of this kind because of the cross-sliding head which offers many advantages. This will be particularly noticeable in the machining of the inlet and exhaust valve holes in the head of the cylinder casting, in the machining of pistons and also of piston rings. The Harley-Davidson Motor Co. has developed a number of interesting fixtures for handling this work, and the tool equipment is worthy of special note. There are, of course, additional operations on motor cycle cylinders, such as milling and grinding, which while not altogether out of the ordinary, present some features of interest. Where a large production is necessary, simple but efficient fixtures and tool equipment must be evolved so that the work can be handled quickly and accurately. In the following article a number of the most interesting features in the making of motor cycle engine parts will be illustrated and described.

First Operation on the Motor Cycle Cylinder Casting

Motor cycle cylinder castings for Harley-Davidson motor cycles are cast singly, and the first operation on this type of casting consists in machining the cylinder bore and neck and

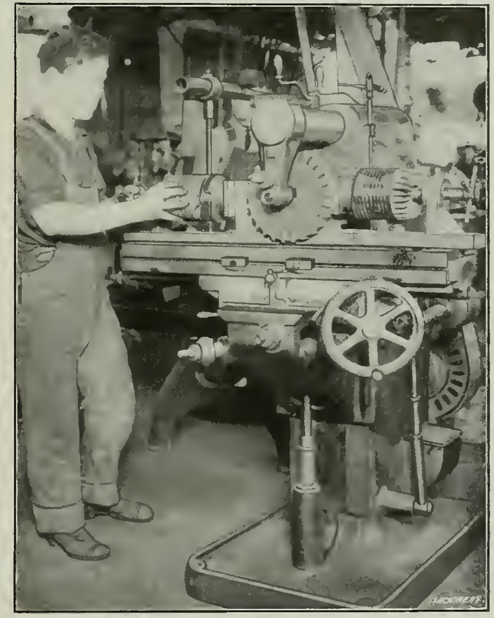


Fig. 3. Milling the Bases of Motor Cycle Cylinder Castings on a Fixture of the Reciprocal Type

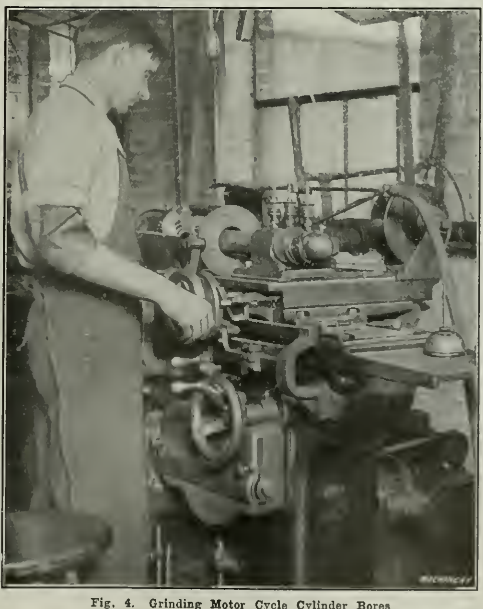


Fig. 4. Grinding Motor Cycle Cylinder Bores

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* For information on this and kindred subjects, see "Production Tools for Reo Engine Cylinders" in the August and September, 1914, numbers of MACHINERY.

† Associate Editor of MACHINERY.

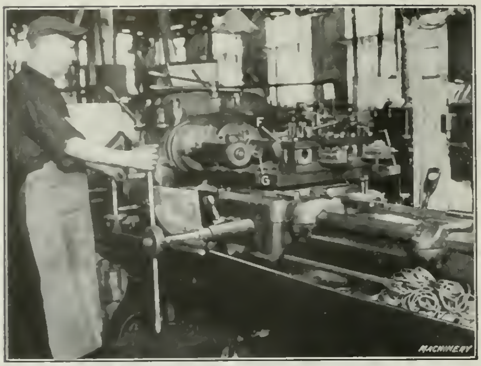


Fig. 5. Machining Piston Rings on the Double-spindle, Flat Turret Lathe

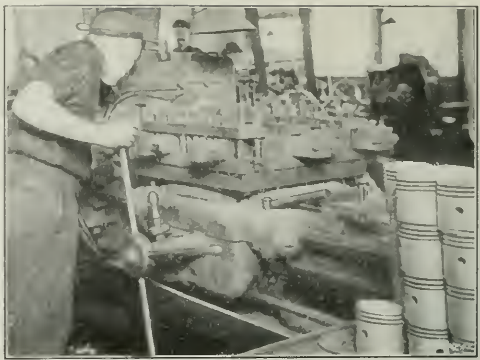


Fig. 6. Machining Motor Cycle Pistons on the Double-spindle Flat Turret Lathe

facing the flange and end. These operations are handled on a single-spindle three-inch flat turret lathe. As shown in Fig. 1, the casting is held in a special chuck screwed onto the nose of the spindle. This chuck has two projecting lugs, which add to the support of the casting around the water jacket housing. The first operation is to rough-bore the cylinder, which in the rough is 3 1/16 inches in diameter by 7 inches deep. Two roughing cuts are first taken, the cross-sliding head being moved over the required amount to take the two cuts and finishing the bore to 3 3/16 inches in diameter. About ¼ inch of metal on the diameter is removed from the bore of the cylinder. After boring, the neck is turned to 3⅝ inches in diameter by 2 inches long, and the end of the cylinder and flange are faced. For these operations the cross-sliding head also comes into play. The flange, of course, is faced on both the front and rear sides to the thickness desired. In all there are about ten separate operations, and it is possible to obtain a production of thirty-five castings in ten hours from one machine.

Second Operation on the Motor Cycle Cylinder Casting

The second series of operations on the motor cycle cylinder casting which consists in machining the inlet and exhaust valve holes in the head of the casting is also performed on a single-spindle flat turret lathe. A special fixture, as shown in Fig. 2, is fastened to a faceplate, the latter being screwed onto the nose of the spindle. This fixture comprises two arms carrying clamping bolts, one of which is provided with a check-nut and the other with a handle, so that when the fixture has once been set for the casting it is not necessary to change the position of the second clamping bolt when replacing or removing a piece. The operator only loosens the handle clamping bolt and in this way releases the work, after the toe-clamps fastening the base of the cylinder casting to the fixture have been released. The casting is located from the previously machined bore by a boss on the faceplate.

In all, there are eleven tools used for performing the series of operations on the inlet and exhaust valve holes. The operations take the following order: First, two rough-boring cuts are taken from the exhaust valve hole and chamber, after which the chamber is faced and counterbored. A smaller hole 9/32 inch in diameter is then drilled and reamed to 5/16 inch diameter, this being located at the bottom of the chamber. Two counterbored portions are then machined 5/16 and 3/8 inch diameter, respectively, 1⅛ inch deep. Following the machining of the exhaust valve hole, the fixture is indexed around to bring the inlet holes in line, and these are then machined. The operations on the inlet valve holes are somewhat similar to those performed on the exhaust valve hole, with the exception that the hole is tapped. The operations enumerated in their proper order are: boring, reaming, recessing and tapping. The cross-sliding head makes possible a considerable production on this job, which requires two different settings. The work is not shifted after it is once placed and clamped in the fixture until it is completely machined, any difference in position being taken care of by the cross-sliding head. The production on this job from one machine is sixty completed cylinder castings in ten hours.

Milling Cylinder Casting Bases

After the machining of the cylinder bores and the inlet and exhaust valve holes, the castings are taken to a drill press and four holes are drilled in the flange of the cylinder casting for clamping it to the crank-case; these holes are also utilized in successive operations as locating points. The next important operation is the milling of the cylinder casting base. This is performed as shown in Fig. 3 on a No. 1-A Kearney & Trecker milling machine, and the operations consist in squaring all four sides of the flange. The castings are held on a fixture of the reciprocal milling type, so that while the cutters are working on one casting, the operator is putting a new piece in the other end of the fixture.

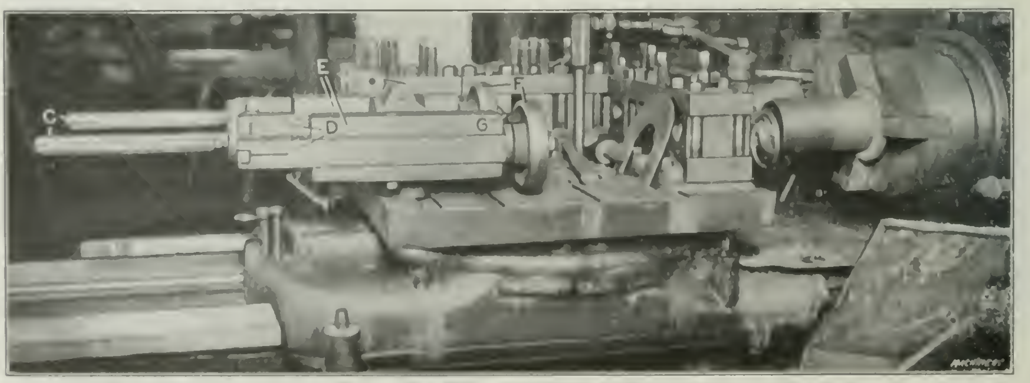


Fig. 7. Close View of Machine in Fig. 5, showing Method of driving the Cam Rolls for securing the Eccentricity on the External Diameter of the Rings

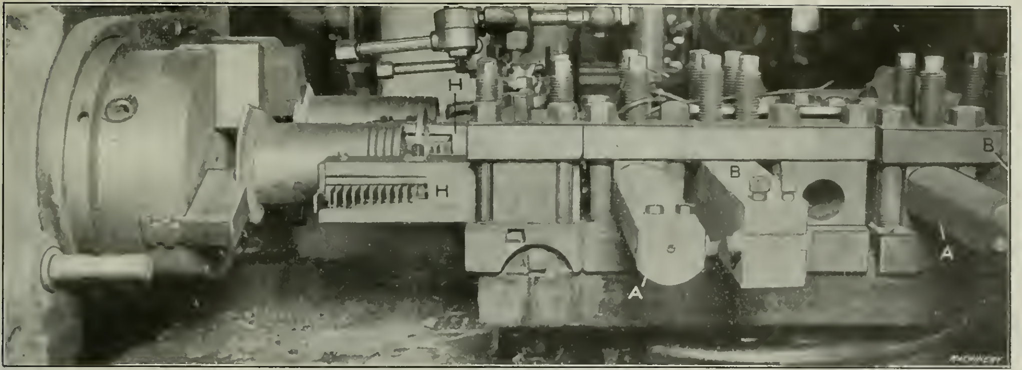


Fig. 8. Close View of Machine shown in Fig. 5, showing the Cutting-off Tools at Work cutting off the Piston Rings

In operation, the castings are located from the four previously drilled holes in the flange which fit locating plugs on the fixture. The castings are held tight up against the fixture by screw clamps, one of which is located in each end of the fixture, and clamps the casting by entering the inlet valve chamber. Two milling cutters 10 inches in diameter having high-speed steel inserted blades 1¼ inch wide are used for machining the flange of the cylinder casting. One-eighth inch of material on each side of the flange is removed, the flange being finished to 3 15/16 inches square by 3/8 inch wide. As this fixture is not provided with any indexing mechanism, it is necessary for the operator to unclamp each casting twice before it is finish-machined, and turn it around to present the two opposing sides to the milling cutters. The machine can work practically continuously, however, as one casting can be changed while the cutters are at work on another. The production on this job is 300 finished cylinder castings in ten hours.

Grinding the Cylinder Bore

The grinding of the cylinder bore is accomplished on a Heald internal grinding machine. A special fixture of the cradle type is used for holding the castings while grinding. This fixture, as shown in Fig. 4, comprises a faceplate screwed onto the nose of the spindle that ordinarily carries the chuck, and by means of extension arms carries an additional faceplate, providing means for locating and clamping the casting. The cylinder casting is held parallel with the travel of the internal grinding head, and is located from the flange at the base of the casting. The amount of material removed from the diameter of the cylinder by grinding varies from 0.006 to 0.010 inch on the diameter, the finished diameter being 3.310 and the limit 0.0005 inch on the diameter. The depth of the bore is 7 inches. The practice is to take one roughing cut and two finishing cuts from the cylinder bore. A special Norton No. 3033 grinding wheel ¾ inch wide by 3 inches in diameter is used, which is rotated at 6800 R. P. M. The work is rotated at about 100 R. P. M. for the rough-grinding cut and at 150 R. P. M. for finishing. The production from one machine is thirty-eight completed cylinder castings in ten hours.

Machining Piston Rings

The tool equipment used on the double-spindle flat turret lathe for machining piston rings comprises a number of interesting features. The piston rings are made from a casting which in the rough is 6 3/4 inches long by 3 9/16 inches outside diameter. As shown in Figs. 5 and 7, two of these castings are held in three-jawed chucks, which are screwed onto the two spindles of the machine. The operations consist in first rough-boring and rough-turning the internal and external diameters of this casting, both operations being handled at the same time. As shown in Fig. 8, the internal and external diameters are bored and turned by tools *A* and *B* securely clamped to the flat turret, as illustrated.

After taking a cut of about 1/16 inch from the external and internal diameters of the casting, the turret is indexed, bringing the finish-boring and turning tools into position. These tools comprise the most interesting part of the tool equipment, and are shown in detail in Fig. 7. The internal boring tool is held in the boring-bars *C*, whereas the external cutting tools are held in tool-holders *D*.

The boring-bars *C* are provided with a keyway and fit a keyed bushing in the spindle of the machine, so that these bars are rotated when in action on the work. The fixtures *E* carrying the external turning tool-holders are set off to one side of the boring-bars, and carry rolls *F* which mesh with eccentric cam rolls *G*, the latter being fastened to the boring-bars *C* which extend through the fixture. Rolls *F* have a circular form and are utilized as a means for transferring an oscillating movement to the tool-holders *D*, the latter being fulcrumed on a pin in the holder *E*. The holders *D*, in addition to being fulcrumed, are also backed up with springs which keep the rolls *F* in contact with the eccentric cam rolls *G*, thus providing for the required eccentric movement to the external cutting tool-holders.

The eccentric cam rolls *G* carry a mark which corresponds to the thinnest part of the piston ring, and when this mark is in line with the external tool the finish-turning operations are completed, and the operator stops the spindle, brings this mark in line with the turning tools and then withdraws the

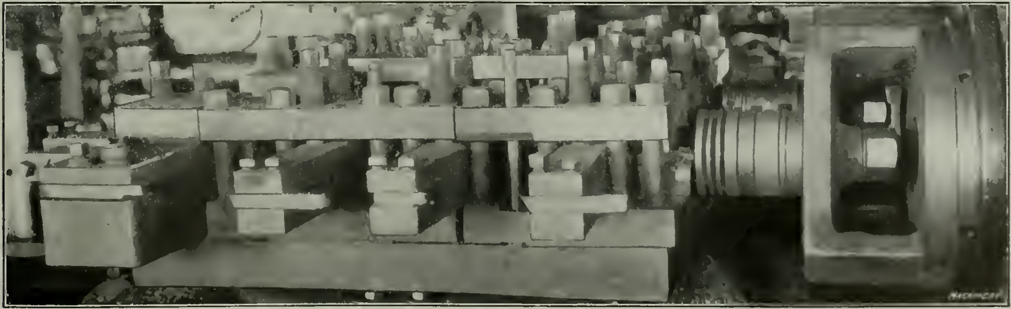


Fig. 9. Tool Set-up used for machining Motor Cycle Pistons on a Double-spindle Flat Turret Lathe

turret. The turning tools in being drawn straight back produce a longitudinal mark on the piston ring castings, which is used in a subsequent operation as a guide for slitting the rings.

After finish-boring and turning, the turret is again indexed and the cutting-off tools are brought into position. As shown in Fig. 8, the cutting-off tool-holders *H* carry twelve blades, each successive one, starting from the turret to the chuck, being set out a little farther, so that the cutting off of the rings is accomplished progressively. This tool-holder cuts off thirteen rings in the first setting, and after the completion of the last ring, the turret is advanced toward the chuck and another series of rings severed from the casting, twenty-one rings being cut from each casting, and as two castings are held in the machine and machined at one time, twice this number or forty-two piston rings are completed at each chucking. It is therefore evident that the production from this machine is high, which it is, averaging a thousand piston rings in ten hours.

Machining Motor Cycle Pistons

Pistons for Harley-Davidson motor cycle engines are also machined on double-spindle flat turret lathes as shown in Fig. 6. Two piston castings are machined at one time, being held on the special fixtures shown in Fig. 9. These fixtures comprise a double faceplate screwed onto the nose of the spindle, and carrying clamping bolts in their forward ends. These clamping bolts hold the pistons up tight against the machined faces of the fixtures by means of pins passing through the connecting-rod pin holes in the piston castings. The first operation is to rough-turn the external diameter of the piston, two cutters being used for this purpose, one working on each side of the piece, as shown in Fig. 9. The second operation is to rough-groove for the piston rings, of which there are three, machine one oil-groove and one clearance-groove, and rough-face the end of the piston, all these operations being handled simultaneously by tools in the turret. The third operation is to finish the piston ring, oil and clearance grooves and also finish-face the end, whereas, the fourth operation is to take a final finishing cut from the external diameter of the pistons, finishing them to 3 5/16 inches diameter by 3½ inches long and removing about ¼ inch of material all around.

There is one point about the machining of these pistons that should not be overlooked. The diameter of the piston ring groove is only 3 1/64 inches, leaving a wall on the piston of only 1/16 inch all around. This makes a rather difficult machining proposition because of the fact that the casting springs considerably if a cut of any depth is taken. It is therefore necessary for the operator to go slow, in machining, and to facilitate the roughing, the casting is supported by a cutting tool on each side. The same tool set-up is also used for taking the final cut so that any tendency of the casting to spring out of shape is minimized. In spite of the fact that the work must be handled with care, 130 pistons are finished in each machine in ten hours.

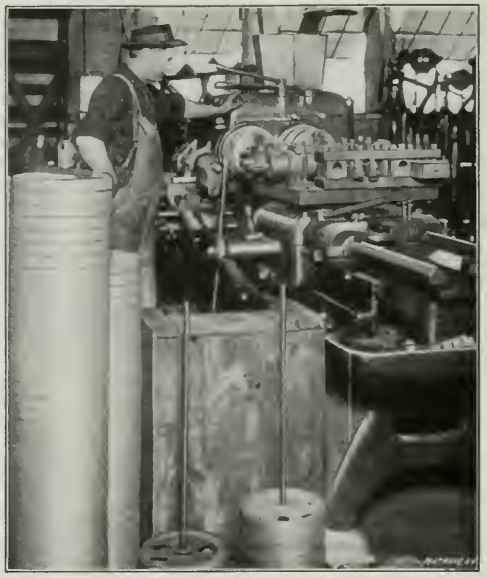


Fig. 10. Machining a Motor Cycle Flywheel on the Double-spindle Flat Turret Lathe

Machining Motor Cycle Flywheels

Another interesting operation performed on double-spindle flat turret lathes is the machining of motor cycle flywheels, two being held at one time in the two chucks fastened to the spindles of the machine. Fig. 10 shows one of the double-spindle flat turret lathes at work on flywheels, whereas Fig. 11 gives a closer and better view of the tool set-up. The flywheel is finished to 9 inches outside diameter, and has a width of rim of 1 3/32 inch. The first operation consists in facing the flange and hub; the second, in turning the rim and drilling the hole at the same time; the third in back-facing the flange and breaking the corners; and the fourth in taper reaming the hole which has already been drilled. The taper on the reamer is 6 inches to the foot. This flywheel is machined all over with the exception of the rear hub, the depth of which is ⅞ inch. The production is 140 flywheels in ten hours.

In the preceding examples, the advantage of the cross-sliding head is clearly indicated. In many instances production has been greatly increased by its use, and it also adds to the accuracy of the work, because the position of the head for each consecutive operation is definitely set by means of stops, interchangeable manufacture thus being possible.

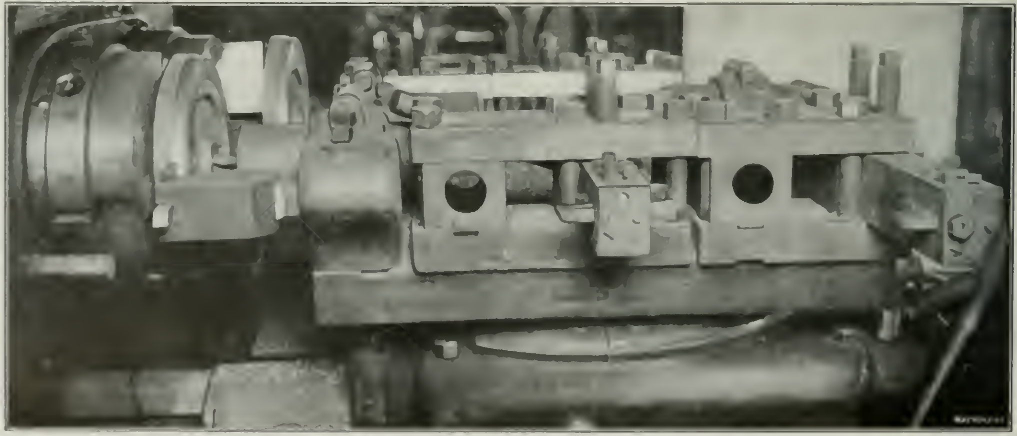


Fig. 11 View of Machine in Fig. 10, showing Tool Set-up for machining Flywheels

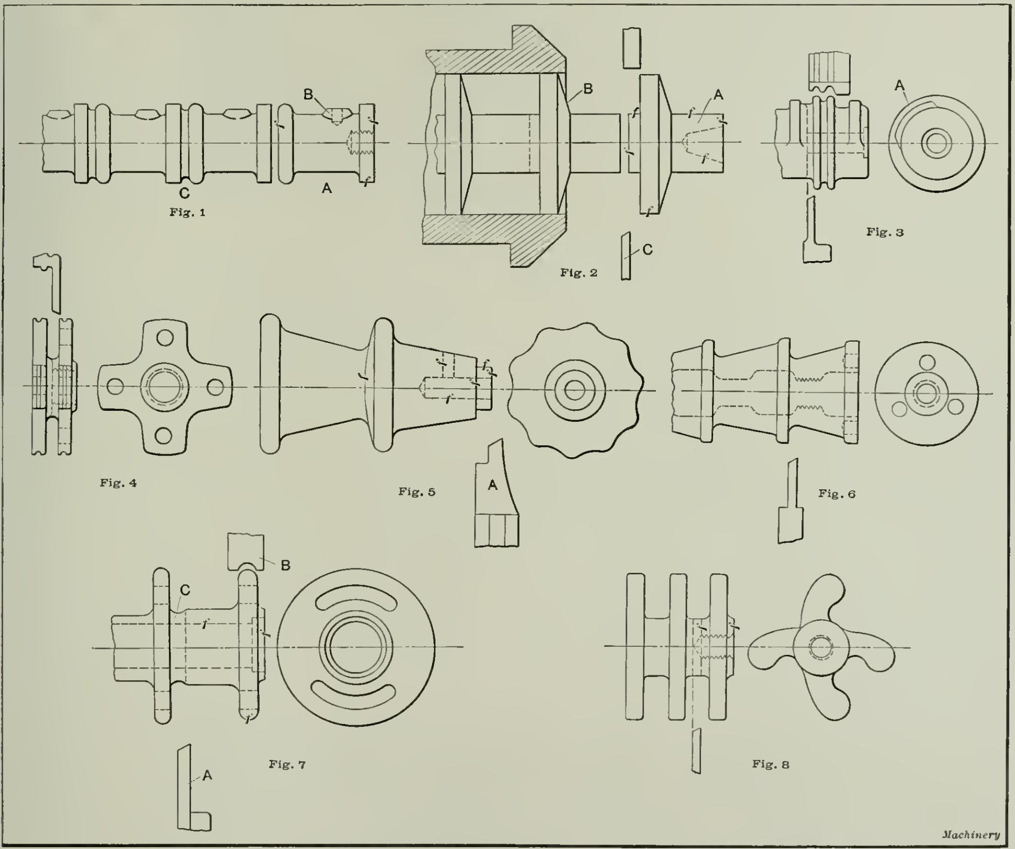
MACHINING CASTINGS IN THE AUTOMATIC SCREW MACHINE

HOW WORK IS CAST TO ENABLE IT TO BE FINISHED ON THE "AUTOMATIC"

BY E. WHITNEY

THE machining of cylindrical cast metal parts is usually performed in the turret lathe or semi-automatic machines. The hand turret lathe requires an operator for each machine, while the semi-automatic machines of the single-chuck type require considerable time to load the work. A few manufacturers have saved considerable expense in machining round parts to be made of cast metal by casting them in bars from 4 to 6 feet in length according to the length of the piece, and finishing them automatically in one of the different forms of screw machines, the same as in handling bar stock. An important feature of this method is the use of the various attachments which belong to the automatic machines. The most success has been found in machining brass parts although the harder metals including cast iron may also be machined successfully. The piece shown at *A* in Fig. 1 is being manufactured in large quantities from hard brass cast in five-foot lengths which carry thirty pieces to one bar. The first advantage gained by using this method is in finishing the piece at both ends without rechucking, as would be necessary in the usual type of hand machine. The ends and the diameter at one end are finished by the cut-off tool when separating the piece from the bar. The boss shown at *B* justifies the piece being made in the manner described; otherwise it should be made from bar stock. The hole in the boss is drilled by the cross-drilling attachment. The way in which these parts are cast in one unit is shown at *C*. It is well to note that bars should not be cast in lengths of more than 5 or 6 feet, as there is danger of warping when the metal cools; also, work which is less than 1 inch in diameter should not be machined in this manner for the same reason.

Fig. 2 shows the kind of work which will allow the greatest saving when machined from bars of cast metal. The length of the bar for this piece was 4½ feet and contained sixteen parts. As the piece was required to be finished all over, it was first made from cold-rolled steel bars which proved to be expensive owing to the waste of metal and time in turning the stem; and as the material could be cast iron as well as steel, it was made in single castings and machined in a hand turret lathe. This method, however, required two operations, as the piece was finished on both ends, and also because the hole was required to line up with the large diameter. The order of operations was as follows: 1. Chuck the work on the extension *A*. 2. Face the end and shoulder, and turn the small diameter and outside diameter. 3. Turn the piece end for end and chuck it on the outside diameter. 4. Center, drill, face and ream the tapered hole. The weak point in the preceding order of operations is in No. 3 because the large diameter is not of sufficient width to secure a good purchase for the chuck jaws. By machining this piece in the automatic screw machine from a cast bar these objections were overcome, and the piece was also finished complete with one setting of the machine. The way in which the cast bar is carried in the chuck is illustrated at *B*, and the cut-off tool is shown at *C*.



Figs. 1 to 8. Examples of Various Types of Castings which are machined in Automatic Screw Machines

The work shown in Fig. 3 has a cam cast on each piece as shown at *A*. This cam later receives a file finish. The work is machined in the manner described for the other pieces and is separated from the bar by the cut-off tool, as shown. A saving was also made on this piece because the length of the cam varied from 30 degrees to 270 degrees, which required the use of four different chucks on the hand machine, whereas on the automatic machines the length of the cams did not affect the holding of the work. The base-plate shown in Fig. 4 is made of cast brass and was formerly turned and tapped on the engine lathe, after which the holes were drilled in the drill press. A saving of 200 per cent was made when this piece was cast in bars and machined in the automatic screw machine. This exceptional saving was not only due to the automatic performance of the turning and threading operations, but also to the use of a special cross-slide drilling attachment, which is not the usual cross drill but comprises a drill that is fed longitudinally. This has been previously described in these columns as well as the method of indexing the stock to drill more than one hole in a piece. Cast-iron knobs may also be machined economically by following the preceding methods and considerable expense saved, especially when they are required to be finished on both ends, as was necessary on the one shown in Fig. 5. In this case both ends are finished by the cut-off tool *A* and the cross-slide drilling attachment is made use of.

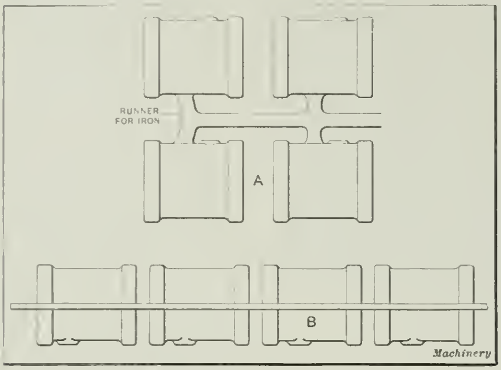


Fig. 9. Two Methods of arranging the Pattern and Mold for the Same Piece

The piece shown in Fig. 6 differs from those previously described in that the hole is cored. The piece is made from soft cast brass and is not required to be finished accurately. The method for drilling the hole is the same as described in connection with Fig. 4. When parts are made with cored holes the bars should be cast in much shorter lengths. Another example of work with a cored hole is shown in Fig. 7 where *A* is the cut-off tool and *B* the forming tool. The groove at *C* is molded into the piece to prevent a sharp corner when it is separated from the bar. Fig. 8 is intended to show how pieces which do not have a cylindrical shape may be cast into a bar and machined in the automatic screw machine. The piece shown is similar in shape to a wing nut and is cast in two separate parts, which are arranged cross-wise.

A study of the preceding cases will show that the largest saving is made when the work requires special operations which the hand turret lathe is not provided for, and also in finishing the work in one setting of the machine instead of chucking twice. Parts which might require special and expensive chucks on the hand machine are peculiarly adapted to be machined from the cast metal bar in the automatic screw machine.

In considering the molding of string patterns, three questions will naturally arise. 1. Can string patterns be readily molded? 2. Is the molding done by machine or by hand? 3. What is the relative cost of castings made singly and in strings, including the patternmaking? String castings may be molded as readily as single ones or those of the gang type, excepting those parts having cored holes which would be more difficult to mold in strings, owing to the length of the cores. For this reason the various operations on the latter (also on parts more than 2 inches in length) should be carefully estimated and compared with the added cost of molding, and they should only be machined in the manner described when the reduced cost of these operations justifies the more difficult method of molding.

Whether the piece is to be molded by machine or by hand depends upon four conditions. 1. The material: Parts molded of brass require more even ramming than when made of cast iron or steel and for this reason could be more readily molded by hand. 2. The length of the piece: The parts shown in Figs. 1 and 6 are of such length that in order to carry a sufficient quantity in one bar, the string pattern would be so long that it could be much more readily molded by hand than by machine. 3. The amount of accuracy required: In molding bars of this kind care should be taken by the molder not to rap the pattern harder at one time than another, and never to rap the pattern harder than necessary to remove it from the sand, as the first error would cause variation in the size of the work and the second cause the work to cast large. This would occur to a greater extent with hand molded bars than with the machine molded ones. But the same may be said of any castings and should not be held as an objection to performing automatic operations in the manner described, as this class of work is usually done on Cleveland automatic machines or those of similar construction which allow for adjustment of all cam or tool travel. 4. The quantity to be made: As in operations of every kind the quantity of parts to be made must be sufficient to justify the first tool cost. For example, the piece shown in Fig. 2 was made in a large molding machine carrying five bars to one mold. The cost of fitting the machine with patterns is greatly outweighed by the increased production, as but two bars could be made in a mold by hand, at one time; also about thirty or thirty-five bars could be machine-molded in the time required to mold two or four by hand. At the same time, it should be remembered that the machine would require two operators and the hand molding but one.

A comparison of patterns is shown in Fig. 9. A gang pattern for molding the piece by hand is shown at *A*, and *B* shows the methods of mounting the two halves of the pattern on a board for molding in a machine of the small type. This comparison shows that the expense of the string pattern and of the gang pattern would be about the same. The patterns for making the pieces shown in Figs. 1, 4 and 6 would be made in two halves, split through the center, having two bars in each mold (for hand molding). The length of the string pattern for the piece shown in Fig. 6 is 3 feet; this is shorter than the others on account of the core. The length of the string pattern for the pieces shown in Figs. 1 and 4 is 4½ feet. The pattern for the piece shown in Fig. 6 should have core prints extending about 1½ inch at each end to insure having the correct core location and to support the core which is made of dry sand. The patterns for the pieces shown in Figs. 2 and 5 would be made of metal, and for machine molding would be fastened to the plate on the machine. If the machine had but one plate only half patterns would be required, as the top and bottom of the mold could be made from the same half pattern. The piece shown in Fig. 3, however, would require two halves to the pattern on account of the cam-lugs which it carries. The piece shown in Fig. 7 may be machine-molded, one mold carrying five or six bars, and the length of each bar should be about 3 feet. A machine-molder could make about seventy-five molds a day (of parts similar to those described) which would equal several hundred pieces, according to their size and the number cast in one mold. A safe estimate on the same work performed by hand would be about one-fifth this amount, making allowance for two men operating the molding machine. In conclusion, the writer wishes to state that the crop ends of the bars were allowed to accumulate until there were enough on hand to machine in the hand screw machines. In some cases this proved advantageous in making the special parts which are often required. These parts differ very little from the regular work and are usually ordered in very small quantities.

BOLT AND NUT MAKING*

GENERAL METHODS USED IN FORGING AND MACHINING EOLTS AND NUTS

BY DOUGLAS T. HAMILTON†

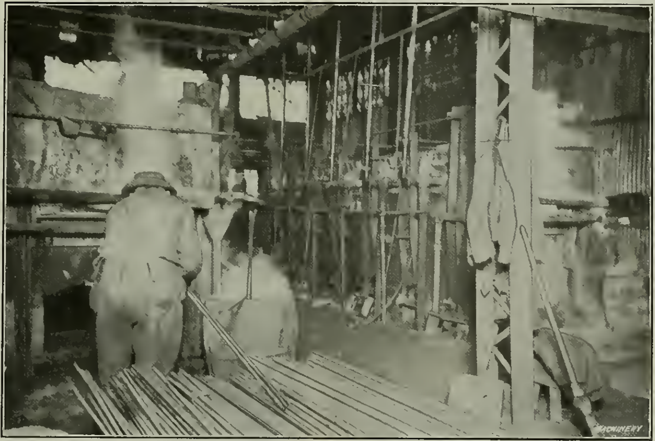


Fig. 1. Placing Rods in Furnace to be heated, from which they pass to Acme Continuous-motion Bolt-making Machine

WHILE the articles on bolt and nut making which appeared in previous numbers of MACHINERY contained considerable information on this subject, there were some details that were not fully dealt with. In the following article, a general resumé will be given of the methods used in a large bolt and nut factory in the Middle West that makes bolts and nuts exclusively. It is therefore evident that the processes used here are, to a certain extent, characteristic of those in general use in the industry.

Heading Bolts

As an example of bolt heading, threading, etc., a ⅝-inch machine bolt 2 inches under the head will be considered. This is made from Bessemer steel rod that is obtained in bars 14 feet long. As shown in Fig. 1, the bars of steel are arranged in a pile at the rear of the furnace and are inserted in the manner illustrated. The furnace is 15 feet long and is heated by natural gas. The temperature to which the rods are heated varies from 2100 to 2200 degrees F. When they have attained the proper temperature the forging machine operator grips one of the bars with a pair of tongs and inserts it in the feeding rolls *A* of the Acme continuous-motion bolt and rivet machine shown in Fig. 3. These rolls are located about 1½ or 2 feet from the front end of the furnace and as the bar is not very large in diameter and cools quickly, it is protected by sheet steel guards in its passage from the furnace to the rolls to keep the temperature as uniform as possible. From the rolls, the rod passes to the gripping dies, where it is gripped, headed and cut off. The machine used for making this bolt is called a "continuous motion bolt and rivet making machine," because the operation is continuous, the bolt receiving only one blow and then being cut off; this sequence is continued uninterruptedly until the bar is completely used up. The production from a machine of the continuous-motion type is evidently greatly in excess of that which can be obtained from single-blow machines. The continuous-motion machine produces from 25,000 to 30,000 bolts in ten hours.

A rather ingenious arrangement is used in connection with the Acme forging machine for carrying the bolts away from the machine. It consists of a short escalator operated by the belt *B* and pulley *C*. The bolts, after being headed and cut off, drop from a chute in the forging machine onto this traveling platform and are carried up by it and dumped into a sheet-iron wheelbarrow, as shown in Fig. 2. When this becomes filled, it is removed and an empty one put in its place. It is therefore unnecessary to pick the bolts up off the floor. This is a very convenient method of transporting them for the other operations. Fig. 2 also shows the position of the operator when he feeds the heated rod into the feeding rolls of the machine.

Removing the Flash

Following the forging operation, after the bolts have become cold, they are transferred to another machine where the flash is removed. The bolts are put in a chute attached to this machine and pass down to a slide from which they are carried into the shearing dies by means of a segment carrier. When this carrier makes one-quarter turn, another slide, operated by a bellcrank and traveling in a position at right angles to the first carrier, picks up the bolt and carries it to the dies. The dies are in segment form and are operated from each side by cranks that receive movement from a slide through the action of a cam groove. Two spring rods fitting in a longitudinal groove act as ejectors for the bolts. The trimming is accomplished by a punch in connection with the dies, which forces the bolts right through the dies into a box under the machine, removing the flash that has been produced by the forging machine dies. This trimming operation is necessary because it is practically impossible to produce bolts in a single-blow continuous-motion bolt and rivet machine without producing flash, especially if a good full head is desired.

Pointing or Chamfering Bolts

In order to facilitate the starting of the threading die on the body of the bolt and also to produce a good end, the bolts before threading are chamfered and rounded off at the same time. The cutting-off operation in the forging machine produces an end that is not altogether straight but is rounded on one side of the body and sharp on the other. This pointing opera-

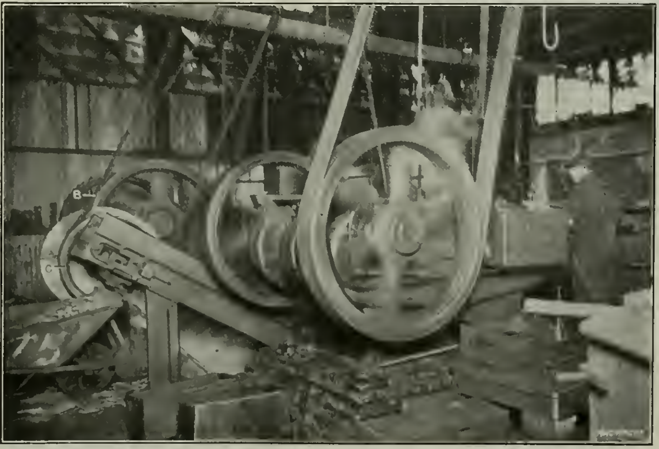


Fig. 2. Rear View of a Pair of Acme Forging Machines, built by the Acme Machinery Co., Cleveland, Ohio, showing Methods of conveying Bolts from Machine to Wheelbarrow

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* For information on bolt and nut making previously published in MACHINERY, see the series of articles on "Machine Forging," in the April, May, June and July, 1913, numbers.

† Associate Editor of MACHINERY.

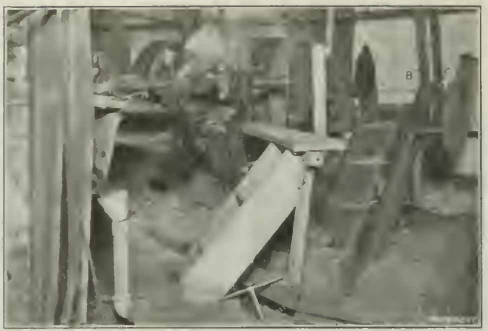

Fig. 3. Close View showing Rod coming from Furnace and being fed into Acme Bolt and Rivet Machine by Feeding Rolls

tion removes this defect and facilitates the starting of the dies. The pointing operation is accomplished in a machine of the type shown in Fig. 4. This is a small bench machine, operated by hand and foot power. The operator holds the bolt in a nest attached to the slide *A* which is forced forward by means of a bellcrank connected by a chain to the foot treadle *B*. The pointing knife is held in the head *C* and is formed on the inner end to the same shape as that required on the end of the bolt. This bench machine can be operated very rapidly and one operator can turn out 25,000 bolts of the size previously mentioned in ten hours.

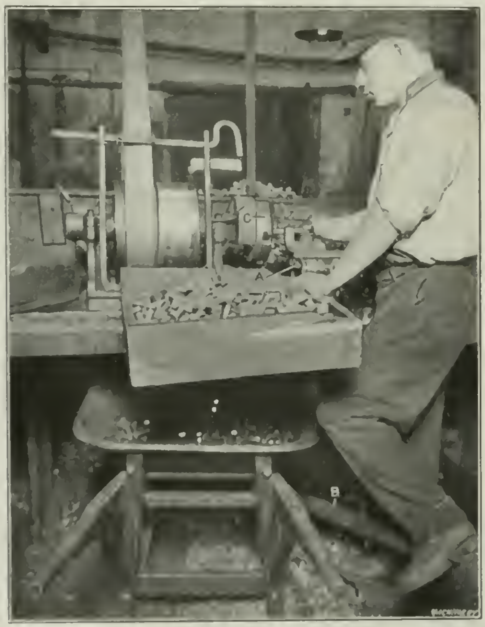

Fig. 4. Pointing Bolts prior to threading

Threading Bolts

Following the pointing operation, the bolts are taken to the two-head threading machine shown in Fig. 5. This machine is provided with two slides, and while one bolt is being threaded the operator is inserting another in the other slide so that one slide is practically in continuous operation all the time. The thread produced on this bolt is 5/8 by 11 pitch, 1 1/4 inch long. The work is just slipped into a groove in a plate fastened to the slide and is backed up by a bracket provided with another plate which bears against the head. The slide is operated by hand to bring the bolt into contact with the chasers of the threading die and then the bolt automatically leads into the die itself, by the action, of course, of the pitch of the chasers. On this machine 6000 bolts can be threaded in ten hours. This finishes the machining operations on the bolt.

Hot-forged Nut Making

The nut used in connection with the bolt just described is of square section and is produced in the hot-forged nut machine shown in Fig. 8. This type of machine, as was described in a previous article, is only used for making square nuts but produces these without fins or burrs. The bar used for making the nuts is 15/16 inch by 19/32 inch thick by 10 feet long and the nut produced is 1 inch across the flats and 9/16 inch thick. The bar is heated in the furnace shown to the right to a temperature varying between 2100 and 2200 degrees F., for a length of about 3 1/2 feet—three heats finishing a ten-foot bar. The bar is then removed to the forging machine and is turned over after making each nut. The method of making square nuts in a machine of this type was clearly illustrated in a diagrammatical view, Fig. 42, that appeared in connection with the article on this subject in the June, 1913, number of MACHINERY. The production of 5/8-inch nuts from a machine of the hot-forged type varies from 2800 to 3000 pounds in ten hours, or in other words from 24,800 to 26,600 nuts.

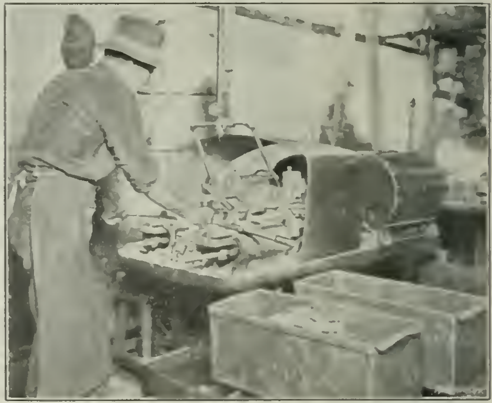

Fig. 5. Threading Bolts in Two-head Threading Machine

Tapping the Nuts

The tapping of the 5/8-inch nuts is accomplished in six-spindle Acme semi-automatic nut tapping machines, a row of which is shown in Fig. 6. Fig. 7 shows a closer view of one of these machines and illustrates the operation of the feeding mechanism and tap. Referring to the latter illustration, it will be seen that the nuts are fed down to the tap through the slide *A* and are moved over in line with the taps by the feeding finger *B*. This feeding finger is operated from a rod at the rear of the machine through a system of levers which come into action as the spindle of the machine is lifted.

Each tap-holding spindle is operated independently. It is counterweighted to prevent breaking the taps and is provided with an automatic lifting device consisting of a worm and auxiliary mechanism. By means of this device, the tap is lifted after one nut has been tapped, allowing the next nut

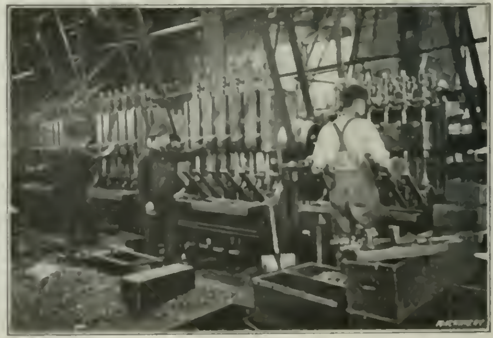

Fig. 6. A Row of Six-spindle Acme Semi-automatic Nut-tapping Machines

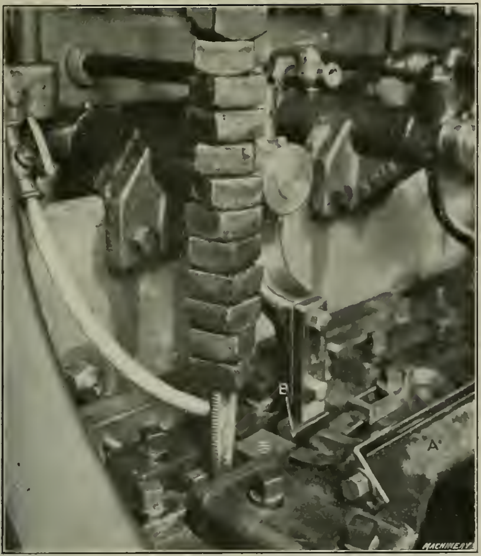

Fig. 7. Close View showing Operation of an Acme Semi-automatic Nut-tapping Machine

to be fed in automatically from the chute to the nut holder. As the tap passes through the nut, the worm shown at the top of the spindle in Fig. 6 drops, and in so doing, comes in contact with a bronze washer. This washer, through a bell-crank arrangement of levers, pushes a shoe into contact with the threads of the worm, whereupon the latter rises and lifts up the tap so that it clears the nut and nut holder, allowing another nut to be fed in. When the tap becomes filled with nuts, it is removed from the spindle by the operator. The spindle automatically stops when the tap is full, as the tap filled with nuts prevents the worm from contacting with the bronze washer. The tap is removed by depressing a foot lever and is held in place by quick-acting ring chucks. The production of ⅝-inch nuts from a six-spindle machine of this kind is great, varying from 15,000 to 17,000 per day of ten hours.

For nuts smaller than ½ inch, Acme semi-automatic nut tapping machines of the hopper type, as shown in Fig. 9, are used. The hoppers of these machines consist of a receptacle inside of which there is an arrangement similar to a turnstile. This agitates the nuts and feeds them down through a chute from which they pass to the chuck. This machine is provided with three spindles carrying taps, but only one tap is in operation at one time on a nut. As one tap becomes filled with nuts, the work-holding turret indexes and brings another tap into operation. This sequence of operations is continued until all the taps are filled. A bell then rings and the operator removes the taps, strips the nuts from them, inserts the taps again and starts the machine. Production on a machine of this type is high, ranging from 15,000 to 20,000 standard ⅜-inch nuts per day of ten hours.

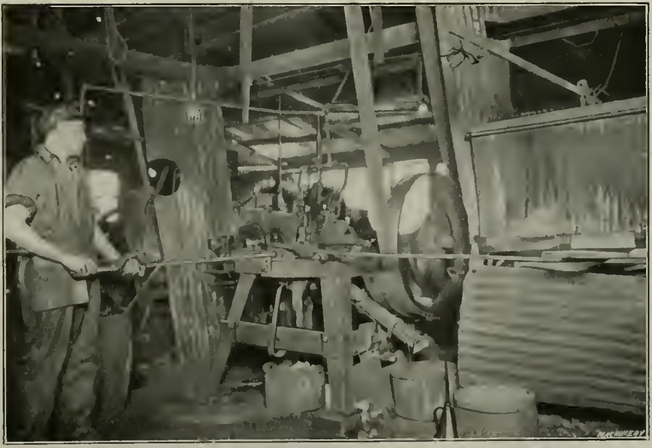

Fig. 8. Making Square Nuts in a Hot-forged Nut Machine

THE LOCOMOTOR

An interesting engine for switching purposes has been developed in Germany during the last year or two. It is known as a locomotor, and consists of a small gasoline or oil engine placed on a wheel base running on the rails. This apparatus weighs about two tons and would therefore be too light to exert the tractive force necessary in switching any considerable number of cars. This difficulty, however, is overcome by an ingenious arrangement by means of which part of the weight of the car to which the locomotor is coupled is transferred from the wheels of the car to the wheels of the locomotor, so that the weight of the car being switched is added to the weight on the driving wheels of this novel switching engine. It has been found especially advantageous to use this motor at small and medium-sized stations, harbor tracks, etc., where the work to be done is hardly enough for a regular switching engine and where the cost of using such an engine is therefore excessive. It is stated that the same work can be performed for less than one-third the cost by using an arrangement such as described.

An interesting item in connection with the development of the locomotor is that its inventor is not a railroad man but an architect. This is another of many examples of how men trained to a certain line of work seldom conceive radically new ideas for doing that work, but rather develop along the lines into which they have been trained, whereas a man comparatively unfamiliar with the general practices in a trade or industry may sometimes conceive of improvements of great value which a specialist would never have thought of.

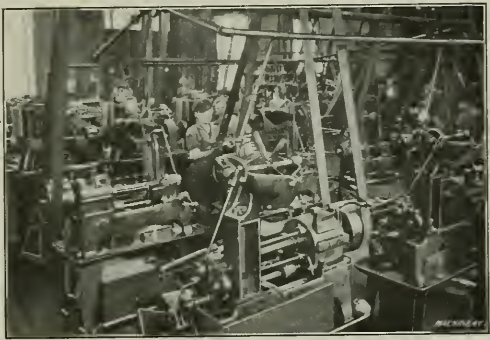

Fig. 9. Hopper Type of Acme Semi-automatic Nut-tapping Machine for Small Nuts

* * *

It is estimated that over 32,000,000 barrels of crude oil were used for fuel by railroads of the United States in 1912. This is an increase of over 4,000,000 barrels as compared with 1911. During the last few years crude oil has replaced coal on many of the railroads in Texas, Oklahoma and Louisiana. The adoption of oil for fuel has added greatly to the comfort of the traveling public and has lessened the labor of the firemen as well as reduced the cost of operation. Over 1200 oil-burning locomotives are in use on the Southern Pacific and more than 800 on the Santa Fe. The total mileage of railroads now operating with fuel oil is about 28,000 miles.

CONVEYORS AND CONVEYOR SYSTEMS

DIFFERENT TYPES OF CONVEYOR SYSTEMS—PRINCIPLES GOVERNING THE DESIGN OF CONVEYOR BELT PULLEYS

BY C. F. HERINGTON*

THE application of machinery for handling and conveying heavy and bulky material has of late assumed considerable importance. No branch of engineering has been more rapidly developed and less written about than the construction of appliances for loading and unloading heavy goods, particularly coal and ore. The modern flour mill may also be cited as an example of automatic handling. So perfect is its automatic equipment that wheat may be unloaded from an ocean-going vessel, stored, cleaned, graded, ground, dressed, packed, weighed, registered and delivered into a railroad car without any manual labor at all. The result is a saving in both time and labor, especially in the number of men employed, for with modern conveying systems the number of men is at least 25 per cent less than where manual labor is employed. Naturally there are heard objections to these labor saving devices, as being detrimental to the interest of labor; but experience has proved the contrary, for wherever we find these conveniences, we also find that the life of the laboring man has been made easier, higher wages have been paid and his economic value to the community has been greatly increased.

Although conveyor systems are, as a matter of history, only about twenty-five years old, so rapid has been their development, that there is now a conveyor system available for any and all kinds of material required to be handled. Conveyor systems are divided into approximately three different classes, each class having a number of styles and ways of performing the work. They are as follows: (a) bucket conveyors; (b) screw conveyors; (c) belt conveyors.

Bucket Conveyors

Bucket conveyors are usually designed for special purposes. For instance, grain conveyors are always encased in wooden and steel casings and the casings are nearly always vertical. The usual support for the buckets in this case is belting—either leather, cotton or rubber. For coal, coke and other heavy materials the buckets are fastened to chain links, either single or double strand, depending upon what capacity the conveyor is designed for; and in this case the conveyor casing is usually carried in a slanting position. Bucket conveyors should always be fed from the side on which the buckets ascend, so that the stream of material runs into the buckets, meeting them on their upward journey. This prevents the material from falling into the conveyor well and does not necessitate the buckets dredging through an accumulation of feed. With bucket conveyors of small capacity, however, it is customary to place a boot at the bottom of the well and the buckets pass down and through this boot and fill themselves coming up through the material.

The reason why bucket conveyors should sometimes be set vertical and sometimes in an inclined position is that in elevating materials of low specific gravity, a conveyor can be driven at a much higher speed than the conveyor which is handling material of higher specific gravity, as a velocity of the material at the point of delivery which would not injure grain, would break up coal and other heavier products. Moreover, the receiving spouts and chutes would be quickly destroyed by the impact of the material. Conveyors in a vertical position are, therefore, only suitable for specifically light material and can be run at a circumferential velocity of 250 to 350 feet per minute. Conveyors for heavy material must be wholly or partially inclined to give a clean delivery without scattering, and they should run at a speed of 50 to 160 feet per minute. It is for this reason that conveyors for specifically heavy material require so much larger buckets, chains, etc., than conveyors of the same bulk capacity for handling lighter material. Bucket conveyors should always be driven from the top so that the upward side of the conveyor (the side containing the load) can be tight, while the empty side will run slack. As a general rule, bucket conveyors are expensive to install and costly to operate, on account of their number of moving and consequently wearing parts, which are in constant need of renewal.

Screw Conveyors

The screw or worm conveyor is without a doubt one of the oldest types. The first screw conveyors were made of soft wood octagonal spindles into which were driven hard wooden blades with pegs at one end. In the course of time this was improved upon by cast iron sections being threaded on a square iron shaft, which was turned for suitable bearings at intervals of 6 or 10 feet. Modern screw conveyors are built up of sectional screw flights, that are fixed to a central shaft or spindle by means of its shank which is tapped and fitted with a nut. The spindle is usually made of steam pipe in lengths of about 8 feet, the different lengths being coupled together. Then there is the continuous screw conveyor, which is a spindle and screw all rolled in one continuous screw into sections of about 10 feet. Screw conveyors are fitted into a wooden or steel trough so as to leave a clearance of between ⅛ and ¼ inch.

A detail of great importance in all screw conveyors is the intermediate bearing; this if cumbersome, obstructs the passage of the material—a drawback that must be carefully avoided. As all adjustable bearings are in halves and of necessity bulky, it is preferable to choose solid bearings, although they lack some advantages that the former possess. The best intermediate bearing is a small phosphor-bronze bushing, secured by a short piece of pipe to a cast-iron support. The pipe is screwed into the support and secured by means of a lock-nut. The bearing can be oiled through the pipe. A word of caution might be added here to the engineer about to install a screw conveyor system. Do not have too long a run for your conveyor without breaking in for a drive—say not over 200 feet for a 6-inch screw, and not over 300 feet for a 9-inch screw conveyor. If possible, always place your drive so as to pull the material toward the drive,

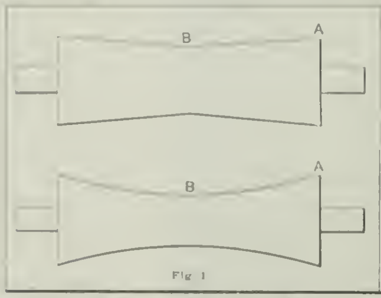

Fig 1

Fig 1 Double Cone Belt Conveyor Pulleys—Objectionable owing to their Variable Surface Speed

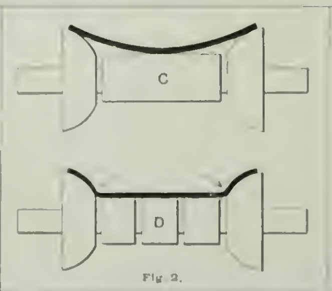

Fig 2.

Fig. 2. Dish Pan" Pulleys which have the Same Disadvantages as Double Cone Pulleys

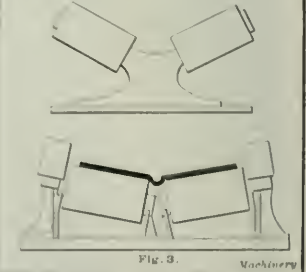

Fig. 3.

Fig. 3. Poor Types of Conveyor Belt Pulleys that cut the Belt instead of allowing it to be destroyed by Ordinary Wear

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* Address, 2315 Decatur Ave., Bronx, N. Y.

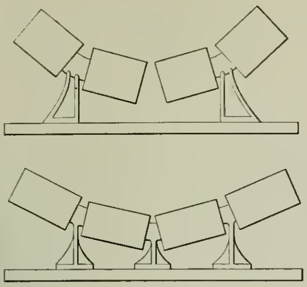

Fig. 4

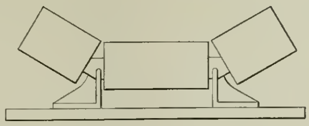

Fig. 5

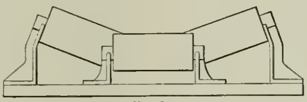

Fig. 6

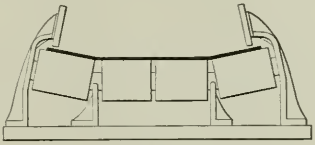

Fig. 7

Machinery

Fig. 4. A Better Type of Belt Pulley. Its Objectionable Feature is the Space at the Center

Fig. 5. Efficient Form of Belt Pulley with Central Space fully supported
Fig. 6. Best Type of Belt Conveyor Pulley

Fig. 7. Belt Conveyor provided with "Skirt Boards" to hold the Material in Place

never at the opposite end so as to push the material away from the drive. If one of the flights or a shaft bearing breaks, you can bring what material lies between the break and the drive toward the drive, while in the other case, if a break occurs you will continue to pile up material and trouble for yourself at the point of breakage, before your overload release coil on the drive will stop the screw.

Belt Conveyors

And now we come to the belt conveyors which, of all conveying systems, are the simplest and best. They are simple in construction, have a minimum number of wearing parts, are positive in action and can be used as carriers on both runs of the belt. Belt conveyors are independent of the carriers and can be loaded at any point, either by hand from bins or by means of automatic feeders; and they can also be discharged at any point and are reversible. They can be used for conveying material in sacks and packages as well as in the bulk, and can be built on portable frames and moved from place to place, all of which tends to make them an ideal system for conveying. From the start, however, the writer hastens to say that putting a belt over two pulleys, pulling and tightening until it is perfectly flat, and installing guide pulleys to "steer" it, does not by any means constitute the successful installation of a belt conveyor. On the contrary, there are a number of points, each small in itself, but which in the aggregate make or unmake a belt conveyor. Some of these points I will try to explain.

Troughing Idlers

The troughing idlers are often constructed more for the immediate convenience of their individual manipulation than with thoughtful consideration for the wear and tear of the belt. As this is first, last and always an item of the greatest importance, it ought to be considered first. Pulleys in line may have a tendency to act like a pair of shears and this is continuous and intensified when the loads are heavier than they ought to be, or when the carriers are spaced too wide apart, a condition that is a fruitful source of destruction to the belt. As a rule, in a belt conveyor of any appreciable length, the belt represents at least two-thirds of the initial cost of installation, and it would hardly seem the part of wisdom to endanger the two-thirds which is subject to constant wear to effect a saving in the one-third which, owing to the nature of the material and the character of the work that it performs when under proper care and management, should last almost indefinitely. Such, however, is often the case. In all kinds of mechanical devices the construction and adaptability of the article in question is always the prime consideration in making a choice, and this principle holds good in conveyor belts, or should do more so than in most cases, because of their large initial cost and liability to injury through misuse.

When troughing idlers were first built they were designed for an angle of troughing of 45, 30, 25, and 20 degrees, and finally the five-pulley idler in contradistinction to the three-pulley idler, was made with the differentiation in the pulleys of 15 degrees. The reason for this is self-evident. The latter type more nearly conforms to the circular, eliminating angular bending and being a compromise, although a bad one because not necessary. Fig. 1 shows what was probably the first troughing idler, the double cone pulley. This design was objectionable because the diameter at *A* is much greater than the diameter at *B*, and consequently the surface speed of the pulley is greater at *A* than at *B*. This produces an abrasive action due to belt slippage, which rapidly divests the belt of the skin or covering, allowing it to absorb moisture and grit so that it is soon destroyed.

Fig. 2 shows the dish pan idlers. Here the three pulleys revolve independently of each other, the theory being that the belt would have a line contact only, as shown at *C;* but in practice it is found that a loaded belt takes the position shown at *D* and all the disadvantages of the double cone pulley still remain. Fig. 3 shows the worst type of troughing idler. Why? Because there is no support for the belt at the center where the load is carried. There is a rolling shear action that cuts the belt, and it sags between the carriers under the weight of the load. The result is that the belt is cut in halves and destroyed, not worn out. Fig. 4 shows the four-pulley type of troughing idler. This is a little better, but is still objectionable on account of the fact that it is open in the center.

Fig. 5 shows a good design of troughing idler, eliminating slip and scour, for the pulleys revolve independently, but not in the same place. Fig. 6 represents the latest and the most perfect of the three pulley designs. It eliminates the rolling shear effect of pulleys in line, while retaining all the other advantages of the general idea. This type of idlers, with the end pulleys at an angle of 40 degrees from the horizontal, used in connection with a good rubber belt, gives the maximum results and a perfect belt conveyor. Fig. 7 shows what is often found on belts that are so flat that the material will spill if not controlled. This is done by what are called skirt boards and they are "death" to a belt. The material catches or scrapes against the skirt board as it passes, digging into the board and into the belt as well. Material gets under the skirt boards and grinds its way along, cutting the edges off the belt and making it narrower and narrower, until entirely destroyed.

Abrasion of Belt

The abrasion of a belt is controlled by so many factors that we will necessarily have to take them up individually.

First: A conveyor belt should never be called upon to do any other work than transfer the material from point to point. But often it is called upon to stop the velocity of the material, producing abrasion that is illegitimate and ought to be taken care of in the design of the transfer or feeding chutes, but which unfortunately is not the case. There are two methods of making transfers: one using gravity, which is always preferable when conditions make it possible, and the other, in cases of absolute necessity, utilizing velocity.

Second: Much depends upon the correct design of the transfer chutes. Too often we see skirt boards used, running parallel with the travel of the belt, to control the spill of the material due primarily to the inability of the belt to conform to the outline of the troughing idler, which in many cases is running almost flat, and in these cases the material catching under the edge of the skirt boards has to drag and wear and abrade until it has reached the end of these retaining devices. This is wrong—absolutely wrong. If the transfer is properly designed, with the center sufficiently contracted and the noses or leads given the necessary freeing angle, skirt boards can be entirely eliminated, and the belt relieved of this wear and tear, which is unnecessary and very destructive.

Third: Installing elevating belts at too steep an angle or running them too fast produces slip and scour. There is a relation between the speed and angle of elevating which must not be overlooked. You can put a sheet of paper under a glass of water and draw it along or you can snap it out and not move the glass.

The Driver or Head Pulley

In order to conform to false economic ideas and to reduce first cost, the head or drawing pulley is often made too small, increasing the necessary tension in order to obtain traction, whereas the true common sense of conveyor belt driving is to have the traction without tension. In dynamo driving, as well as in conveyor driving, tension must be eliminated if you wish to get the best results in longevity of your belting. This is sometimes overcome, or attempted to be, by the use of lagged pulleys, but too frequently this is only the excuse for decreasing their diameter rather than decreasing the tension. In no part of the design of belt conveyors is more damage done than in this one particular feature, for it is true that the usual type of conveyor belt requires absolutely this excessive tension in order to make it track or approximately run true.

Cleaning a Conveyor Belt

The method that is commonly used of employing a brush to clean the conveyor belt and often using it on a tripper between the two pulleys to prevent the material on the working side being imbedded in the cover of the belt by the pressure of the snub pulley, is bad to say the least. Both the pulleys on a tripper are crown pulleys, which prevents the brush from having a level or flat surface to operate against. If the material is wet, as is often the case, it clings and cannot be removed except with the use of so much pressure by the brush on the belt as to do serious damage to the cover, as well as rapidly wearing the brush, necessitating an almost constant adjustment. A much preferable method of cleaning a belt is to have a driven shaft with loose auxiliary shafts pivoted together and thrown out by centrifugal force, which strike the belt with a continuous and incessant series of blows, jarring the material loose and necessitating no adjustment. This method is equally efficient and divested of all the disabilities inherent in the use of the complicated mechanism required to operate the brush. Such an equipment is shown in Fig. 8.

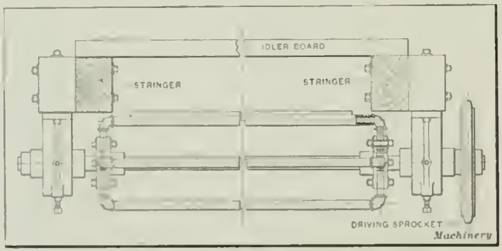

Fig. 8. Efficient Device for cleaning a Conveyor Belt

Improper Handling

In operating belt conveyors in series, especially if any of the sections are elevating, there should be a gradual stepping up of speed from the initial receiving conveyor to the ultimate distributing conveyor, if it is desired to prevent breakage. If the item of breakage does not enter into the problem, the speeds can be uniform. To produce breakage, choke a thin rapid stream with a thick, slow one by incorporating a large slow-moving conveyor into a series of conveyors with faster speeds, and this object will be accomplished. When starting, the conveyor should be at full speed before any material is fed onto the belt; and when stopping, the conveyor should be run at full speed at least five or ten minutes after the feed has been stopped, in order to have delivered the laggards or those pieces which may have a tendency to roll back, and which if delivered over the head pulleys when going slow, join in the transfer chutes and thereby do great injury to the belt.

Snub Pulleys

It is preferable, where it is possible to eliminate snub pulleys, to do so, rather increasing the diameter of the head or tail pulley and making a long lead to the first return idler; as the tendency of all snub pulleys is to bring the working surface of the belt with the material clinging to it against this snub pulley, embedding the material, which cuts its way into the body of the belt and thereby does serious damage.

Feeds

Correct feed is often the most essential adjunct of a belt conveyor, for its successful operation, and needs careful thought and consideration. The general principle involved is that the material should reach the belt moving in the same direction and at approximately the belt's speed or travel. This can be done in most cases, and always, if sufficient thought is given to the proposition in time. The feeding chute should be arranged to deliver the bulk of the load to the center of the belt, having the wings or leads sufficiently opened up or at an angle, so as to make the belt free itself and let the load distribute and come to a state of rest.

Deep Troughing

Originally belts were designed to have a deep trough. This gives the greatest capacity, cleanest carry, it is the easiest to feed on and to design the feeding chute for, and has only been modified to conform to the weakness developed in the belting which broke at the bending points, where the horizontal and angle pulleys met and sheared and destroyed the belt. To any longer suffer under the prejudice of this modified and unmechanical condition and construction is not necessary.

Decking

One of the most important features of a conveyor system, and the one too frequently overlooked, is the necessity for protecting the lower returning belt from any material dropping on it; and this is particularly true when the feed is very close to the end pulley, as is usually the case. This is very destructive, especially in carrying such material as ore, stone, gravel, coke, and in fact, almost any material, because it goes between the inner and unprotected surface of the belt and the pulley, and is embedded, destroying the thin film of protective cover, baring the fabric, allowing absorption of moisture and grit, and producing rapid destruction and disintegration of the belt.

Spacing of Idlers

When it is considered that the belt usually represents two-thirds of the cost of installation, the machinery one-third, and the troughing idlers often the least proportion of the one-third, it would seem the part of wisdom not to space them too far apart, producing an unnecessary sag in the belt and causing a flexing that does no good and often much harm. A little closer spacing is much to be desired and no additional power is required, as more power is saved by the elimination of the sag than is required to operate the additional pulleys. A perfect belt conveyor should embody maximum capacity, minimum expense, deep troughing and a clean carry, minimum tension and a perfect alignment, and absence of edge wear and corner break; all this can be obtained if you design the conveyor system to secure the desirable features mentioned and eliminate the objectionable ones.

* * *

Specifications for railway track scales adopted by railway engineers provide that knife-edge stresses shall not exceed 5000 pounds per lineal inch and that deflections in the levers from a straight line joining the end pivots should not exceed 1/2000 of their length, figured as a single beam. Unit stresses shall not exceed 2000 pounds for cast iron in tension, 3000 pounds for cast iron in compression, 7500 pounds for cast steel in tension and 8000 pounds for cast steel in compression.

WIRE PRODUCTS AND WIRE-WORKING MACHINES[*]

SOME OF THE PRACTICAL AND COMMERCIAL ASPECTS OF THE MANUFACTURE OF PARTS MADE FROM WIRE

BY E. R. MINER[†]

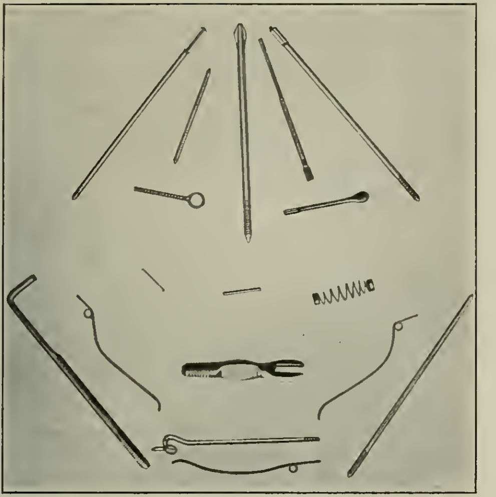

Fig. 1. Some Wire Products used in the Manufacture of Pianos

In every piano there are from sixteen to twenty-four different parts made from wire, and of some of these parts, two hundred or more are used. In all the pianos annually manufactured, many millions of these wire parts are employed. Suppose a certain section of the country turns out 10,000 pianos a year. One particular wire product forms a part of each key action. On a piano there is an average of eight octaves or 104 keys. Then of this one product alone, the 10,000 pianos would use 1,040,000 pieces. Made by hand, this product would require much labor and mean considerable business and the cost would be heavy. These parts are not made by hand, however, but are turned out by automatic machinery at the rate of 150 a minute. One operator can easily run three machines so that the entire requirement of this particular piece for the 10,000 pianos could be supplied by the work of one man with proper machinery in somewhat less than four days of eight working hours each. As a consequence, these parts can be sold very cheaply and also as a consequence, the supplying of only 1,040,000 of these parts would not be much of a business.

As before mentioned, there are from sixteen to twenty-four other parts that are made from wire, and there are many more than 10,000 pianos made in a year. No one manufacturer of pianos, though, will use enough of any particular wire part to pay for an investment in the necessary machinery for making it. The piano manufacturer finds it cheaper to buy them, which fact creates a distinct business—that of piano hardware, and probably 90 per cent of all the piano hardware is manufactured by half a dozen concerns. Judged by the number of separate parts, the business is enormous, as 40,000,000 to 50,000,000 pieces of one kind is no unusual output for one manufacturer. Before the days of the automatic wire-working machine, filling such an order would have been a practical impossibility—it would have required all the resources of a dozen factories, but as business is today, an order for 50,000,000 parts is just a filler in—it represents one more product to help keep the automatic machines going.

What is true of pianos is true of pretty nearly every industry. The electrical trade uses thousands of differently formed wires as do the shoe, clothing, cleaning, dyeing, laundry, harness, automobile trades, and in fact practically every trade uses wire in some form or other. The butcher uses a galvanized wire skewer in the roast beef instead of the old-time wooden pin. Even the humble clothespin creates a market for some millions of wire springs a year.

The General Conditions of Wire Forming

A wire shape used on a piece of electrical apparatus might require the utmost exactness as to accuracy, while a wire shape used on a toy might be satisfactory within a rather wide range of limits of shape, size or length. Perhaps the electrical part is not used in large quantities, and looked at from a quantity standpoint, it might appear that it could be made by hand. After an investigation, this would be found impossible, because on account of the extreme accuracy required hand labor would increase the cost so much that it could not compete with something else on the market. The part could be made complete in an automatic wire-forming machine, but the quantity required would not warrant the investment necessary unless the same machine could be used for other purposes. The solution of the problem would be in having the parts made outside by some factory already equipped with wire-working machinery, or if for some reason this is undesirable, in making tools which can be used in a press or other machine. But this method would require perhaps several separate handlings and operations.

In the case of the toy part, cheapness and quantity required would forbid any method of manufacture other than by automatic machinery. Suppose, for illustration, a piece of wire is to be bent into the form of a staple. If the wire were light and easily bent, and only a few pieces were required, the operator would grasp the two ends, after it was straightened and cut off, and bend it over a piece of round rod or pipe. If the wire were hard and of large diameter, he would use a hammer or pair of pliers. In either event, he would likely get one leg of the staple longer than the other. Of course the two legs could be made to the same length by working more carefully, measuring to the center and working over a form, but the time consumed would be greater. If he had a bench or hand-manipulated bending machine, the stop would be set at a correct distance and the forming tools

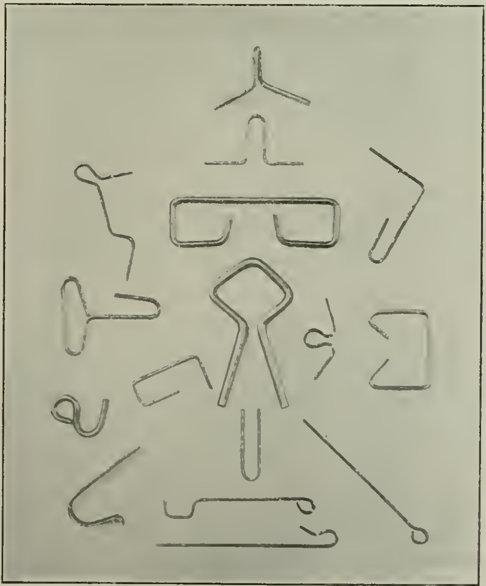

Fig. 2. Characteristic Products of a Four-slide Wire-forming Machine

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[*] For other articles on wire-forming machines and tools see "Tools for Four Slide Automatic Wire-forming Machines," published in the February, 1912, number.

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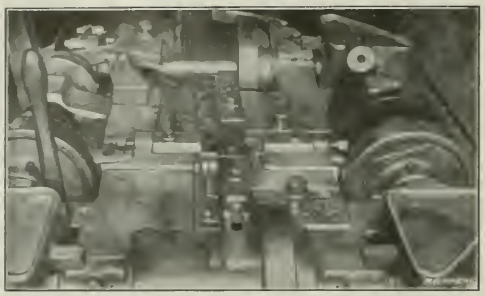


Fig. 3. Flat Bed and Four Slides of a Wire-forming Machine

or pins properly arranged, and then by bringing the wire up to the stop and pulling the handle, the staple would be bent properly, provided the wire was held firmly to the stop. If the wire was allowed to slip, the two legs would be uneven. If accuracy was required and the quantity was too great for such hand manipulation, the wire could be run through a wire straightening and cutting-off machine and then tools might be made which would permit of forming the wire in a press, but unless the wire form was very simple, the presswork would require several operations, using as many different sets of tools.

Each one of these methods might, under certain conditions, be satisfactory. It would all depend upon the quantity desired and the cost that could be afforded. Each method mentioned would vary the cost, as each method would give a different quantity output as a day's work.

Suppose that a shop has put out an article requiring in some part of its make-up a formed wire. The first orders were small and the wire pieces were formed by hand. As orders increased, the methods changed from purely hand work to the partly mechanical work of the hand-bending machine. At last orders reached a point where 5000 a day, or at the rate of 300 working days 1,500,000 a year were used. This was pretty large and they began to look around for improved machinery.

Now an automatic wire-bending machine might turn out this particular wire form at the rate of 200 per minute, or an entire day's requirement of 5000 in less than half an hour. For the balance of the day, the machine would lie idle. As the cost of such machine might be quite an item, the output would not warrant the investment. To get down to fundamentals we have:

1. In the manufacture of wire products the wire is usually purchased in the form of a coil. This wire has to be straightened and cut to length. This necessitates two operations, though if a straightening and cut-off machine is used it represents but one handling. After this, the wire may be formed:

2. By hand bending.

3. By bench or hand manipulated bending machine.

4. By special tools in presses in one or several handlings and operations.

5. By specially arranged or semi-automatic machines.

6. By full automatic wire-forming machines. (These last would take the wire direct from the coil and straighten and cut off.)

To decide upon the method to employ for any particular product one must consider: (A) Quantity of output desired; (B) accuracy required; (C) maximum cost that can be allowed; and (D) possible use of machines for other purposes.

These points are brought out because almost all wire-working machinery is purchased to meet certain requirements. If a manufacturer needs a lathe or a drill the purchase is a simple transaction. Either machine will accommodate different but standard tools, and will do certain kinds of work up to a specified capacity. The wire-working machine is a different proposition. If one is making a small, simple wire corkscrew that is given away with bottles of medicine, the quantity needed may be so large that it would pay to purchase a special machine fitted up to make nothing but these corkscrews. If the corkscrew was of more fancy design and the quantity required not so large, it might be advisable to purchase a standard wire-forming machine which by a change of tools, could be used for other purposes.

The point to note is this: the special machine may cost from $500 to $5000 more than a standard machine. Both machines make the corkscrew equally well, but the standard machine may turn out only fifty a minute while the special machine makes two hundred a minute, both working entirely automatically. Figuring on still smaller quantities, another type of machine might be bought for less than the standard machine, but such machine would be only partly automatic. That is, if the complete corkscrew required five operations, they might be split up and a machine built to perform three operations; then, by changing the tools and running through the machine again, the other two operations would be performed. Conditions might make any one of these machines the most economical to install.

It can be seen that while the specification 24-inch lathe may be a fair description of requirements, a request for a corkscrew-making wire machine would be no description at all. To obtain any basis of real cost, the purchaser must settle the questions A, B, C and D for himself, then make up an exact sample of the product and send this sample to the wire machine manufacturer, at the same time telling him the quantity required in a given time and the limits of accuracy. This last is important for the difference between a half-inch round bend and a half-inch square angle might mean a difference of several hundred dollars in the cost of the machine.

Typical Wire-forming Machine Principles

An automatic wire-forming machine is usually called a "four-slide." Stripped of technicalities, a four-slide machine consists of a flat bed of metal, over which operate four horizontal slides or plungers to and from a central former and at right angles to each other. Special tools are secured to the ends of these horizontal slides, and correctly timed cams move them forward so that the tools act on the metal progressively and in connection with stationary tools or formers fastened to the bed-plate or with tools which may be operated with the bed or in other ways.

The four-slide machine is really a series of small presses which are brought to bear upon different sides of the work in horizontal planes instead of working in a vertical direction as in common presses. In more complicated work, other little presses are added in the form of attachments which

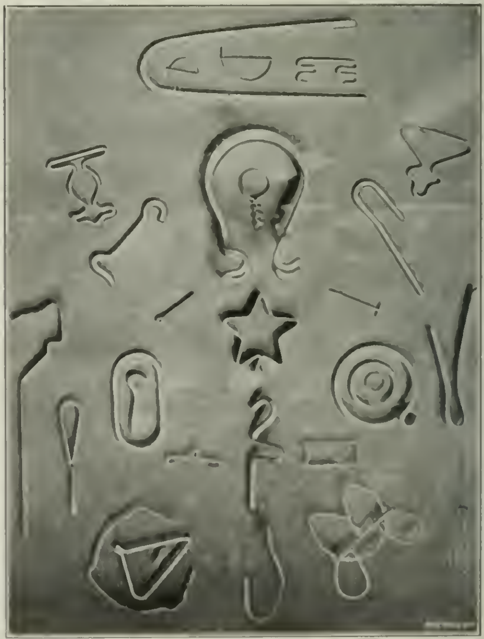


Fig. 4. Common Wire Forms of Many Industries

may be operated in a vertical plane or at various angles. If it was necessary to bend the wire into some simple form such as a right angle, tools could be made for an ordinary press which would satisfactorily form the wire into proper shape if the wire was fed to a stop and would at the same time cut it off. If, however, it was desired to form the wire into a rather complicated design, an ordinary press could not be used for a very simple reason. When the plunger of the press descends, it would necessarily operate on the whole length of wire within the press at practically the same time. If then there is a twist or bend in the center of the wire, there would not be sufficient opportunity for the wire to draw in from the ends to give the length required to make the center bend. In other words, the two ends of the wire would be gripped at practically the same moment as the center and there would be no forming length left.

But on the automatic wire-forming machine, or "four-slide," the cams are so timed that a proper length of wire will be straightened, fed into the machine, cut off and then each press or slide made to operate a fraction of a second later or earlier than another. In this way, the wire will be pulled forward, properly formed, relieved or carried forward again so that another slide can further form it, and so on. Each release or each forward carrying of the wire is allowed sufficient length of wire for the operation.

Action in Forming a Shape

Suppose that the before-mentioned staple is to be made in a four-slide wire-forming machine. The wire would be drawn from the reel and carried through the straightener and forward until the required length was central with a forming pin or tool. The front slide would then push forward and grip the wire at this point, holding it firmly against the forming tool. At the moment the slide grips the wire, the cut-off would operate to sever the proper length. Two other slides would then move forward, one from each side to bend the wire to shape. If there were some further operation to be performed, the back slide would move forward and complete the job. In the case of the staple-shaped piece, the back slide might be disconnected and not used at all, but if the article being formed was a ring the back slide would close the ends and set them. Allowance would be made in the shaping tools to take care of the spring of the wire, and the resulting product would be a commercially perfect article turned out at the rate of perhaps two hundred a minute—all alike.

Flat Metal Forming Machines

There are two types of "four-slides" on the market. One of them is termed the "wire-forming machine" and the other the "flat metal-forming machine." The wire-forming machine with suitable tools and attachments can be made to form, flatten, point, cut, mill and otherwise put into commercial shape products made from round wire. It will also operate on flat wire or ribbon stock with the exception that it is not adapted to cutting specially shaped ends, piercing holes, or to light stamping or embossing.

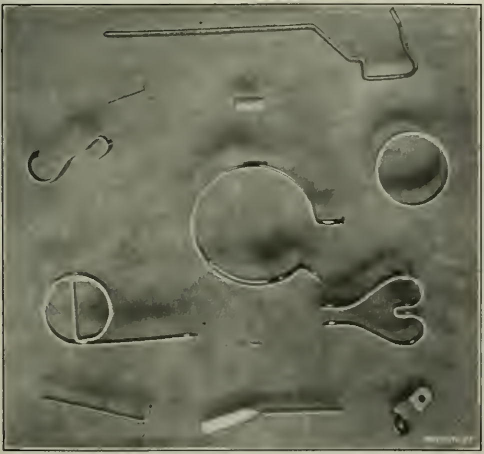


Fig. 5. Characteristic Products of a Four-slide Flat Metal-forming Machine

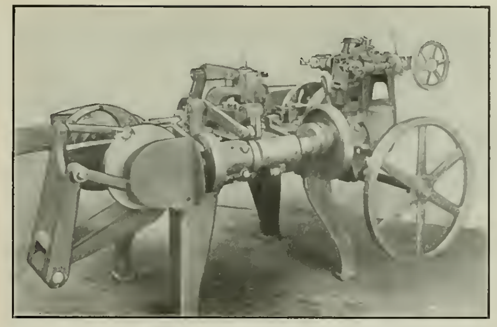


Fig. 6. Comparison of Sizes of Wire-forming Machines—a No. 00 standing on the Gear Guards of a No. 5

The flat metal-forming machine is designed to handle ribbon stock; that is, narrow sheet metal marketed in coil form. This machine will do everything that a wire four-slide machine will do, and in addition it will cut specially shaped ends, pierce holes and do light embossing. Round wire can also be worked in this machine. In general appearance and mechanical principle, the two types of machines are alike.

Sizes and Capacities

Both types of four-slide machines are made in certain standard sizes, having a varying range both as to size of wire which can be handled and the length that can be fed into the machine. Sizes usually kept in stock for quick delivery run from the small No. 00 machine and include the Nos. 0, 1, 2, 3, 4 and 5 machines. The range of these machines covers the smallest worked wire up to ½ inch diameter, and the feeding capacity as to length runs up to 20 inches. Larger machines are built to order with a capacity of ¾-inch diameter wire and 24-inch feed.

The flat metal machine is not ordinarily carried in stock in as many sizes, but the size numbers run the same as those of the wire-forming machine. The capacity as to thickness and width of flat metal is figured on the cross-section area. For example, if a machine of certain size will take metal 0.032 inch thick and ⅛ inch wide, it would also take metal ½ inch wide if it were but 0.008 inch thick. The cross-section area of the first-mentioned stock is $0.032 \times 1/8 = 0.004$ square inch; and of the second-mentioned stock, $0.008 \times 1/2 = 0.004$ square inch also. It will be seen that the capacity of these machines as to width and thickness is rather too complicated to be discussed in this article, and any matters of this sort should be referred to a manufacturer. The feeding lengths of the flat metal machines run the same as for the wire machines.

Straighteners

The various mechanical details of forming machines vary with the different manufacturers, but the general principle of design is the same throughout and, as stated before, the general design of a flat metal machine is the same as the wire-forming machine. The wire, of course, is received in a coil, which is placed on a reel and thence goes to the straightener. Two types of straighteners are used, the double roll and the rotary. The double roll type is made in two forms—with rolls grooved to fit round wire and with wider plain rolls adapted to flat wire or ribbon stock. The double-roll and the rotary type of straightener are each adapted to its particular work and either may be applied, according to the characteristics of the article to be made or the quality of wire to be used.

The double-roll straightener is the one generally used and it is found satisfactory for the usual run of work. When used for round wire, one set of rolls is arranged horizontally and another set vertically, the rolls being grooved. For ribbon stock the rolls are plain and arranged vertically only. The rolls are staggered and adjustment is provided for bringing them closer together or setting further apart to accommo-

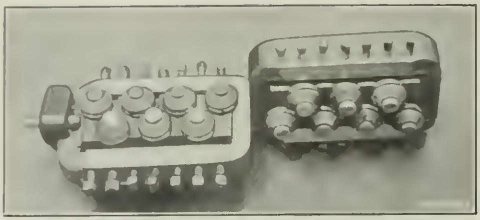


Fig. 7. Double Roll Type of Wire Straightener

date various thicknesses of stock. The action is very much the same as when drawing a piece of wire through the fingers. The wire is bent slightly in one direction and immediately after is bent in exactly the opposite direction. If released, the wire would take an intermediate position about half way between the two bends. The adjustment of the rolls is such that this bending back and forth takes out all bends and kinks and the wire leaves the straightener commercially straight.

A commercially straight wire appears absolutely straight to the average eye and this is all that is required for most articles. There are articles, however, in which greater refinement is necessary as to straightness, and the double roll straightener is displaced by the rotary type. The double roll type also is not adapted to the straightening of hard spring wire.

The rotary straightener has a steel spindle containing staggered steel guides. The wire is brought through a quill in the end of the spindle, and it then passes over the steel guides and out through the opposite end. The spindle is made to revolve rapidly and at the same time is reciprocated backward and forward, being mounted in a bracket on a slide and moving with the feed mechanism of the machine. With this type of straightener, wire can be made as nearly straight as it is possible to get it. For products such as typewriter bars, where perfect alignment must be had, the rotary straightener must be used to obtain satisfactory results. It is also used for working hard spring wire.

Feed Mechanism and Cut-off

Next to the straightener comes the feed mechanism. This is one of the most important parts of the machine. Unless the feed works perfectly, every subsequent operation will be thrown out of time. The tools will be jammed with an over length of wire or damaged by not receiving enough. This particular machine part varies considerably in design with different manufacturers. Essentially, it is an arrangement that slides along the wire a predetermined distance, closes on or grips the wire, and in returning, pulls a specified length through the straightener and pushes it into the machine to be operated upon. It is easy to understand that the gripping part of the feed is of chief importance. A good grip must take hold immediately so that each length of wire will be exactly alike. For the same reason, there must be no slipping through the grip, and, last, the grip must not mar, cut, flatten or otherwise distort the wire.

As the feed lets the wire go and starts on its return movement the wire, if not held, would tend to slacken or even buckle between the feed and the straightener. To overcome this a second grip or binder is placed between the cut-off and the end of the feed stroke. As the feed grip loosens, the binder holds the wire tightly between itself and the straightener, preventing any slip and insuring the greatest possible accuracy in length of wire feed and cut-off. Next to the binder is the cut-off, and as its name implies it cuts off the wire in lengths predetermined by adjustment of the wire feed.

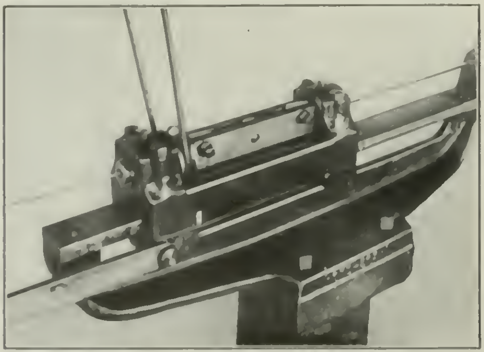


Fig. 8. Rotary Type of Wire Straightener

Form-holders, Forms and Stripper

Now we come to the form-holder bracket which holds the form-holder, which in turn holds the form. The form-holder bracket is adjustable to and from the wire line. When operating the machine this bracket has to resist all strain or push from the slides from four different directions. It must therefore be designed to resist all strain with a minimum of spring, and it should not in any way obstruct a full view of the tools while operating.

In most bending operations there is a principal die or forming tool around which the wire or metal is shaped. The form-holder is the machine part for holding this principal forming die, and there are three types as follows: the stationary holder, the swinging holder and the solid holder. The stationary holder is a type used for the lighter classes of product, being easily handled and containing only the necessary amount of metal. The swinging form-holder swings upon a pivot but is held to the wire line by a spring. In making narrow forms, the tool on the front slide presses the form-holder backward until it is solidly held against the bracket, and this backward movement of the form allows room for the side tool to operate. Without such backward movement, the action of the side tool would be restricted, owing to the projecting bracket of the cut-off. The solid form-holder is similar to the stationary type but is of heavier construction and is usually built to fit solidly into the bracket, giving in effect a single mass construction. Regardless of the type, a tapped hole and grooves are provided on the lower end of the form-holder, to which the actual form or tool can be tongued and held securely in place.

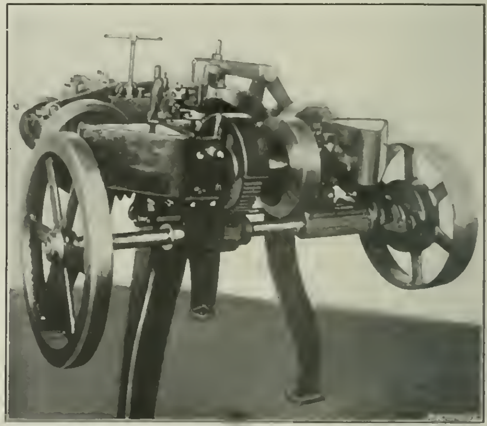


Fig. 9. Typical Four-slide Wire-forming Machine shown from another Angle than in Fig. 6

We now come to the slides and lastly the stripper which is a rod passing down through the form-holder and having on its lower end thin stripper plates. The stripper rod is reciprocated by cams and the mechanism strips or knocks the work off the form to get it out of the way of the incoming wire.

These parts, briefly described, are the parts of a standard stock machine. Such a machine will form hundreds of different articles when provided with suitable tools, and by adding attachments these machines will turn out the most complicated kinds of work. As may be noted by referring to the illustration Fig. 9 the machine has four shafts running along the four sides. These shafts give ample space for the application of differently shaped cams, and being on all four sides, it is possible to obtain operation in any direction.

RECENT LEGAL DECISIONS INVOLVING MACHINERY

What Machinery Must be Guarded

(Federal) Iowa statutes which makes it the duty of the owner of any manufacturing or other establishment where machinery is used, among other things, to properly guard "machinery of every description," as construed by the Supreme Court of the state, is intended to require the guarding of all machines of a character dangerous to employes operating them or working in their vicinity.—*United States Gypsum Co. v. Karnaca. 216 Fed. 857.*

Suit for Patent Infringement

(Federal) Where the owner of a threshing machine patent failed to mark all machines made thereunder with the patent mark, and, with knowledge of its infringement by another company, gave no notice of the fact for six years, which was the first that the other company knew of the existence of the patent, and afterward delayed bringing suit, it was held that the owner of the patent was not entitled to an accounting for damages or profits, but was not barred by such laches from enjoining the further infringement of the patent.—*Closz & Howard Mfg. Co. v. J. I. Case Threshing Mach. Co. 216 Fed. 937.*

Compensation of Machinery Salesman

(New York) Under a contract whereby plaintiff was employed by defendant, whose principal office was in New York City as an exclusive sales agent for machinery in certain territory, and was to forward all inquiries from outside his territory to defendant, who in turn was to forward to him all inquiries received by it from his territory, and whereby all sales by defendant for delivery and erection within his territory should entitle him to compensation, he was restricted to commissions upon machinery sold for erection within his territory, and a sale of machinery by defendant directly to a corporation having a main office in his territory but for erection outside such territory did not entitle him to a commission.

Under such contract, as modified by renewal provisions to the effect that the agent might sell machines to any purchaser whose main office was within his territory, but whose works were within the defendant's territory, and receive his profits thereon, and that when machines were sold by defendant to parties whose main offices were within defendant's territory, but were shipped into the agent's territory, the agent should be entitled to his share of the profits, he was entitled to a commission on a direct sale of machinery to a buyer whose main office was in his territory, for erection outside thereof, made directly by defendant by correspondence with the buyer's general office in the agent's territory, and also on a sale of which he was the procuring cause, made to a buyer with its main office in his territory, although the machinery was to be erected outside thereof, and on a sale to a buyer in his territory, though intended for outside territory, negotiated by him through defendant's office, but was not entitled to commissions on a sale by defendant negotiated through a buyer's branch office in his territory, the buyer's main office being in defendant's territory, or on a sale of machines to a company whose main office was outside his territory to be installed outside of such territory.—*McGann v. Ruggles-Coles Engineering Co., 149 N. Y. S. 696.*

Machinery Must be in Safe Condition

(Kentucky) A master must use ordinary care to provide his servants with machines reasonably safe, and the servants are not bound to inspect such machines to ascertain whether the master has performed his duty, but if a servant is injured by a defect so obvious that it would have been discovered by ordinary care he cannot recover.—*Fluhart Collieries Co. v. Meeks, 169 S. W. 686.*

Contract for Sale of Engine

(Kentucky) Where a contract for the sale of a traction engine provided that if within five days from first use it failed to fill the warranty, written notice should be given the seller and reasonable time allowed to remedy the difficulty, and if it could not be made to fill the warranty it should be immediately returned by the buyer to the place where it was received, with the seller's option to furnish another machine or return the money and credit the notes which had been received for the purchase price and thereby rescind the contract, it was held that the remedies specified in the contract constituted the only relief to which the buyer was entitled, and if he failed to return the machine and demand the purchase money and notes he was bound to pay the price.

Where the contract provided that no general or special agent or local dealer was authorized to make any change in the warranty, that workmen or experts had no authority to bind the seller by any contract or statement, or to waive any of the conditions of the contract, a local agent on ascertaining that the engine did not comply with the warranty had no authority to modify the same and direct the buyer to take the engine home or try to at the seller's risk or expense.—*Nichols & Shepard Co. v. Stubbs Thresher Co. 170 S. W. 4.*

Capitalization of Machine Company on Basis of Earnings

(New Jersey) Where a corporation was organized to manufacture and sell a certain patented machine in the United States, which at the time had become standardized on certain railroads, and it then appeared that the demand would necessarily increase, and new conditions which subsequently arose to render such machine less valuable could not then have been anticipated, capitalization on the basis of earnings for the preceding year did not constitute an overvaluation, so as to render stockholders liable to assessment on the subsequent insolvency of the corporation.—*Railway Review v. Graff Drill & Machine Co. 91 A. 1021.*

Sale of Second-hand Machinery

(Alabama) In the sale of second-hand machinery f. o. b. cars in good condition, there was no implied warranty of its reasonable adaptation to the uses for which it was bought.—*Johnson v. Carden, 65 So. 813.*

Action for Breach of Warranty

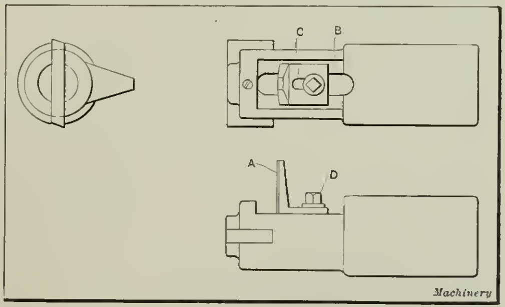
(Alabama) A buyer of machinery ordered for a particular purpose may accept it, and on breach of the seller's warranty of fitness for such purpose may maintain an action for breach of the warranty—*Western Union Telegraph Co. v. Jackson Lumber Co., 65 So. 962.*

* * *

POSITIVE STOP FOR BORING-BAR

BY HORACE R. GARDNER*

Where accuracy is required in the depth of a counterbored hole and the stops on the machine cannot be depended upon to give the required degree of accuracy, I have found that the device here described is very effective. I have used it on the boring-bar in a chucking machine, but the same idea could readily be applied to other machines.



Boring-bar equipped with Positive Adjustable Stop

Referring to the illustration, it will be seen that a stop *A*, which is made of hardened tool steel, is fastened to the bar to limit the depth to which the tool can cut. The working face of the stop is slightly rounded to avoid sharp corners that would cut the surface of the work. The stop is provided with a tongue which fits into the slot *B* in the bar to keep it from turning, and adjustment is provided by the slot *C*, the stop being set in the required position and held firmly in place by the cap-screw *D*. By using a little red lead or Prussian blue on the face of the stop to show when it touches the work, extreme accuracy can be obtained.

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* Address: 179 Henry St., Detroit, Mich.

ANNUAL MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

EXTRACT PRESIDENT HARTNESS' ADDRESS—TECHNICAL PROGRAM—BIOGRAPHIES OF BRASHEAR AND SWEET

THE thirty-fifth annual meeting of the American Society of Mechanical Engineers was held in New York City, December 1 to 4 inclusive. It comprised the usual social and technical programs, including various excursions. The meeting opened Tuesday evening with an address by President James Hartness, and following the address was a reception in honor of the incoming president, John A. Brashear, and the retiring president.

The subject of President James Hartness' address was "The Human Element—the Key to Economic Problems." It pointed out that the world of mechanism has become so intricate and complex that it has gone beyond the capacity of any single individual to comprehend, and it is only by selecting the character and limiting the amount of material to be taken into the mind that we can hope to accomplish the best results. Specialization and repetition, by which habit is formed, are both essential to success. It is a fact that large organizations are essential as affording an opportunity for the most complete sub-division of work and the greatest degree of specialization.

John A. Brashear

Granting that the large organization is necessary in this age, not only in bringing out the best in the individual but in maintaining the supremacy of American industry against foreign competition, may it not be that we may approach the ideal in the large industrial plant? It was Mr. Hartness' belief that a large industrial plant should have capital equal to or as large as any competing organization. It should have a small harmonious board of directors with an able leader; and each executive should possess some special knowledge essential to the organization. As regards employes, each man should be treated in a respectful manner and needless direction or heartless correction by overbearing executives should never be permitted. Criticism or reprimand should not be uttered in the presence of others, for the best control of the organization comes from contact with the better side of man, and that side is not reached by those who ride rough-shod over a man's self-respect.

He pleaded for permanency of organization, pointing to the fact that investors look with distrust upon a management that is always changing officers, changing men, changing models, changing methods without regard to the inertia of habit and the human element which is the life-blood of every organization. They also look with doubt on any scheme of management that allows careless employment and discharge of men without due regard to the losses involved by such changes.

The technical program on Wednesday comprised the following papers and discussions:

"Floor Surfaces in Fireproof Buildings," by Sanford E. Thompson.

"Reinforced-concrete Factory Buildings," by F. W. Dean.

"Measuring Efficiency," by H. L. Gantt.

"Standardization in the Factory," by C. B. Auel.

"Operation of Grinding Wheels in Machine Grinding," by George I. Alden.

"Friction Losses in the Universal Joint," by P. F. Walker and W. J. Malcolmson.

"Steam Locomotives of Today" (Sub-committee report).

On Wednesday evening the John Fritz medal was awarded to Prof. John E. Sweet "in recognition of his achievements in machine design and his pioneer work in applying sound engineering principles to the construction and development of the high-speed engine."

On Thursday the following papers and discussions were presented:

"The Future of the Police Arm from an Engineering Standpoint," by Henry Bruere.

"Some Factors in Municipal Engineering," by Morris L. Cooke.

"The New Charter for St. Louis," by Edward Flad.

"The Engineer and Publicity," by C. E. Drayer.

"Snow Removal" (a committee report).

"The Design and Operation of the Cleveland Municipal Electric Light Plant," by Frederick W. Ballard.

"The Handling of Sewage Sludge," by George S. Webster.

"Training for the Municipal Service in Germany," by Clyde Lyndon King.

"A Study of Cleaning Filter Sands With No Opportunity for Bonus Payments," by Sanford E. Thompson.

"Factors in Hardening Tool Steel," by John A. Mathews and Howard J. Stagg, Jr.

"Standardization of Chilled Iron Crane Wheels," by F. K. Vial.

"The Mechanical Elimination of Seams in Steel Products, Notably Steel Rails," by R. W. Hunt.

Topical Discussion on Alloy Steels.

Thursday evening a dinner dance was given to members, visitors and friends at the Hotel Astor.

The professional session Friday morning was as follows:

"A Rate-flow Meter," by H. C. Hayes.

"Laboratory for Testing and Investigating Liquid Flow Meters of Large Capacity," by W. S. Giele.

"A New Volume Regulator for Air Compressors," by Ragnar Wikander.

"Physical Laws of Methane Gas," by P. F. Walker.

"The Clinkering of Coal," by Lionel S. Marks.

"Damages for Loss of Water Power," by F. W. Dean.

The excursions included an inspection of the *Lusitania* of the Cunard Line; Ellis Island; Hill Building; New York Telephone Long Distance Exchange; Brooklyn Navy Yard; The McCall Corporation; Biograph Moving Picture Studio; United Electric Light & Power Co., 201st St. Plant; Watson-Stillman Co.'s plant at Aldene, N. J., etc.

John A. Brashear

John A. Brashear, the newly elected president of the American Society of Mechanical Engineers, is known throughout the world as a manufacturer of astronomical and physical instruments. He was born in Brownsville, Pa., in 1840 and received a common school education. A traveling astronomer exhibiting the wonders of the heavens to passersby at five cents a look, gave the boy his first glimpse of astronomy, which became his passion. Following the example of his fellows, he learned the trade of patternmaking and at the age of twenty-two, was established apparently for life as a millwright in a Pittsburg rolling mill.

But unlike many other workmen about him, he was not content to work for bread and butter alone. He had recently married, and he and his ambitious young wife spent their evenings in the study of astronomy. Having no money to buy a telescope, they set to work to make one for themselves. In their little home, which they had built with their own hands, they set up a shop with a tiny engine and lathe and there made the tubes and ground the lenses, often working until midnight in the absorbing joy of the task, after a long hard day at the mill and in the home. Their first glass, a 5-inch one, took three years to grind, but being dissatisfied with its limitations, they set to work on a 12-inch glass, only to have it break in the silvering process after two years of patient grinding and correcting. The next glass proved successful, and its production was destined to be the turning point in young Brashear's career. S. P. Langley, then in charge of the Allegheny Observatory, had for some time known of the young astronomer's work, and now began to entrust him with some of the observatory instruments. At the same time, certain astronomical articles written by Mr. Brashear had attracted the attention of William Thaw, one of the patrons of the observatory, and it was he who advanced the necessary capital that enabled Mr. Brashear to move to Allegheny, Pa., and set up a shop there. An account of the accomplishments of this shop would be a history of modern astronomy and without them much of that history could not have been written. Perhaps the most important achievement was in connection with the design and development of the spectroscope for astronomical uses, particularly with reference to the mechanical features.

In 1888 Mr. Brashear completed the spectroscope for the 36-inch telescope, furnishing the mechanical parts only, the optical parts being secured from Prof. Steinheil of Munich. The complete small spectroscope was furnished by Mr. Brashear, including the prism and all other optical parts. It was found that better work could be secured with the small spectroscope than with the large one and that the optical parts were of higher grade than those obtained from Munich. The re-working of the optical parts of the large spectroscope was undertaken by Mr. Brashear with complete success.

The excellence of the work done at Lick Observatory is attributed to Mr. Brashear's skill and genius. His more purely scientific work also brought recognition, and about the time of his moving to Allegheny he was given an appointment in the University of Western Pennsylvania, of which the Allegheny Observatory was a department.

The John A. Brashear Co., Ltd., formed by Dr. Brashear with his son-in-law, James B. McDowell, in Allegheny, has from its beginning been devoted to the construction of apparatus for special work, rather than more commercially profitable products. It is the boast of the concern that it has no patents and no secrets, and that whatever it has accomplished is freely given to the world. The Allegheny Observatory is also unique in that it is put, in every possible way, at the disposal of the public through lectures and through access to the telescope and other similar means. These projects are typical of Dr. Brashear's attitude and spirit throughout his career. He was honored with the degree of LL.D. by Washington and Jefferson College and is a member of several scientific and engineering bodies.

John E. Sweet

John E. Sweet

John E. Sweet to whom the John Fritz medal was awarded in New York City Wednesday evening, December 2, was born at Pompey, N. Y., October 21, 1832. His boyhood was spent on his father's farm, and was given up to the varied work that a farmer's boy is called upon to do. He secured a common school education at the local schools of his native town, and at eighteen was apprenticed to learn the carpenter's and joiner's trade, his life thereafter being devoted chiefly to carpentry and building until he was nearly thirty. Meanwhile he had studied architecture and did considerable architectural work before the outbreak of the Civil War. In 1862 he went abroad, and while there he secured a patent on a nail machine in which the Patent Nut & Bolt Co. of Birmingham, England, took an interest. Mr. Sweet entered the employ of the company, and at that time began to write upon technical subjects, contributing to London *Engineering*. He returned to America in 1864, working as a draftsman in Syracuse, N. Y., on a varied line of machines. During this time he worked on a matrix impressing machine arranged with a keyboard, which was intended to do away with the use of movable type. This machine was the progenitor of the present linotype machine. In the early seventies Mr. Sweet conceived the idea of the "Straight Line" engine, which is inseparably connected with his name, and is perhaps his most characteristic piece of work.

His prominence as a national figure dates from his connection with Sibley College of Mechanical Arts of Cornell University in 1873. His connection with the university lasted until 1879 and in this period of six years he arose from a position of comparative obscurity to one of national prominence. Mechanical engineering as a department of organized education was a new thing. There were no precedents and regarding its practicability there was almost universal skepticism. Its plan, its scope, its aims, were unformed even among its friends—and its friends were few. There were no experienced educators.

Prof. Sweet's work was first that of a teacher, and second, that of a pioneer in mechanical construction. In the latter capacity he laid an enduring foundation for interchangeable manufacturing. His experience as a draftsman in England had shown him the fundamental importance of the work of Joseph Whitworth, which heretofore had found little appreciation in America. Combining a keen appreciation of Whitworth's advanced standards of accuracy with original conceptions of correct principles, he established a school of construction, the influence of which was far-reaching. Along with this went an application of art in design—not the art of organization, but the art of perfect adaptation to purpose. The "Straight Line" steam engine was an embodiment of the mechanical principles advocated by him.

Prof. Sweet was one of the founders of the American Society of Mechanical Engineers, and was elected its third president. He was later elected an honorary member. He was one of the judges on machine tools at the Chicago Exposition, and is well known as a contributor to the technical press on mechanical topics. He has always been keenly interested in technical education, and one of his great ambitions has been to establish a trade school where young men can be instructed in the mechanical arts in a way that will fit them to become mechanics. As a teacher he was one whose pupils became disciples, and this is testified to by the existence of an informal organization of men who call themselves "Prof. Sweet's boys." They gather year after year on the occasion of his birthday for an annual dinner with him in Syracuse.

* * *

THE VALUE OF PATENTS

The Swedish Patent and Registration Office some years ago compiled a table showing the percentage of patents in force in various European countries after a certain number of years from the time when the patent had been issued. As is well known, patents in practically all countries except the United States become invalid on account of non-working after a certain number of years, so that while the term of patents in most European countries is fifteen years, only six per cent of the total number of patents issued are in force at the end of the fifteenth year, in several countries, including Sweden; in Germany this figure is only 3.5, and in Great Britain, 3 per cent. Italy shows the smallest percentage of patents alive at the end of the fifteen years, there being only two out of every one hundred patents issued in force for the total number of years. No better example could be shown to indicate how few inventions are really of practical value, because it is safe to assume that nearly all the really useful inventions are kept alive for their full term by being properly worked. Another interesting fact is also brought out by the investigation referred to. The patents relating to the chemical field prove to have the longest longevity; next come the electrical patents. The patents which appear to be of the smallest value in proportion to the number issued are those relating to ordinary mechanical appliances—still another reason why the man who thinks he has made a wonderful invention of a remarkable mechanical contrivance should think twice before he wastes his hard-earned money on a patent.

FACTORS IN HARDENING TOOL STEEL*

STRUCTURE OF TOOL STEEL—TIME OF HEATING—SPEED OF QUENCHING IN DIFFERENT BATHS—EFFECT OF MASS ON HARDNESS AND OTHER POINTS OF IMPORTANCE TO THE HARDENER

THE phenomena of carburizing iron and hardening it by quenching have been known for many centuries, yet the explanation of hardening steel has not yet been given to the satisfaction of all. Many theories have been advanced and each has its adherents, but one can scarcely say that any generally accepted explanation exists. As recently as this year, two very interesting new theories were advanced at the May meeting of the Iron and Steel Institute of Great Britain. In what follows we are not so much interested in the theories as in the practice of the art of hardening and tempering tool steel, and we shall confine our attention to carbon steels, giving some consideration to the so-called special steels containing various alloys, usually below 3 per cent. We shall not discuss high-speed steels, nor the many low-carbon alloy steels, primarily of value on account of their tensile qualities but also, in many cases, of limited value for tools, especially those used for hot work.

Composition of Tool Steel

Tool steels are included within the range of 0.60 to 1.50 per cent carbon, but not less than 90 per cent of them fall within carbon limits of 0.75 to 1.35 per cent. They are usually made by the very old crucible process or the very new electric processes, and just now there is considerable discussion as to the relative merits of these methods. Carbon forms at least one definite compound with iron, Fe_3C, known as cementite. This is the hardest constituent in steel. Cementite exists in annealed steel associated with a perfectly definite quantity of iron, or ferrite, as it is metallographically known. This definite relation between ferrite and cementite yields the constituent pearlite, in which the cementite and ferrite may exist in a laminated or a granular condition. This aggregate contains a definite percentage of carbon, 0.89 per cent, and steel containing 0.89 per cent carbon in its normal condition is found to consist of nothing but pearlite when examined microscopically. In steel containing less than 0.89 per cent carbon the cementite associates with sufficient ferrite to form pearlite, and leaves the excess ferrite free in distinct microscopic grains or crystals. On the other hand, if the steel contains above 0.89 carbon, there is more cementite present than can become associated with ferrite, and the excess being unable to find a partner, so to speak, exists in separate particles, either granular or in a more or less perfect net work surrounding the pearlite. The definite percentage of carbon which yields a full pearlitic structure in the annealed or natural condition is known as the eutectoid composition. Steels of lesser carbon are called hypo-eutectoid, and steels of higher carbon are called hyper-eutectoid steels. We are indebted to Professor Howe for these names.

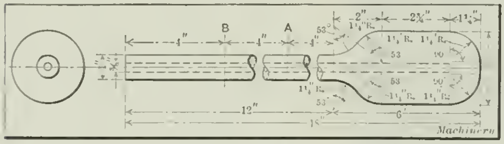

Fig. 1. Test Piece used in determining Quenching Effect of Various Baths

Effect of Temperature Changes on Structure of Tool Steel

When carbon steel is heated above a certain temperature, a change takes place in the constitution of the steel. This temperature is known as the carbon change point, critical temperature, or, preferably as the decalescence point. When this temperature is reached the pearlite becomes austenite, a solid solution of iron carbide in iron. This change occurs at a nearly constant temperature, but in the case of hypo-eutectoid steels, the austenite first formed above the decalescence point acts as a solvent for the excess ferrite. In other words, at a somewhat higher temperature than the decalescence point, we obtain a homogeneous solid solution of all the cementite in all the ferrite. This is the best condition for hardening a low-carbon tool steel and accounts for the practice of heating low-carbon steels hotter than hyper-eutectoid steels for hardening. The excess cementite of hyper-eutectoid steels is not readily soluble in the austenite first formed from the pearlite, and it requires a high temperature to complete the solution of the excess cementite. Practically considered, nothing is gained by doing so.

Steels quenched quickly from above the decalescence temperature retain the carbon more or less perfectly in the condition of solid solution that existed above the decalescence point. The structural name for the quenched product is martensite. Hypo-eutectoid steels, hardened, may show either all martensite or martensite and ferrite. Hyper-eutectoid steel should show martensite and cementite. The martensite of eutectoid steels has been called hardenite by Professor Arnold. Just as in the change of ice to water or of water to ice, there is an evolution or absorption of heat, so is there an absorption or evolution of heat in steel on passing through its critical range. There are several methods of determining this change point, but as these methods are so well known, we will omit detailed descriptions of the operations involved.

The position of this critical temperature is fairly constant in all straight carbon tool steels, but is affected to a variable degree by the addition of alloys. Just as the addition of salt to water lowers the temperature at which the solution freezes, so the addition of alloys lowers the freezing point of steel and frequently lowers the position of the critical temperatures. The addition of 10 per cent of nickel to a 1.00 per cent carbon steel, or of 4 per cent of manganese, for example, lowers the critical point to such an amount that steels of these types are martensitic at ordinary temperatures, even after slow cooling.

The determination of critical temperatures has materially assisted in the solution of many metallurgical problems. So far as we are concerned in this article, however, it is sufficient that for the practical hardening of tool steels this critical temperature must be exceeded by a fairly good margin, at least 25 to 50 degrees F., depending on the size, shape, mass and composition. On heating steel through its critical range changes occur other than those noted. Steel is strongly magnetic below the critical range, but loses its magnetism within and above. The electrical resistance for hard steel increases with the temperature up to the critical point in a curve which is nearly a straight line. On passing through, the resistance increases abruptly, and after having passed through, the increase per degree rise in temperature is very much less than in either of the other two cases. The specific volume of a hardened steel is approximately 0.01 greater than in its annealed condition. These marked changes in physical characteristics occurring at definite temperatures are indicative of the disturbances going on in the steel and occur at the temperature at which carbide carbon goes into solution on heating, or dissolved carbon is precipitated from solution on cooling.

Volume Changes in Tool Steel

The volume changes—both expansion and contraction—which occur during the critical ranges of temperature are of great practical importance to the hardener. The permanent changes in dimensions which steel undergoes in hardening are of the utmost interest to the hardener and associated with these changes is the problem of hardening cracks. It is an axiom that heat expands and cold contracts, but with steel there is a certain critical temperature at which an abnormal behavior is noticed, namely, a sudden shrinkage on heating and an expansion on cooling. The expansion of steel in heating to 750 degrees C., is about one-eighth inch per foot, and when we recall that, in quenching, a corresponding contraction attempts to take place suddenly, it is little wonder that strains are set up that may exceed the ultimate strength of the steel.

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* Abstract of a paper presented at the annual meeting of the American Society of Mechanical Engineers, New York City, December 3, 1914, by John A. M[illegible]ws and Howard J. Stagg, Jr.

What is the relation of the foregoing to over-heating, *i.e.*, heating above that temperature at which it is necessary to harden? After passing through the critical range, the expansion takes place at its maximum rate. When steel is heated in such a manner it assumes the shape corresponding to the maximum temperature, and on cooling the whole piece tends to return to, or near, its original size. In so doing, the outer or first cooled portion is hardened first and forms a hard, brittle, unyielding shell, and the strains set up by the slower cooling interior may either fracture the shell, producing external cracks (especially if the shell be uneven in thickness), or burst the piece at the center if the shell is of even thickness and strength. This latter occurrence is accompanied by a peculiar appearance of the fracture and frequently and wrongly called pipe.

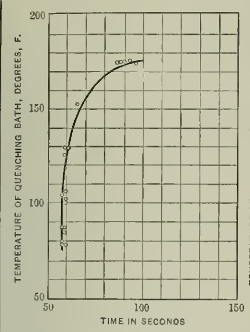


Fig. 2. Quenching Effect of Syracuse City Water

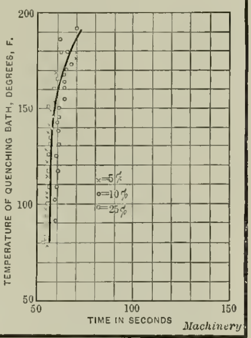


Fig. 3. Quenching Effect of Brine Solutions

Time of Heating

Too much stress cannot be laid on the fact that there is a correct length of time for heating tool steel and that this time of heating is as important as the temperature to which it is heated. There are at least two dangers which must be avoided. First, if the heating be too fast, a uniform temperature does not exist throughout the mass being heated. For example, a die block heated too quickly may exhibit the following conditions: The outer portions may be above Ac_1, and expanding at the maximum rate; the intermediate portions may be in the transformation range and contracting; while the inner portion, which is below Ac_1, is slowly expanding at the characteristic rate below Ac_1. What wonder that steel fractures under such conditions!

Second, grain size depends among other variables upon temperatures above Ac_1, and time above Ac_1. If heating be of such a character that the piece is held above Ac_1 for an abnormally long time, the crystals may have grown to such an extent that on quenching, abnormal grain size is retained and the result is a weak, if not cracked, piece. Quick heating in a furnace which is considerably hotter than the correct hardening temperature is extremely bad practice. The difficulty is that the thin parts, corners, and edges are liable to attain an overheated temperature before the larger portions of the piece attain the correct hardening temperature, and this overheating of the thin parts produces large grain size, abnormal expansion and tends to produce cracks.

Speed of Quenching

If a sample of steel is cooled slowly from above Ac_1 the solid solution which has been formed breaks up and precipitates its cementite and ferrite and we have then an annealed steel. If the cooling on the contrary is rapid, the solid solution is not given the time necessary to permit the complete dissociation into cementite and pearlite and we find formed the intermediate break down of austenite, known as martensite. If the cooling be intermediate in its speed between extremely slow and extremely fast, we find intermediate microconstituents such as troostite or sorbite. The correct constituent in a hardened steel is martensite, and to form this the material must be cooled quickly.

There are several degrees of "quickness" which at once suggest themselves. There is, however, a critical rate of cooling through the range which must be attained before the piece will be hardened. On quenching it is clear that the surfaces of the section are cooled and hardened first. If the mass being cooled is of considerable size, different degrees of hardness are noticed from the outside to the middle. The cooling medium used, its temperature, and condition affect the rate of cooling. Benedicks has investigated this subject and arrived at conclusions of extreme interest. He found that in order that a liquid present in large bulk may have a good quenching power it is necessary that it should possess a high latent heat of vaporization, and that it be maintained at a temperature low enough to avoid too abundant formation of vapor. High specific heat, low viscosity and large heat conductivity all act, it is true, in the direction of quick cooling, but the influence of the two factors previously mentioned appears to be of a different and lesser grade than the heat of vapor formation.

The authors have devoted considerable time to investigating numerous commercial quenching media which are in use in typical hardening plants of the country at the present time. The results given are only a small portion of those actually obtained, but they are typical. In attacking the problem, the following method was adopted: A test piece of the dimensions shown in Fig. 1 was machined from a solid bar, and a hole drilled through the neck to within an equal distance from each side and bottom of the test piece. Into this hole a calibrated, platinum-rhodium couple was inserted and the leads connected to a calibrated galvanometer. The test piece was then immersed in a lead pot, also containing a thermo-couple to the point *A*, and the lead pot was maintained at a temperature of 1200 degrees F. When the couple inside of the test piece was at 1200 degrees F., and the couple in the lead pot read 1200 degrees, the test piece was removed and quenched to the point *B* in 25 gallons of the quenching medium under consideration. At the start the quenching medium was maintained at room temperature. The time in seconds that it took the test piece to fall from a temperature of 1200 degrees to a temperature of 700 degrees was noted by the aid of a stop-watch. It is clear that immersing the test piece in the quenching medium raised the temperature of the medium. The test piece was then replaced in the lead, heated to 1200 degrees, quenched into the medium at this higher temperature and the time again taken with the stop-watch. These operations were continued until the quenching media, in the case of oils, had attained a temperature of about 250 degrees F. The results obtained, time in seconds, for a fall from 1200 degrees to 700 degrees were plotted against the temperature of the quenching medium and a series of curves as shown in Figs. 2 to 13, inclusive, was obtained.

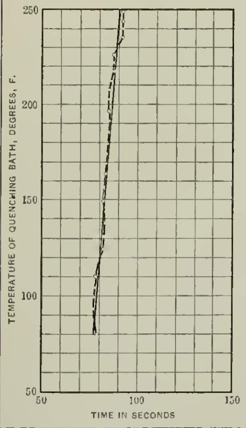


Fig. 4. Quenching Effect of New Fish Oil

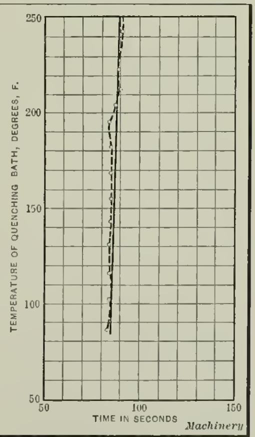


Fig. 5. Quenching Effect of No. 2 Lard Oil

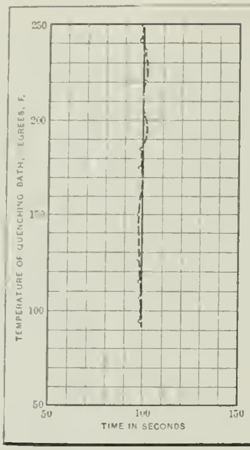


Fig. 6. Quenching Effect of Prime Lard Oil in Use Two Years

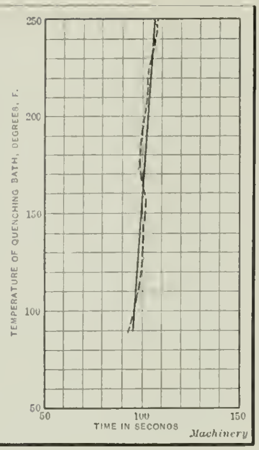


Fig. 7. Quenching Effect of Boiled Linseed Oil

A consideration of the results is interesting. Pure water (Fig. 2) has a fairly constant quenching rate up to a temperature of 100 degrees F., where it begins to fall off. At 125 degrees the slope is very marked. Brine solutions (Fig. 3) have both a quicker rate of cooling and are more effective at higher temperatures than water. The curve does not begin to fall off seriously until a temperature in the neighborhood of 150 degrees is reached.

As is well known, the oils are slower in their quenching powers than water or brine solutions, but the majority of them have a much more constant rate of cooling at higher temperatures than water or brine.

The curve shown in Fig. 13 is for a thick viscous oil somewhat similar to cylinder oil. This curve is particularly interesting in that it has a slower quenching effect at low temperatures than at higher temperatures.

A comparison of curves in Figs. 5 and 6, shows the variation in quenching effect of the same oil due to continued service. The differences in quenching rates may well account for different results from the same steel in different shops, or in the same shop.

Hardness as Affected by Mass

It has been known for some time that different masses of the same material on being quenched under like conditions give varying physical properties, but it is only within recent years that the quantitative effect has been measured.

In order to determine the effect of mass on hardness, test pieces 4 inches long were made from the same ingot in sizes increasing 1/8 inch in both breadth and thickness. The smallest was 3/8 inch square and the largest 3¼ inches square. Three ingots of different type analyses were chosen and a series of test pieces made from each. The test pieces were heated in a semi-muffle furnace to a constant temperature for each type of material, quenched, and the Brinell hardness test made. Each series was then drawn to 600 degrees F. in a salt bath and Brinell tests again taken. The pieces were then reheated to 1200 degrees in a salt bath and Brinell hardness tests again made. The results are partly shown in Fig. 14, the Brinell hardness being plotted against the test piece size. It will be noted that the smaller the sample the greater the hardness, indicating that the smaller sections are cooled with greater rapidity than the larger, and hence more hardness is developed. The same agencies are at work in tool steel. The larger the mass the smaller the depth of hardness when quenched under similar conditions.

Benedicks has shown that for steel of constant mass, the higher the temperature, the greater the rate of cooling. This confirms our experience that in order to produce the same amount of hardness in a small and large section, it is necessary to heat the larger section hotter than the smaller. A commercial application of this phenomenon will perhaps be interesting. The authors were recently confronted with the problem of finding out the correct temperature for hardening tools made from the same steel in sizes varying from 1/16 inch diameter to ¾ inch diameter. The temperature-size curve shown in Fig. 15 was finally adopted. As the curve shows, a 3/16 inch round bar will harden at 1395 degrees F., while a ¾ inch round bar should be heated to 1450 degrees—a difference of 55 degrees.

Expansion and Contraction in Hardening

One of the authors made several hundred hardening experiments and several thousand measurements to study the effect of hardening upon the shape of steel parts. The materials used were cylinders of steel and taps. Crucible steel alone was examined and the following variables were considered: (*a*) the effect of original form or diameter upon the diameter after hardening; (*b*) the influence of carbon on change of form; (c) the influence of initial temperatures at quenching; (*d*) the influence of length of time of heating; (*e*) the influence of repeated hardenings; and (*f*) the effect of annealing previously hardened steels, upon change of shape in rehardening. Obviously, when plain cylinders of steel are considered, there are four changes of shape possible, expansion in length and diameter, contraction in length and diameter, expansion in length and contraction in diameter, and contraction in length with expansion in diameter.

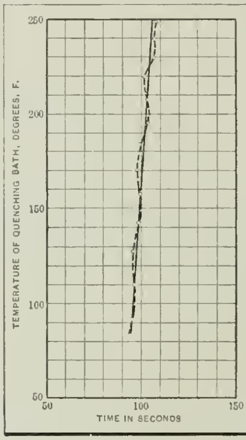


Fig. 8. Quenching Effect of Raw Linseed Oil

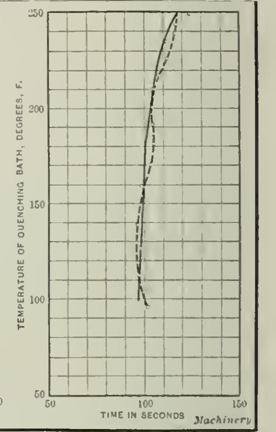


Fig. 9. Quenching Effect of New Extra-bleached Fish Oil

Under the influence of the variable conditions mentioned above, all four changes were actually produced. Steel was also found which expanded in length on first hardening and contracted indefinitely thereafter on repeated hardenings. Another steel expanded in length on two hardenings and contracted on the next two. In a variable carbon series of

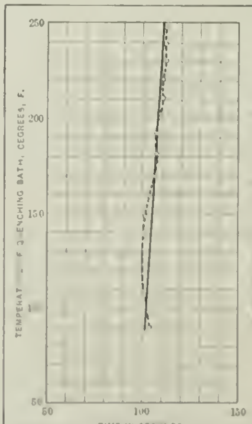


Fig. 10. Quenching Effect of New Yellow Cottonseed Oil

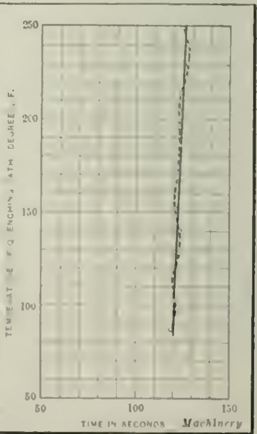


Fig. 11. Quenching Effect of New Tempering Oil

steels from 0.50 to 1.33 per cent carbon, the magnitude of the change in length after four hardenings increased as the carbon increased. For the same series it was noted that the volume changes were greater when hardening annealed rather than unannealed bars. The increase in length is greater, the higher the hardening heat for all carbon steels. It is variable conditions that give variable results; hence, it is of vital importance that steel be furnished uniform, chemically as well as physically, and it is equally important that the user employ every possible refinement in the handling of his product. It is only under varying conditions of heat, size, time, composition, etc., that the results vary. Constant conditions give constant results. It cannot be overlooked, however, that constant conditions are not always attainable. The maker of steel cannot control conditions in his customer's shop and the customer cannot control conditions in the steel plant, and the human element must be considered in both. The properties we have been describing are inherent properties of carbon steel, and because of them many a dispute has arisen over tools lost in hardening. The placing of the exact responsibility is very difficult even though it were not true that it is human nature to shirk responsibility.

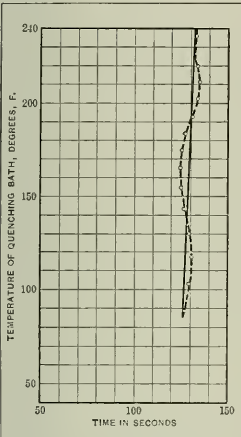


Fig. 12. Quenching Effect of New Mineral Tempering Oil

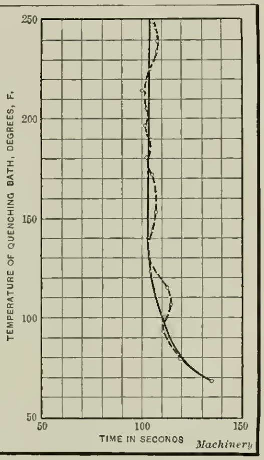


Fig. 13. Quenching Effect of No. 1 Dark Tempering Oil

Furnaces and Methods of Heating

Much has been said regarding the superiority of gas furnaces over oil furnaces and *vice versa*. The fuel used is immaterial for good practice so long as the following points are taken care of:

1. The furnace and hearth should be of sufficient size so as not to be affected materially in temperature by the introduction of the parts to be hardened.

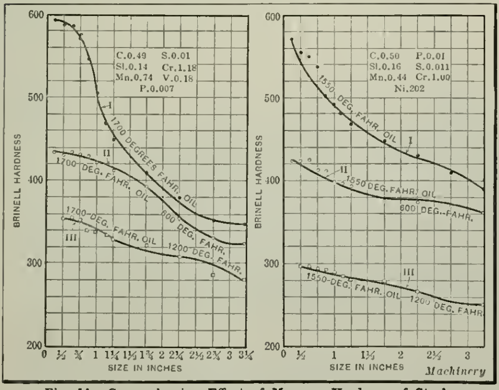


Fig. 14. Curve showing Effect of Mass on Hardness of Steel, as determined by Brinell Test

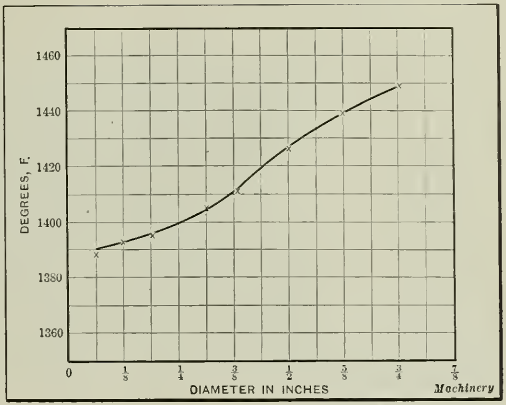


Fig. 15. Temperature-size Curve for hardening Tools

2. The furnace should heat at a uniform rate.
3. The furnace should be of uniform temperature over its entire hearth.
4. The furnace should be run under neutral, or reducing, conditions. A good rough test for this is the introduction of a piece of wood or paper upon the hearth. If the paper, or wood, burns, the atmosphere is oxidizing; if they char, it is reducing or neutral.
5. The temperature control must be at all times exact and it must be possible of exact duplication on repetition work.

A blacksmith's fire is satisfactory under good handling but the difficulty is that for constant work it is too exacting on the operator and requires too many manipulations to secure uniform and continuous results.

* * *

Public buildings are notorious for inefficient arrangement, utility having been sacrificed in their design to so-called architectural beauty. It is difficult to convince the average public building architect that utility and architectural grace can be harmoniously combined, but the great office buildings of New York City and other cities present many examples of handsome architecture and the highest efficiency for business purposes. With all these examples to copy, however, the new post-office in New York City adjacent to the great Pennsylvania R. R. station is an example of inefficient arrangement for public use. The unfortunate patrons of this mammoth structure must climb *twenty-seven* steps in order to buy a one-cent stamp. Why in the name of plain common sense should the architect and others responsible for the design and construction of this costly building have sacrificed its practical utility to the fancied impressive effect of a long flight of steps leading up to its portals? If the building had been designed to be rented for business purposes, we are sure that this blunder would not have been committed. Can not the same gage or measure of practicality be applied to public buildings?

* * *

An alloy may generally be defined as an intimate mixture of two or more metals obtained by melting them together. Most of these mixtures are mechanical in their nature, although some form chemical compounds. When two metals are melted together to form an alloy, the substance formed is, for all practical purposes, a new metal. Its appearance is different from that of the two or more original metals, and its properties, in general, are entirely different. Sometimes the alloy is harder than either of the ingredients, as, for example, brass, which is harder than either the copper or zinc from which it is made. One of the peculiar properties of nearly all alloys, which differentiates them from chemical compounds, is that the percentages of the composition may be changed within certain limits without materially affecting the characteristic properties of the alloy. In the case of the chemical compound, the proportions must always be the same.

SOME TYPES OF AUTOMOBILE CRANKSHAFT LATHES

UNIVERSAL MACHINES FOR THE CRANKSHAFT MANUFACTURER AND SPECIAL EQUIPMENTS FOR THE AUTOMOBILE BUILDER

BY WILLIAM O. STRAUSS*

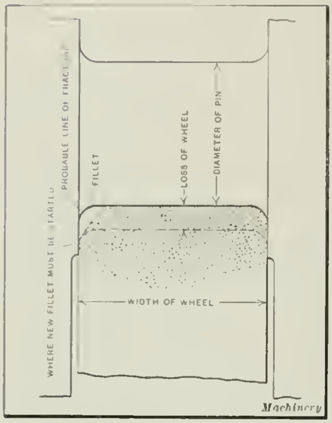
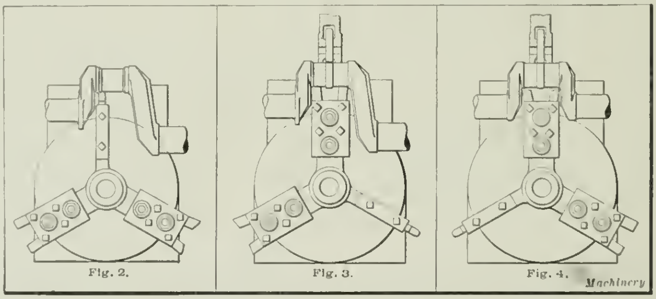


Fig. 1. Effect of breaking off Fillet in causing Rapid Waste of Wheel

Makers producing automobile crankshafts on a sufficiently large scale to warrant the purchase of special crankshaft machines may be roughly divided into two classes: First, those who are engaged in the manufacture of finished crankshafts for the trade, who do a contract business in the industry and require a flexible machine (type A) that is entirely universal within its range and capable of handling a wide variety of cranks for motors of both four and six cylinders. Second, the automobile builder who confines himself to a single model, simply requiring duplicate and practically automatic production on a large scale. His requirements are for a machine (type B), stripped of every degree of flexibility, that is capable of being quickly set up for a single job, and for which the investment is as low as is consistent with good materials and design necessary for the maximum production that the stability of the crank itself permits.

The economy of rough-turning crankpins preparatory to finish-grinding, as compared with rough-grinding, has been so thoroughly determined in the highly specialized shops that it needs but small mention here as a competitive proposition. The rapid disintegration of the coarse grained wheel from contact with the fins left from the forging dies, and the necessity of frequent re-dressing to maintain the fillets, as shown in Fig. 1, is a big factor from the standpoint of wheel upkeep, besides causing frequent delays in the production chain. By way of comparison, it is sufficient to say that a single set of properly treated high-speed steel tools will turn from 150 to 200 ordinary drop-forged or hydraulic pressed cranks, with a scleroscope reading of 35 to 40 degrees, without resharpening. The tools are held in removable blocks that are ground to gage and inserted after sharpening in a few seconds. In fact, an extra set is always kept sharpened and in reserve for instant use. The superiority of this method is now recognized by all of the larger manufacturers, while the crank grinder is considered the proper method for finishing the pins.



Figs. 2 to 4. Turning Pin, forming Fillets, and finishing Cheeks of Crankshaft

The Type A or Universal Machine

The type A machine, as mentioned before, is fully universal within its range and has a capacity for crankshafts up to and including a motor stroke of $6\frac{1}{2}$ inches for four or six cylinders, the length of the crank being unlimited. This machine is a relatively recent development and has been carried out along entirely original lines. It has passed through many experimental stages, as the practice of the industry dictated, from an ordinary engine lathe with a throw block on the faceplate and a plain block rest to carry the tools, to the present machine. The novel and distinguishing feature is the indexing three bladed turret that carries the cutting tools, and the roller back-rest to absorb the thrusts, operated from a common handwheel through a telescopic screw, the other essentials being a universal indexing head and tail fixture for carrying the crank and a double-end drive mechanism to remove all torsion from the work and prevent twisting the pins out of alignment. The cranks before they are delivered to the machine are centered, the end and center bearings are roughed out to the proper grinding size, and the flanges are generally finished. They are then ready for the crank-pin turning machine.

The method of turning is as follows: The round nosed turning or spotting tool (Fig. 2) is first run into a positive cross-stop, sizing the diameter to within 0.015 or 0.020 inch of the finished size. The feed is then thrown in and the carriage fed along until the automatic stop lever engages a trip dog. The carriage is then returned against a positive stop by means of the carriage handwheel. This locates it for the filleting tools. The roller back-rest is next brought into position by means of the cross-feed handwheel, operating through a telescopic screw. This roller rest effectually absorbs all of the cutter thrust and prevents the shaft springing and riding over the edges of the tools. The turret is next indexed, bring the fillet forming tools into position (Fig. 3). These are then fed in against a stop, removing that part left by the turning tool and giving the pin the proper width fillets of the correct radius.

If the crankshaft is one with straight cheeks and these must be finished, the checking tools are next run in, giving the correct width between the cheeks (Fig. 4). These tools can also be used to remove any fins left from the forging dies

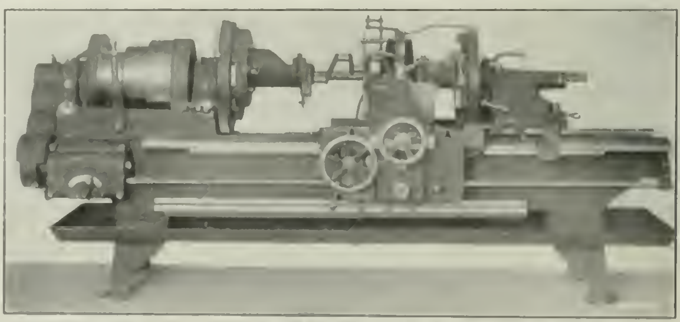


Fig. 5. Front View of Type A or Universal Machine equipped with Double End Drive

in case there is no checking to be done. It will be noted that the roller rest is used on both the second and third operation. The backrest is then run out of the way, the automatic stop lever raised, the carriage run down to the next pin in the same plane, and the sequence of operations repeated. After both pins in the same plane are finished, the head and tail fixtures are locked to maintain the setting, the clamp on the tail fixture opened, and the crank spun on its axis, bringing the next set of pins on the turning center of the lathe, then indexed and clamped from the head fixture.

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* With the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio.

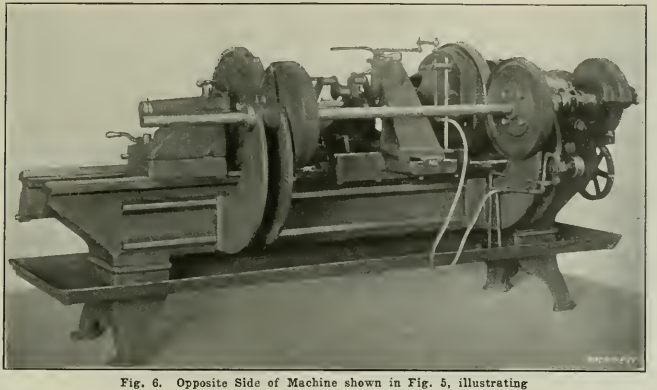

Fig. 6. Opposite Side of Machine shown in Fig. 5, illustrating Geared Connection of Head and Tail Fixtures

With the double-end drive machines discussed later, the locking plunger for the fixtures is unnecessary, as the alignment is maintained through the gearing. The index ring is provided with twelve slots, engine divided, enabling pins at every 30 degrees to be finished. This covers every condition for four and six cylinder cranks. The tools are carried in removable holders, and may very readily be removed and other tools substituted for different widths of pins; in other words, every single factor has been designed to render the lathe entirely universal within its limits and to enable the settings and adjustments to be made with as little difficulty as possible.

The Fixtures

The lathe to which these crank fixtures are applied is a 21-inch LeBlond heavy duty cone driven automobile lathe, with the well-known LeBlond double friction back-geared headstock, which enables the speed changes for the turning and filleting to be made without stopping; and in connection with an efficient double friction countershaft gives a selection of four speeds on each cone step while running. The spindle bearings are hardened and ground, the bearings are of chilled cast iron of unusual density and maximum wear resisting properties. The result is a practically indestructible bearing and the one suited to this severe class of work involving heavy intermittent shocks. The threaded spindle nose carries a heavy faceplate with a broad dovetail slide, on which the head fixture is mounted. This slide is graduated and the head fixture moved along by means of an Acme screw. The amount of throw is regulated in this manner, the adjustment being from zero to 3¼ inches throw or 6½ inches stroke—sufficient to cover commercial requirements. After this adjustment is made, the tail fixture is set to coincide; and both fixtures are rigidly clamped by four T-slot bolts, or they may be dowelled into position. On long set-ups it is probably better to dowel the fixtures to the slide.

The head end crank carrier is provided with a hardened and ground index ring and plunger by means of which the fixture is indexed, bringing the different pins or sets of pins onto the turning center of the lathe. The index plunger is operated through a rack and pinion and has a radial and a taper face, drawing the index ring against the radial face by means of the taper, thus insuring the accuracy of the indexing mechanism. The plunger is held against the ring by means of a coiled wire spring. Bolts conveniently placed near the outside of the swivel effectively clamp the two members together after indexing. The fixtures are provided with hinged caps with renewable tool steel split bushing, by means of which cranks with different diameter line bearings are clamped in the fixtures. Before pulling the caps down tight, the crank is quickly centered by a V-block in the head fixture operated by the knurled head screw, which also serves as a driving dog for the crank. The tail fixture does not require an index mechanism, as the hinged cap is simply opened

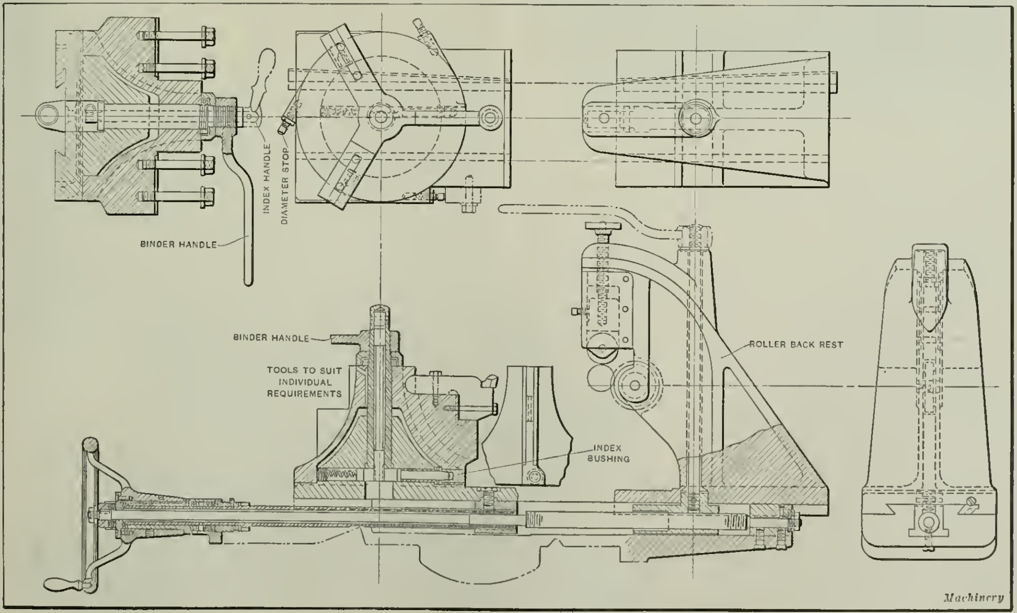

Fig. 7. Design of Three-tool Turret and Roller Back-rest for Type A Machine

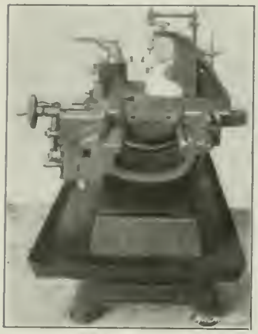

Fig. 8. End View of Type A Machine

and the crank allowed to rotate on its axis while the fixture is locked to the tailstock to prevent its weight tending to twist the crank. The spindle of the tailstock has been removed, and a new and larger spindle which carries the fixture has been provided. This spindle runs the entire length of the tailstock, revolves in bronze bushings, and is provided with a ball thrust adjustment on the rear end.

The Arrangement of the Double End Drive

The double end drive serves two purposes. First, it makes both ends of the machine drivers, and prevents one set of pins twisting in relation to the other. Second, it eliminates an operation necessary with a single end drive machine, *i.e.*, locking the two fixtures in alignment when removing and replacing the cranks, as the fixture alignment is maintained through the gear connection between the fixtures. Gear teeth are cut in the periphery of the fixtures on both the head and tail end. With these gears mesh a pair of accurately cut spur gears, connected by a splined shaft at the back of the lathe and paralleling its centers. These gears take liberal bearings in two heavily ribbed cast-iron brackets rising from a broad planed dovetail cast integral with the bed, as shown in Fig. 6. The gear on the head is mounted on a flange keyed to the shaft and clamped in its driving position by four large studs set in circular slots in the web of the gear. This arrangement permits of adjustment in the alignment of the two fixtures and furnishes a means of compensating for wear in the gear teeth. The tall bracket is adjustable with the tailstock along the bed for different lengths of cranks. Both fixtures are of cast steel.

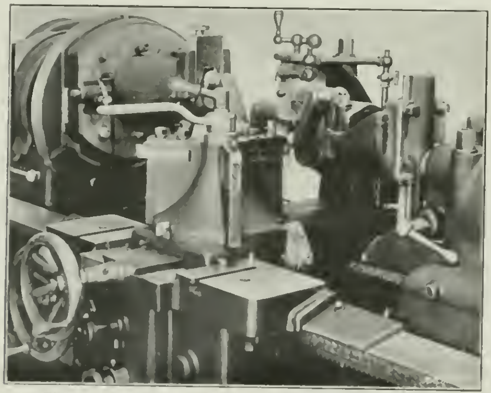

Fig. 9. Same Type of Turret and Back-rest shown in Fig. 7

The Arrangement of the Turret and Roller Back-rest

The turret and roller rest construction is shown in detail in Fig. 7. A simple hardened jaw clutch arrangement enables both to be operated through the same handwheel by means of a telescopic screw, and the power cross-feed is available for both. The top roller of the back-rest is set in a sliding block operated by a knurled knob which enables the rollers to be quickly adjusted to the diameter of the crank pin. Telescopic guards for the slide exclude all chips and dirt from the cross-slide and screw. The cross-slide is unusually wide to receive the tool-block and rest, both of which are accurately gibbed thereto. Positive locating stops and automatic length stops render the sizing of the pins practically automatic. The operators of these machines acquire a remarkable degree of proficiency in handling the turret mechanism, and are able to produce an ordinary four-throw crank turned, and the fillets formed, with an allowance of 0.015 inch for grinding and a limit of ± 0.003 inch in from 10 to 12 minutes each. A steel chip pan and large rotary pump permit of flooding the work with cutting compound. Outlines illustrating two types of cranks that are advantageously handled on the universal machine are shown in Fig. 10.

Type B or Manufacturing Machine for One Kind of Crankshaft

The style B or manufacturing machine is a newer development than the type A, resulting from the automobile manufacturers confining themselves to a single model, produced on a large scale and requiring only a minimum degree of flexibility. The most interesting feature is the fact that two pins, lying in the same plane and not necessarily adjacent, are finished at the same time. For a four-cylinder crank the equipment, of course, consists of two machines, one for the inside adjacent pins and another machine for the outside pins. The machine illustrated in Fig. 11 is for a crank of this kind. This type of construction increases the handling time, but the time saved by finishing two pins simultaneously, as well as the absence of any indexing operations, far outbalances the additional handling time incidental. As on the type A machine, the line bearings and flanges are finished on an ordinary automobile lathe before they are delivered to the pin lathe. The holes in the flanges are drilled and reamed to receive the flywheel, and the crank is aligned and driven from these holes by means of a hardened pin in the head fixture. As no index mechanism or adjustment for different strokes is required, the fixtures simply take the form of plain crank carriers with hinged caps. They are of cast steel to insure ample strength.

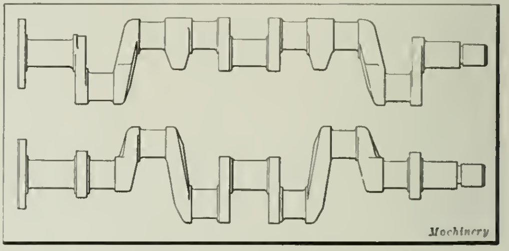

Fig. 10. Two Types of Crankshafts that are advantageously handled on the Universal Machine

These cranks are of such design that they require no finishing on the cheeks, the tools simply consisting of the round nose turning tools on the front block and the tools for forming the fillets on the rear slide. The operations are as follows: The crank is centered by V-blocks in relation to the pins. The line bearings are roughed out and the flange finished, after which the flange is drilled and reamed. The

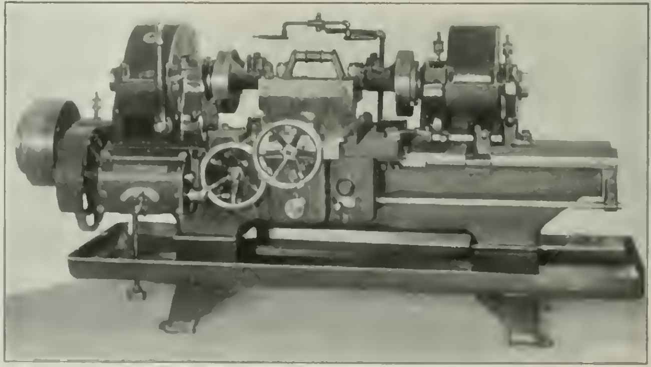

Fig. 11. Type B or Manufacturing Lathe for machining One Kind of Crankshaft

crank is then ready for the pin lathe. It is clamped in the fixture by means of the hinged cap on the fixture, and the pins are centered by the locating stud. The flange on the crank comes back to an end bearing on a shoulder of the locating stud, fixing the pins longitudinally. The round nosed turning tools are then brought in to a positive stop, sizing the pin diameter to within 0.015 inch to 0.020 inch of the finished size. The longitudinal feed is next engaged and the carriage fed along until it engages an automatic feed stop. The carriage is then returned against a positive stop dog in a spacing bar on the carriage, which locates the filleting tools, as well as the starting point for the turning tools on the next crank. The filleting tools are brought in to a stop, forming the radius and overlapping the traverse of the turning tool. It will be noted that this operation is going on with two pins simultaneously; as the machines are worked in pairs, both in operation at the same time, it is possible to finish a four cylinder crank complete in about two minutes. In fact, this is the rate at which they are being finished in one of the largest automobile shops in the country.

Both fixtures are positively driven through gearing. One of the large gears is mounted on a flange and is adjustable about its hub through a circular slot in the web, enabling the fixtures to be re-aligned or adjusted at any time. The initial drive is from a large pulley, carried on an oil bushing on the head end bearing stand. This pulley is clutched to the driving shaft which runs through the center of the bed, by means of a powerful friction clutch in its periphery, operated by the handle conveniently placed on the headstock. On releasing this clutch the same handle applies a friction brake, bringing the spindle to an instant stop. The driving shaft is carried in bronze bushed bearings in each head pedestal, and carries a pinion on each end between its bearings. This pinion drives both headstocks in unison, so that the crank is driven from both ends and has no tendency to twist under the cut. The driving shaft is of spindle steel, large in diameter, rigidly supported in long bearings, and runs at a relatively high speed, thus eliminating torsion. The reduction between this shaft and the spindle is approximately 4 to 1, as the crank is turned at a speed of about 50 feet or 100 revolutions per minute, so that the pulley runs at nearly 400 revolutions, thus furnishing ample driving power. It is 16 inches in diameter and carries a 5-inch belt. The pinions on the driving shaft mesh with accurately cut spur gears of broad face, to insure noiseless operation. To further reduce noise, the gears run continuously in heavy grease and are encased in close fitting cast-iron guards. The spindles are carried in relatively long bronze bushed bearings, with the front journals hardened and ground. The spindles are made from high carbon crucible forgings, with a large flange forged on to carry the crank fixtures, which are bolted and doweled to a false plate on the flange, so that the fixtures can be interchanged at any time.

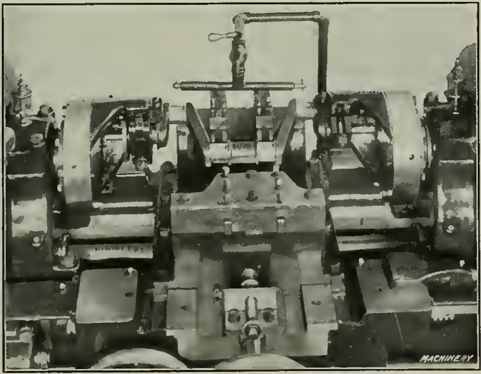

Fig. 12. Type B Machine tooled up for turning Inside Crank-pins

The change gear box and apron are of the LeBlond standard construction for automobile work, and were described in MACHINERY some time ago. The carriage and bed construction, however, require some special mention. The carriage bridge is as wide as the widest spaced pins, and provides a support for the cut the full width of the tool-blocks. The slide takes a bearing the full width of the bridge, distributed over a wide dovetail and a square lock slide, and accurately gibbed thereto. This extremely wide bridge is permissible on account of the fact that the carriage does not travel over 2½ inches at the most, the travel representing the width of the cut between the filleting tools. The carriage takes its bearing on the compensating shear of the LeBlond heavy-duty bed, giving a total of 227 square inches of carriage bearing surface. This is distributed over just three planes, on which the wear must be relative to maintain alignment. The front shear provides a right angle bearing to the tool thrust the full length of the carriage and a broad flat plane at the front and rear to take the down thrust. The total included angle of the shear is 85 degrees and gibs are provided front and rear. A double friction countershaft provides the necessary speed changes and a pan bed with a geared rotary pump and distributors enables the work to be flooded with cutting compound.

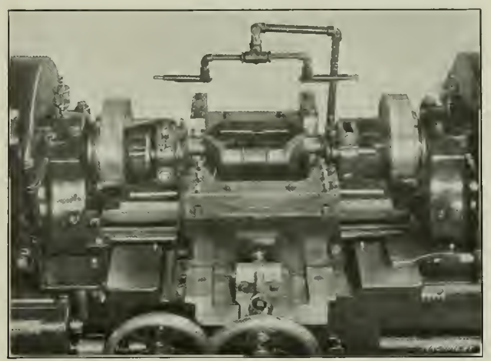
Fig. 13. Type B Machine tooled up for turning Outside Crank-pins

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INDUSTRIAL CONDITIONS IN GERMANY

According to figures recently published in Germany, from reports of thirty-four labor unions with a membership of over a million and a half, 21 per cent of these are out of employment. In some trades, as much as 62 per cent of the men are unemployed. Considering the fact that a large percentage of the members are employed in the war, this would indicate that practically all of those that are at home are out of work. Only in the ammunition industries and a few allied trades is employment general. The automobile builders, for instance, are, according to the *Scientific American*, working twenty-four hours per day in an endeavor to keep up with the demands of the army. In many of these factories there is difficulty in carrying on the work, as so many of the skilled workmen have been called to the front, and in spite of the fact that there are so many people out of work, it is difficult to secure skilled labor to take the place of those in the field. In some cases, the employes of shops engaged on government contracts have been sent back to their works, in order to enable the work to be completed. A number of factories have been taken over entirely by the government and some of those near the scene of activities are devoted entirely to repairing damages sustained in action. This is particularly the case with factories in Belgium. Difficulties are encountered in securing supplies of rubber for tires and in the transportation of materials required.

* * *

It is stated in a French contemporary that it has been determined by experiments that a layer of electrolytically deposited copper from 0.001 to 0.002 inch thick is the most advantageous coating agent for protecting portions of steel to be casehardened from carbonization. Nickel cannot be used instead of copper because it is permeable to carbon monoxide.

TAYLORISM AND THE BONUS SYSTEM*

BY W. L. MYLES†

In the November number of MACHINERY, on page 191, there appears an article by Frank Richards entitled "Taylorism and the Bonus System," in which he very strongly denounces the methods of the Taylor system of pay for the mechanic. He agrees with the *London Engineer* in an article in which they speak of this system as a "peculiarly hideous method of dehumanization." He also states that it is far from having the ultimate effect of working in the interest of either employer or employe, that it deliberately brings about the degradation and belittlement of the individual workman and paralyzes all incentive. In some respects I agree with him most heartily, and give him credit for the courageous way in which he makes his denouncements. A good many of our so-called scientific systems of management are so loaded with red tape, useless forms and rules that I doubt if the money and labor they claim to save ever reach the amount of the cost of their maintenance. For it hardly seems possible to produce a man with the required ability to enable him to prescribe from the office exactly how the work in the shop should be performed by the mechanic, because conditions and materials are constantly changing. Even if this man has the shop training of today, tomorrow's methods of work may be entirely different, so his instruction and method of work would be out of date and inefficient. Again, the red tape necessary to go through in handling the work and using the prescribed tools, etc., goes to hinder more than help the man doing the job. It destroys confidence in himself and takes away all incentive.

To Mr. Richards' reference to the bonus system I most strongly object, and think that he misrepresents the basic principles of the true bonus plan of rewarding labor. After nearly eight years of practical experience with the differential bonus piece-work system I am thoroughly convinced that his views are entirely wrong. From the statements he makes in his article, one would be led to think that the increased production under the bonus system was due solely to the efforts of the mechanics, and they therefore should receive all the money saved. The mechanic himself does not expect this, and knows that in any extensive system of efficiency the overhead charges of maintaining such a system are no small item, and should receive their just portion of the profits, as the good results obtained from this system are from the close observation and cooperation of both brain and hands. Mr. Richards also states that the bonus system dodges the honesty of the men. This is entirely a mistaken idea. The bonus system is a means of affording substantial justice to the employe who is willing to put forth his efforts, requiring him at the same time to conform to the best interests of his employer. It is a known fact that 90 per cent of the working men of the country are doing less than 60 per cent of what they might do without physical injury or over-exertion. Under the day's work plan, all men classed as mechanics are paid a like amount per day, but in most cases you will find that there are a few men who are doing 50 per cent more than the rest. I would ask Mr. Richards if in this arrangement of pay he thinks there is any justice for the conscientious hard worker. No, there is none. If the bonus system was introduced into a shop for no other reason than that of rewarding the worker who is worthy, it is well worth while; but this is only one of its benefits.

Not only is this system a means of rewarding labor, but it is a material factor in cost accounting. We have long given up the practice of taking the foremen's guess or even the expert estimator's figures as to what a job will cost. We know under the bonus system, from the records we have made, just what that job will cost us before we undertake it. We have heard of instances where a man has boasted of his ability to read men and tell just what they are capable of producing, but the bonus system has taught us to place little faith in such claims. We all can make guesses and some of us can come very close to knowing just what a machine we are building will produce, because we know what material and workmanship goes into it; but who can know or even guess the capabilities of man, when his mind has been properly trained and his hands experienced? This is what the true bonus system tends to do, and not to doubt the honesty or rob the workingman of his share of the profits. When the bonus system was introduced in our shop we made a guess as to what percentage of efficiency we were receiving from the men for the amount of pay they were receiving on the day's work plan, and the records of results obtained under the bonus system showed conclusively that we favored the men in our guess.

One of the main questions not entirely solved by the manufacturer is, how are we going to increase the mechanic's efficiency, keep him satisfied and successfully reduce the manufacturing costs, enabling us to meet the keen competition in business? Suppose we advance the wages of labor say from 10 to 25 per cent, would we receive that proportion in increased output? No, not on the average, as a large percentage would not do any more work than before the advance. They would simply take it as a matter of fact. That is human nature. In all probability we would do exactly the same if we were in their place and working under the same conditions. I am convinced that in the mechanic lies the power to increase or materially decrease the cost of manufacturing and that such a result is best attained by taking him into your confidence, treating him as a fellow human being and not as a machine or know-nothing, as is the custom in many shops. Cooperate with him, give him the benefit of the executive ability which you have been fortunate enough to acquire, and in all probability he will surprise you by his hearty cooperation. Both employer and employe will become more efficient in their respective positions as a result.

The bonus system benefits the workingman because of the chance afforded him to show his individuality; he does not have to divide the spoils or honors with some other fellow worker who may not have put forth the same amount of energy in accomplishment of the task, but nevertheless receives the full reward. It benefits the workingman by reducing to a large degree the physical effort formerly put forth in accomplishing his task, for under this system he is instructed and directed as to the best method of performing his work, and by following as far as possible these instructions and directions he soon realizes that by the cooperation of his hands and brains less physical effort is required. This system frees the mechanic from the drudgery of purely routine work and puts new interest and energy into him. It arouses and cultivates that zest for reasonable racing, with the possible chance of beating his fellow workmen, and before long he has unconsciously reached a higher level of efficiency and consequently increased his earning capacity.

To prove to the skeptical manager, and also to Mr. Richards, that the bonus system actually produces results in securing lower production costs, higher wages, increased efficiency and a better quality of work, I could make mention of many cases where such an end has been obtained under this system. But the mentioning of a few cases will suffice. From the records of different operators on bonus for a period of six months, results were obtained which are shown in the table. This shows a total average increase for all of 0.064 cent per hour or 26 per cent higher wages. Another striking example of efficiency which came to the writer's notice was that where a gang of eight men worked on an assembling job for a period

RESULTS OBTAINED WITH THE BONUS SYSTEM

Class of Operators	AverageDay Rate per Hour	Average Bonus Rate per Hour	Average Increase in Rate per Hour	Per cent Increase
Lathe...........	0.30	0.365	0.065	21.7
Planer.......	0.325	0.39	0.065	20.0
Drill Press	0.225	0.28	0.055	24.5
Milling Machine..	0.187	0.242	0.055	29.4
Screw Machine.	0.162	0.216	0.054	33.3
Boring Mill......	0.342	0.43	0.088	25.7
			0.064	25.76

Machinery

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* For additional information on the bonus system and allied subjects published in MACHINERY, see also "Taylorism and the Bonus System" by Frank Richards, November 1914, and other articles there referred to.

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of several weeks, their average day's work rate per hour was 32 cents, but while on bonus they averaged 45 cents per hour—an average increase of 13 cents per hour or about 40 per cent higher wage. How do you account for such an achievement? Consider another case in point. A task, after a careful and detailed study was made of it, was put on bonus with a time allowance per piece 47 per cent less than it took to do each piece on day work. When the task was finished the time was reduced 54 per cent less than the time allowed, *i.e.*, the task was completed with a time reduction of 101 per cent less than it took on day work, with an average increase for the mechanic of 18 cents per hour or 48 per cent higher wage. This was due partly to the change of routine and method of handling the work, and proves beyond a doubt that the bonus system is not entirely a system to increase the workingman's efficiency alone, but likewise obtains and maintains a higher degree of efficiency throughout the whole organization, for its basic principles are cooperation, reward and greater efficiency. If we were to try today to eliminate the bonus plan of pay from our works, we would find it difficult to make our men satisfied with the resumption of the day-work plan.

* * *

CAUSES OF EXPORT TRADE

It is probably a puzzle to many Americans why England, Germany and France have, in the past, obtained such a firm hold on South American trade, while the United States has hardly had a chance at it. The answer, however, is simple. England, Germany and France have supplied the capital by which the railroads in South America have been built, and many of the industrial improvements been made. It is estimated that in the seven years from 1906 to 1913, Great Britain supplied the Argentine Republic with nearly $600,000,000 for developments; Brazil with $440,000,000 and Chile and other South American countries with $250,000,000. The total British investment in South America is reckoned at about $3,000,000,000. Germany and France have also supplied vast amounts of capital, although less than Great Britain. The United States has not invested capital in these countries because all the available capital here can find profitable employment at home.

Now what has the investing of money in a country to do with securing trade? It has everything to do with it. In the first place, the investors have probably obtained positions as directors in large industrial undertakings and railroads in South America, and naturally they have directed the trade channels to their own countries; but this may have been a minor influence. The most important cause is that when Great Britain, Germany and France have been selling goods to South America they have, to a large extent, invested the purchase price in these countries; that is, they have sold the goods on credit. The individual merchant may have received his pay, but England or France or Germany, considered as a whole, has not been paid. In other words, the transaction is like that of selling goods to a farmer and taking a mortgage on his farm in part payment of the bill. Evidently, under those conditions, the South American countries would do business with such nations as were able to transact business with them on this basis. The capital in the United States has had no need to go (to any large extent) outside of its boundaries for investment; hence there has been no incentive to sell goods on this basis.

* * *

ELECTRICAL CONGRESS POSTPONED

The executive secretary of the International Engineering Congress which is to be held in San Francisco, September 20-25, has issued a statement in regard to the International Electrical Congress which was to be held in San Francisco in September at the same time as the International Engineering Congress. Owing to the European war and the impossibility of convening the International Electrotechnical Commission, under whose authorization the Electrical Congress was to have been held, it has been decided by the governing body of the American Institute of Electrical Engineers to indefinitely postpone the holding of the Electrical Congress. This, however, does not affect the International Engineering Congress, which will be held as originally planned.

COST OF MUNITIONS OF WAR

At this time when the principal nations of Europe are at war and the question of increasing the defenses of the United States is being agitated, a few figures on the costs of guns, etc., will be of interest. The following data on the cost of guns, howitzers, mortars, mountings, carriages, projectiles, powder charges and fuses were furnished by the ordnance departments, Washington, D. C., and are therefore authoritative.

3-inch field gun	$ 1,825.00
4.7-inch field gun	4,650.00
4.7-inch howitzer	2,150.00
6-inch howitzer	3,325.00
6-inch seacoast gun	6,700.00
12-inch seacoast mortar	11,000.00
14-inch seacoast gun	55,000.00

The costs of carriages and mountings for seacoast guns are:

15-pounder barbette	$ 5,000.00
5-inch barbette	13,500.00
6-inch barbette	14,000.00
6-inch disappearing	24,000.00
10-inch disappearing	37,000.00
12-inch disappearing	65,000.00
14-inch disappearing	85,000.00
16-inch disappearing	130,000.00
12-inch mortar	18,000.00

The cost of artillery carriages of the mobile or transportable type follows:

3-inch field gun carriage	$ 2,181.00
3.8-inch howitzer carriage	8,500.00
3.8-inch gun carriage	5,462.00
4.7-inch howitzer carriage	10,562.00
4.7-inch gun carriage	4,361.00
6-inch howitzer carriage	14,147.00

If manufactured in the government plant, a round of ammunition costs approximately as given in the following, but when purchased from manufacturers, the cost is higher.

3-inch field gun	$ 10.00
4.7-inch gun	28.00
6-inch howitzer	43.00
3-inch, 15-pounder	15.00
6-inch	60.00
12-inch gun	500.00
12-inch mortar	300.00
14-inch gun	800.00
16-inch gun	1,200.00

The smokeless powder for seacoast ammunition costs 53 cents a pound when purchased and somewhat less when manufactured by the government.

Following are data on the cost of naval guns, carriages, etc.

3-inch naval gun	$ 3,973.00
5-inch naval gun	7,600.00
7-inch naval gun	21,850.00
12-inch naval gun	72,820.00
14-inch naval gun	112,000.00
3-inch gun mounting	2,500.00
5-inch gun mounting	9,860.00
7-inch gun mounting	11,000.00
12-inch gun mounting	52,357.00
14-inch gun mounting	44,000.00
3-inch projectile	1.97
5-inch projectile	8.72
7-inch projectile	62.00
12-inch projectile	165.00
14-inch projectile	400.00
3-inch gun powder charge	2.12
5-inch gun powder charge	9.40
7-inch gun powder charge	30.60
12-inch gun powder charge	147.40
14-inch gun powder charge	201.40
3-inch gun fuse	0.80
5-inch gun fuse	1.45
7-inch gun fuse	4.80
12-inch gun fuse	4.80
14-inch gun fuse	4.80

The cost of a torpedo is $8500 and of the explosive $350.

A navy rifle complete costs $20; pistol, $18. The navy pays 53 cents a pound for smokeless powder and 14 cents a pound for black powder.

The following data of costs of armor-plates and shells have been compiled from bids of private concerns:

4-inch naval gun shells	$ 9.50
5-inch naval gun shells	12.00
14-inch naval gun shells	415.00
7374 tons armor-plate, per ton	435.00
401 tons armor-plate, per ton	486.00
290 tons armor-plate, per ton	466.00
63 tons armor-plate, per ton	376.00

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

DRILL JIG FOR MACHINING HALF HOLES

A rather unusual form of jig for drilling a half hole in the work to match a similar half hole in another piece is shown in Fig. 1. This is a familiar device which is employed when it is desired to assemble two pieces and drive a pin into the hole to act as a driver. To drill such a half hole, it is usually necessary to plug up the hole in the work in some way which will back up the side of the drill that is not cutting. This is accomplished in the present instance by having a stud *A*, which is a push fit in the work, back up the drill. An angle iron or plate *B* is attached to the stud *A* and held in position by a bolt *C*, the plate *B* being also doweled in place. A hole is drilled in this angle iron to receive the bushing *D* which guides the drill in the usual manner. The remainder of the jig consists of the key *E* which locks the jig in place on the work.

In using this tool, the key *E* is pulled back clear of the work and the stud *A* which carries the angle iron is pushed into the hole until the stud brings up against the shoulder of the work. By pushing the tapered key *E* up until it binds on the flat of the work, and then tapping it lightly, the jig is held securely in place. When drilling one of these half holes it is found that if an ordinary twist drill is used there is a tendency for it to "hog in," which is likely to result in breaking the tool. For this reason, it is desirable to use a straight fluted or farmer's drill of the form shown at *A* in Fig. 2; although good results may also be obtained by taking a twist drill and grinding the lips to the form shown at *B*, thus removing the hook resulting from the spiral form of the flutes. A drill which is ground in this way presents a square or slightly obtuse cutting edge to the work, thus doing away with the trouble experienced from drills breaking when ground in the usual way.

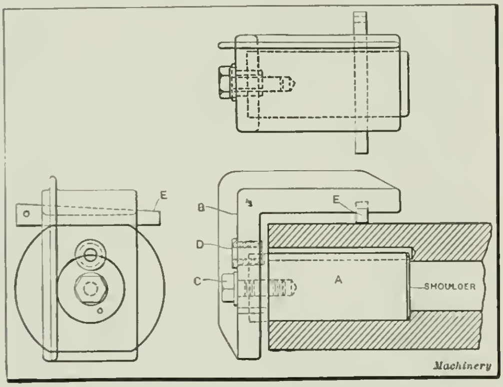


Fig. 1. Useful Form of Jig for drilling Half Holes

When drilling the hole, the work is set up on end on the drill press table and the drill is fed through the bushing in the usual way, the bushing holding the drill in position until it starts to cut. As the drill is fed down, there is a tendency to force it away from the work, but this tendency is resisted by the hardened stud *A* so that the half hole must be drilled parallel with the axis of the work. This jig affords a convenient means of quickly accomplishing this work and having the two half holes match up accurately, so that no difficulty is experienced in assembling the work.

F. SERVER

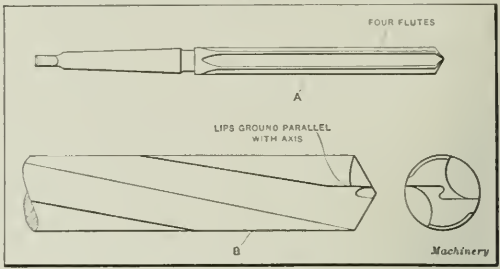


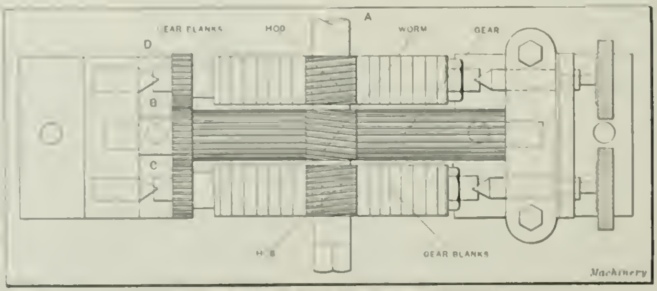
Fig. 2. Straight Fluted Drill A and Method of grinding Twist Drill B, for Use in Jig shown in Fig. 1

HOBBING SMALL GEARS ON THE MILLING MACHINE

Not long ago we started on a new class of work which required a considerable number of small spur gears to be cut. These gears had fifty-four 32-pitch teeth; the face width was ¼ inch and the thickness of the hub ½ inch, with an irregular shaped hole broached in the hub. They did not have to be particularly accurate, and in the absence of a hobbing machine, we naturally considered using the milling machine or gear cutting machine, but the rate of production on both of these equipments was too low. As a result, I designed the hobbing attachment for use on a milling machine which is illustrated and described herewith.

It will be seen that two work-holding mandrels are used, and while the work was being cut on these mandrels other blanks were set up on two duplicate mandrels ready to be mounted in the attachment. The two hobs are carried on an arbor *A* which is mounted in the milling machine spindle. Between the two hobs there is a worm which meshes with a long spur gear that is rotated in this way: The motion is transmitted to gear *B* which meshes with the gears *C* and *D* mounted on the end of the mandrels on which the gear blanks are carried. In this way the desired rotation of the two hobs and the work is secured, and the gears are cut at a very satisfactory rate of production.

The long gear which meshes with the worm on the arbor *A*, is of the same diameter and pitch as the gears to be cut. This gear is permanently mounted in the attachment. It will be seen that two adjustable centers are provided for supporting the mandrels on which the work is carried. The hobs were cut right-hand, while the worm on the arbor *A* is of the same pitch but left-hand. By the use of this attachment, it was possible to turn out the work at the rate of one gear a minute.



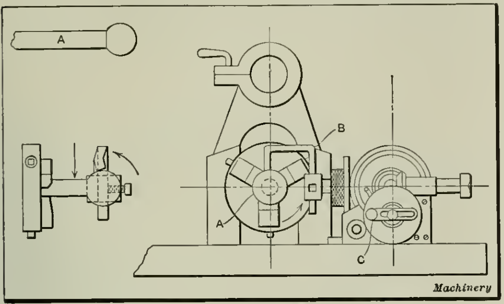
Fixture for Use in hobbing Small Spur Gears on Milling Machine

Although the attachment described in the foregoing was made especially for use on a Brown & Sharpe plain milling machine, it will be readily seen that it could be employed on various other types of milling machines with equally satisfactory results.

GEORGE WERNER, JR.
Newark, N. J.

TURNING A BALL ON THE MILLING MACHINE

On numerous occasions I have been called on to produce balls for socket joints, spherical reamers, end-mills, etc., and I handled this work on a lathe equipped with a compound rest. However, I was never satisfied with the results obtained in this way, and finally hit upon the method described in the following. On one occasion I had to make several pieces of the form shown at *A*, which were to be used in the clutch mechanism of a certain type of power press. I first turned the shaft to the required size and roughed out the ball as well as I could on the lathe. Having proceeded to this point, I bent a piece of good tool steel to the shape shown at *B*, and placed this tool in the milling machine fly cutter which was mounted in the index head. I then placed a chuck on the machine spindle, put the finished shank in the chuck and lined up the work with an indicator. Having proceeded thus far, I brought the tool into contact with the rough ball, after which the cut was started, turning the work and the tool in the directions indicated by the arrows. It will be evident that the tool was rotated by turning the crank *C* on the index head. By the use of this method, a very nice ball was easily obtained.

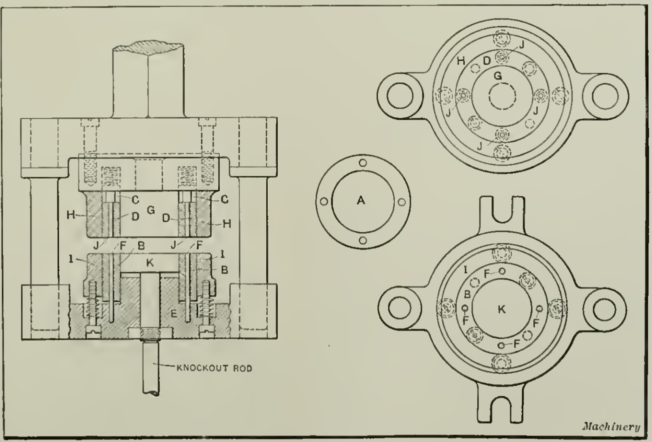


Set-up for turning a Ball on Milling Machine

It is important to have the tool cut on the front edge with the work rotating in the direction indicated in the illustration. If the tool cuts at the back edge it will tend to dig into the work and spoil the finish. If there are several pieces of one size to machine, after setting the tool to cut the correct size and finishing one piece the table can be moved to the left to enable the finished work to be removed from the chuck and a fresh blank mounted in its place. After this has been done the table is brought back to a stop which lines up the center of the sphere with the center of the cutting edge of the tool. By this means, the necessity of moving the tool is done away with.

In machining a spherical shaped end-mill for milling the ball, I turn the shank very close to the required size and insert it in the milling machine collet, after which the collet is placed in the spindle of the milling machine. After turning and fluting the ball to a size within 0.0005 inch over that required, I harden the work and then grind the shank to the correct size. After this has been done, the work is stoned until it fits the templet accurately.

George Slider
New Haven, Conn.

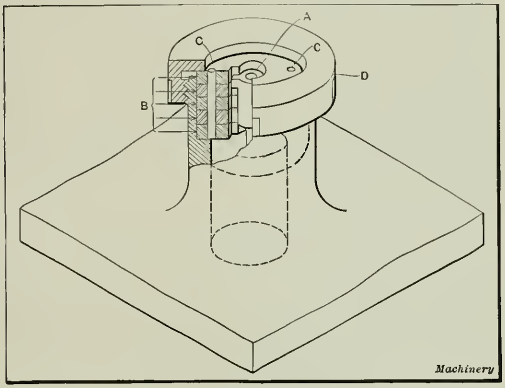


Mica Insulator and Sub-press for handling this Class of Work

EXTERNAL BROACHING

The subject of broaches which have their cutting edges located internally has received comparatively little attention. Generally it is better to accomplish the forming of exterior surfaces by other means, but in some cases the ability to do a successful job of external broaching will be a means of accomplishing a material reduction in manufacturing costs. In the accompanying illustration an internal broach is shown with the work to be broached passing through the cutting teeth at *A*. The teeth consist of disks *B* of the proper form, which are held in the desired relation to each other by the two dowel pins *C*, and the whole tool is held in the fixture base by tightening the nut *D* with a spanner wrench.

This broaching is performed after milling the rear end of the work in order to insure that it is true with the forward turned portion, and that the size is kept within very close limits. The punch in the spindle of the arbor press is made to fit the hole in the rear of the work and a tray under the machine catches the work as it leaves the broach. The results obtained in this particular case have warranted an extension of the idea to other operations of a similar nature, with some creditable savings in the cost of production and a bettering of the quality of work produced.



Broach with Internal Teeth for finishing an Outside Surface

Hart Ford

SUB-PRESS FOR BLANKING MICA INSULATORS

While employed by an electrical concern I was confronted with the problem of blanking and piercing the holes in mica insulators of the form shown at *A*. A plain die was tried out, but the stock flaked so badly—especially when the dies got the least bit dull, and they wore very rapidly owing to the abrasive nature of the material—that it was evident a more effective method would have to be developed. After giving the matter some thought, the sub-press shown in the illustration was designed, and as the stock was held flat and gripped between the upper and lower dies, the tendency to tear the material while blanking out the insulator and piercing the holes was eliminated.

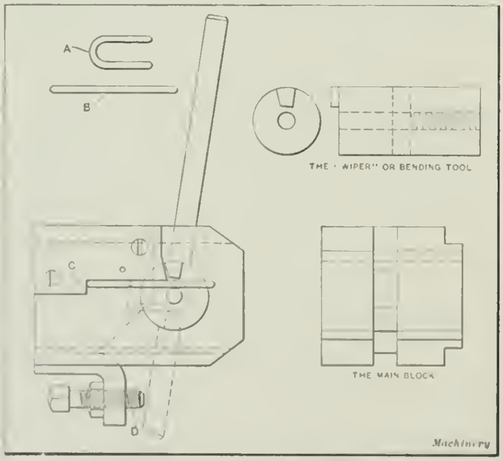
In operation, the upper die or punch descends, and as the springs under the die *B* are weaker than the rubber buffer *C* behind the punch *D*, it follows that the die *B* will be pushed down until it is stopped by the bolster *E*. It will be seen that the piercing punches *F* are held fast in the bolster *E*, and when the die *B* is depressed these punches enter the holes in the blanking punch *D* and pierce the four holes in the insulator. The large hole in the insulator is cut out and the complete insulator is blanked from the stock at the same time, this result being obtained through the action of the punches *G* and *H*, and the die *B*. The reason for having the die *B* work up and down is that it is normally at the same level as the piercing punches, thus affording an easy means of grinding and of presenting a perfectly flat surface on which to place the mica. In addition, the holding action required to prevent tearing the stock is obtained by having the work held between the upper and lower dies while the four small holes are being pierced. The piercings on the four small holes are pressed back into the stock, and the large center piercing is blanked and also pressed back into the stock, through the combined action of the knock-outs *I*, *J* and *K*.

All working parts of this punch and die should be made a close fit, as a little flaking of the stock is bound to take place, and if there is any clearance such flakes are likely to wedge in the working parts of the tool and cause trouble. In addition to its use on mica, a die of this kind could also be used for working celluloid or very thin sheet metal, where enough compression could be procured by the rubber buffer to resist the piercing action. The buffer is made of sufficient length to afford the necessary compression behind the upper die.

New Britain, Conn. W. C. Betz

WIRE BENDING FIXTURE

During an experience covering some twenty years I have met few toolmakers who have had much experience in making hand-operated fixtures for bending or forming wire. As a result it has occurred to me that a description of a tool of this type, which operates in a somewhat unusual way, would be of interest to readers of Machinery. This fixture is used for bending U-shaped wire staples of the form shown at *A*. Blanks *B* of the proper length are cut off and dropped into the top of the fixture, where they are located in the correct position by bringing the end of the blank into contact with the shoulder *C*, which is formed in a hardened tool-steel plate screwed to the top of the main block. This plate also serves as a stop to limit the movement of the handle in one direction. The illustration shows the handle in full lines with the straight wire blank in position ready for bending. The dotted lines show the handle and work after the bending operation has been completed. It will be seen that an adjustable stop *D* is provided for limiting the movement of the handle at the end of the stroke.



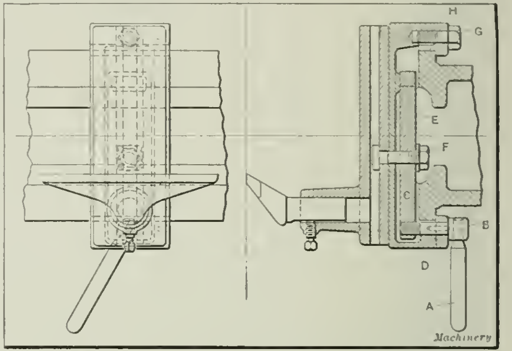
Hand-operated Fixture for bending Wire Staples

An interesting feature of this fixture is that the wire is not positively clamped or held during the bending operation. The plate in which the shoulder *C* is formed holds the wire against sidewise movement, while the "wiper" or bending tool draws it around the mandrel. The "bite" of the wiper is depended on to draw the wire forward. The design of this tool enables work to be produced very rapidly, and an idea of the rate of production will be gathered from the fact that a boy working on a piece-work rate of five cents per hundred would have little difficulty in earning from $2.50 to $3 in a ten-hour day.

Arlington, R. I. George P. Breitschmid

IMPROVED TURRET LATHE HAND-REST

In machining certain parts of brass and other relatively soft metals the use of a hand-rest is found to be the means of greatly increasing production. The accompanying illustration shows an improved form of turret lathe hand-rest which I have found by experience to increase the rate of production for those classes of work for which it is adapted. The saddle is locked in position on the bed and the cross-slide in position on the saddle by a single movement of the binder lever *A*. This lever is within easy reach of the operator and enables him to adjust the position of the tool-rest very rapidly.



Hand-rest for Turret Lathe provided with Improved Clamping Device

It will be seen that the binder bolt *B* is threaded into the clamp *C* and that by turning the binder lever the binder bolt is turned in the clamp. The front cap *D* has a bearing on the under side of the saddle and the bed of the machine. Turning the binder lever causes the binder bolt to draw this front cap *D* up against the bed, thus clamping the saddle in place. The rear end of the clamp *C* bears against the saddle *E* and when the binder lever *A* is thrown over it will be seen that the front end of the clamp *C* is drawn down. This draws down the clamp bolt *F* which is responsible for clamping the slide in the required position.

To remove the hand-rest from the machine, it is merely necessary to unscrew the cap-screw *G* about 5/16 inch. This allows the cap *H*, which is held by this screw, to be released from under the lathe bed. The saddle is then moved out until the front cap will clear the bed, after which the entire hand-rest can be removed as a complete unit. It will be evident from this description that there is no danger of parts of the rest getting lost during the time that it is removed from the lathe.

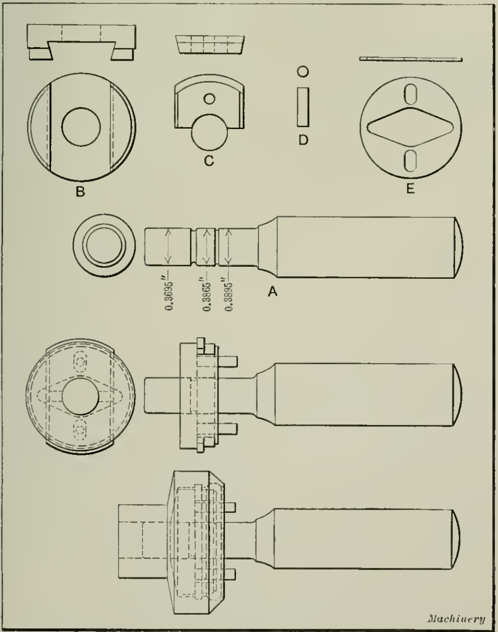
Cincinnati, Ohio. William P. Winters

QUICK METHOD OF CUTTING RUBBER TUBING INTO RINGS

The other day I was called upon to cut some 2½-inch soft rubber tubing up into rings ½ inch in width. As it was necessary to have the ends of these rings perfectly smooth and at right angles to the walls of the tubing, it appeared that I was "up against it." However, after experimenting for some time I hit upon the following kink which enabled me to turn the rings out quite rapidly and still maintain the required quality of work. The method consisted of forcing a round piece of wood lengthwise through the rubber tubing, the size of the wooden rod being such that it expanded the tubing just a little. An ordinary penknife was clamped into the toolpost of the lathe and by revolving the tubing and bringing the blade of the penknife against the under-side of the tubing, I found it possible to cut the rings off very accurately. When using this method, plenty of water should be applied to the cutting edge to prevent the knife from sticking and tearing the rubber. J. R. H.

LIMIT GAGE FOR MEASURING RECESSED WORK

The parts of a limit gage for measuring recessed work are shown in the accompanying illustration together with an assembled view of this tool and an illustration showing how it is used. The plug *A* enters the hole in the body of the gage *B* which has a dovetail slide machined in it to receive the two gage plates *C*. Pins *D* fit in the holes in the plates *C* and also extend through the elongated holes in the cover-plate *E*. In using this gage, the operator takes hold of the two pins *D* between his thumb and index finger and draws the sliding plates *C* back until the pins engage the inner ends of the elongated holes in the cover plate *E*. The plug *A* is then pushed into the hole and causes the sliding plates *C* to move out from the center. It will be seen that there are two shoulders above the pilot on the plug *A*. In order for the work to pass inspection, it will be possible for the first shoulder to enter the hole in the gage; but if the second shoulder can also be entered into the hole, it shows that the work is too large and results in its rejection. After gaging, the plug *A* is pulled out and the pins *D* drawn back so that the gage can be removed from the work.



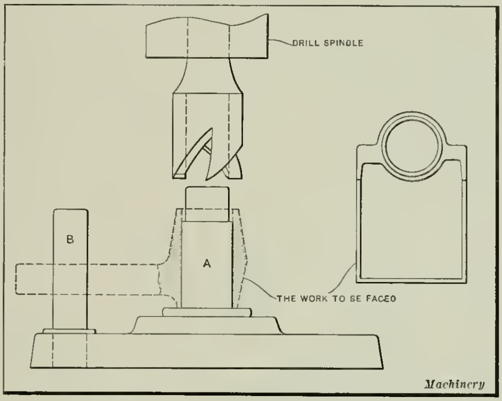
Parts and Assembled Gage and its Application in gaging a Recess

In making this tool, the plug *A* is hardened, ground and lapped to the required size. The body *B* is next made with the dovetail groove to receive the sliding plates *C* which are made in one piece to enable the hole to be lapped to size and the piece to be placed on a mandrel to grind the outer surfaces to the required diameter. Before hardening, the piece forming the two plates *C* is sawed almost through at the center from both sides, and after lapping the hole and grinding the outside, the piece is parted to form the two plates *C*. The cover plate *E* with elongated holes to receive the pins *D* has already been referred to. A gage of this type could be used to advantage in measuring a great variety of recessed work.

Dayton, Ohio. M. T. Byrne

IMPROVED METHOD OF FACING AND COUNTERBORING

The accompanying illustration shows a hollow mill for performing facing and counterboring operations, and a fixture in which the work to be machined is mounted on the stud *A*. The purpose of this equipment is to avoid trouble which arises when using the ordinary form of counterbore, owing to the tendency of the pilot to cut or bind in the hole. It will be seen that the stud *A* is provided with a pilot which enters the hollow mill and acts as a guide while the work is carried on the body of the stud. The pilot is made 0.0015 inch smaller than the hole in the mill and is hardened to give it the required durability. The body of the stud must be slightly shorter than the length to which it is required to finish the work.



Tool for facing and counterboring, which eliminates Trouble from Pilot cutting or binding in Hole

The work to be faced is shown in the illustration and the dotted lines also show the position of the work on the stud *A*. It will be seen that the work swings around until it comes into contact with the stop stud *B* which prevents it from turning while the machining operation is performed. One end is faced off square, after which the work is turned over and faced on the opposite side, the second operation serving the double purpose of facing the work and bringing it to the required length. The stud *A* can either be mounted in a stand for use on the drill press or it may be provided with a tapered shank to enable it to be set up in the lathe tailstock. When used in the lathe, the cutter is mounted in the spindle and it may either be provided with a taper shank to fit directly in the spindle or held in a chuck. If the work to be machined has no overhanging part that can be engaged by a stop to prevent it from turning, a special holder is easily made. For example, in facing bushings of small diameters, the holder consists of an arm with a split collar which is clamped around the bushing by a wing nut. The arm comes into contact with the ways of the lathe or the tool-rest, and prevents the work from turning.

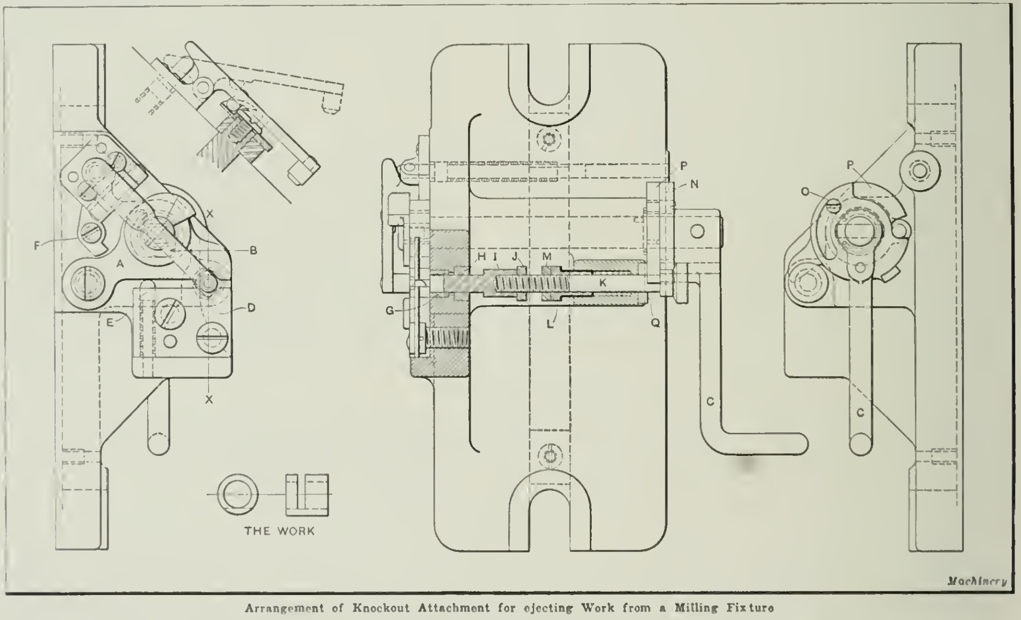
It will be evident that this form of tool will not replace the commercial counterbore for toolroom use, but it is certainly a most valuable tool for manufacturing operations. The combination is not only more durable, but a higher rate of production can be obtained by using it. The writer does not claim to be the originator of the idea but believes that it possesses sufficient merit to warrant bringing it to the attention of those readers of Machinery who are not already familiar with it.

Readville, Mass. O. A. Webster

MILLING FIXTURE WITH A KNOCK-OUT ATTACHMENT

A milling operation usually heats the work to a point which makes it impossible—or at least unpleasant—to remove it from the fixture by hand; and in such cases it becomes necessary to use a tool for this purpose. Again, the work may be quite small and the fixture so constructed that the fingers cannot reach it, again making the use of some sort of tool necessary. A piece of wire may be satisfactory for this purpose but it takes time to manipulate it, and to pick it up and lay it down, when both hands are required for handling the work and operating the fixture or feed mechanism. In many cases the time consumed in taking the completed work out of the fixture is so great a part of the total time that it becomes imperative to provide for the automatic removal of the work. This is particularly true when automatic ejection may be easily and positively accomplished, as in the case of the fixture which forms the subject of this article.

This fixture was designed for milling the slot in the small machine steel collar shown in the illustration. The work is of such a size and shape that it cannot be removed from the fixture by hand, and as the operator required one hand to deliver blanks to the fixture while the other operated the gripping lever, the automatic removal of the finished pieces soon paid for the added cost of the fixture and eventually effected a material saving in the cost of production. The fixture is shown in position ready for the milling operation, the swinging jaw A being closed against the work by the cam *B* which is carried on a shaft operated by the lever *C*. The work is held against the fixed jaw *D* and centered by the V-grooves in the two jaws. To release the work, the lever *C* is raised, turning the shaft and cam, and thus relieving the pressure on the work and allowing the swinging jaw to be turned back by means of the spring plunger *E* until it strikes the adjustable stop *F*.



Arrangement of Knockout Attachment for ejecting Work from a Milling Fixture

In the plan view, the top of the fixture is cut off along the line *XX* to show the knock-out mechanism in cross-section. Flush with the left hand face of the cast-iron base there is a work-seat *G*, and next to it the anvil *H*, which is located against the shoulder in the base to prevent the knock-out mechanism from disturbing the work-seat. The hammer *I* is slightly larger than the hole in the work and has a shoulder which strikes the anvil after the end of the hammer strikes the work. The force of the blow may be reduced by loosening the lock-nut *J* and turning back the bolt *K* until the desired length of stroke has been obtained, after which the lock-nut is again tightened. The tension of the knock-out spring may be regulated by means of the threaded sleeve *L* and the lock-nut *M*, thus providing further adjustment of the blow. The knock-out is released by the upward movement of the lever *C*.

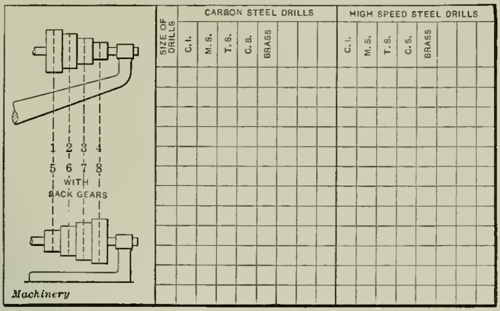
The disk *N* is fastened to the lever *C* and slotted to receive the stop-screw *O* which is fixed in a second disk *P*. As the lever is swung up, the disk *N* strikes the stop-screw which carries the disk *P* with it. The projecting arm on the disk *P* lies between the shoulder on the knock-out bolt and the steel plate *Q*. When this arm on the disk *P* is suddenly swung out of the way, the knock-out delivers a sharp blow of sufficient force to throw the work clear of the fixture, after which it drops into a pan placed to receive it. In this way the removal of the work does not take up any time, as the knock-out has delivered its blow when the gripping lever reaches the top of its swing, so that a new piece may be put in place and the lever once more swung down to clamp the piece in the fixture.

Bridgeport, Conn. F. W. Barrows

DRILLING SPEEDS

In a machine shop where jobbing and contract machine work are done, there are always a number of mechanics who have drilling to do but who possess little or no idea of the proper speeds to employ. In many cases it depends entirely upon the operator's judgment whether or not the machine is run at the highest speed that is consistent with good work. If the mechanic's judgment is poor—mere guesswork—a satisfactory rate of production combined with good work cannot be reasonably expected. When such a mechanic is given a table of drilling speeds expressed in revolutions per minute, it frequently happens that he does not know how to use it, and the average foreman does not have much time to explain details of this kind. A table of the form presented herewith represents a simple means of conveying the required information in regard to suitable drill speeds. Such a table can be made on tracing cloth so that blueprints may be made from time to time. These prints should be pasted on a piece of board and given a coat of shellac or varnish to keep them clean. They can be hung near the drilling machines for ready reference.

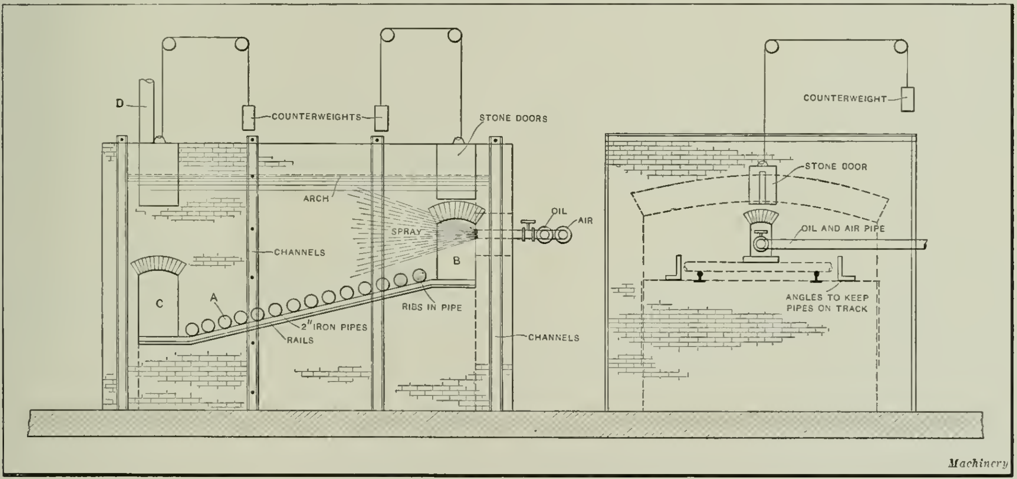
It will be seen that the diagram at the left of the table



SIZE OF DRILLS	CARBON STEEL DRILLS								HIGH SPEED STEEL DRILLS							
	C.I.	M.S.	T.S.	C.S.	BRASS				C.I.	M.S.	T.S.	C.S.	BRASS			

Diagram and Table of Drilling Speeds

shows the belt positions with and without the back-gears, these positions being numbered 1, 2, 3 and 4 for the direct drive, and 5, 6, 7 and 8 when the drive is through the back-gears. It will be obvious that each one of these belt positions corresponds to a certain number of revolutions per minute of the drill spindle. By calculation or from data taken from a machinists' handbook, the table at the right-hand side may be filled in with the numbers of the belt positions, giving the speeds nearest the correct ones. With this the mechanic only has to know the size and kind of drill he is using and material he is drilling, in order to determine the correct drilling speed to employ. The preceding information refers to the application of a table of this sort to drilling machines, but similar tables could be compiled for lathes, milling machines, boring mills and any other machines that make use of cone pulleys and back-gears to provide the necessary speed variations. The table could be made to include the proper feed to employ with each speed and material, but great care must be used or the entire object of the scheme will be lost. The average machinist has difficulty in using any but the simplest of tables, and his judgment in regard to the feeds is generally more accurate than his ideas of the correct cutting speeds. F. G. M.



Arrangement of Oil-heated Furnace for hardening Umbrella Ribs

FLUELESS HARDENING FURNACE

Some time ago I built an oil-heated furnace for use in hardening the ribs of umbrellas. As this has one or two unusual features in its construction and method of operation, it may prove of interest to some of MACHINERY'S readers. The umbrella ribs are inserted in pipes and placed in the furnace so that the pipes rest on two iron rails, as shown at *A*, which serve as a track. The pipes are charged into the furnace through the door *B* and withdrawn through the door *C*; in passing through the furnace in this way, the ribs contained in the pipes have been brought to the proper temperature for quenching.

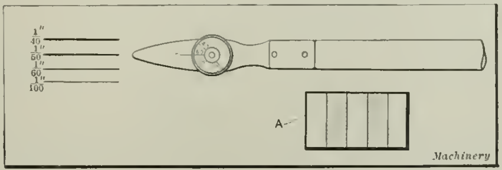
The oil for heating the furnace is sprayed into the combustion chamber with air at 30 pounds pressure. An interesting feature of the method of operation is that the furnace was originally used with a flue *D* but it was found that a large amount of heat was lost through the flue. In attempting to correct this loss of efficiency, we shut the flue off entirely and were surprised to find that very little trouble was experienced through the gases that were given off. After closing the flue in this way, the time required for bringing the work to the hardening temperature was practically cut in half.

Umbrella ribs are made of steel with various carbon contents and as a result, they must be quenched at different temperatures. Consequently, we still adhere to the color method for determining the proper quenching temperature. For example, carbon steel containing 1.20 per cent of carbon is brought to a white heat and then quenched in a tank of fish oil. This variation in the steel used makes it necessary for the man in charge of the hardening department to have had sufficient experience to judge the proper quenching temperature accurately. The ribs are made of carbon steel stock 1/32 by 1/4 inch in size, which is bent to the required form.

Westchester, N. Y. JOHN E. CAHILL

DRAWING LINES OF UNIFORM THICKNESS

In a certain drafting room where I was employed, all drawings had to be made with the different classes of lines kept to a uniform thickness, as shown in the accompanying illustration at *A*. To obtain this result, the draftsmen were in the habit of using a cut-and-try method; that is to say, they drew a number of lines on a piece of scratch paper, scaling each time and resetting the pen until a line of the desired thickness was obtained. This was necessarily a slow method and to avoid the loss of time in this way, I equipped my pen as shown in the accompanying illustration. An index or zero line was first scribed on the nib and then after adjusting the pen to draw the different thicknesses of lines required, lines were marked on the head of the thumb-screw

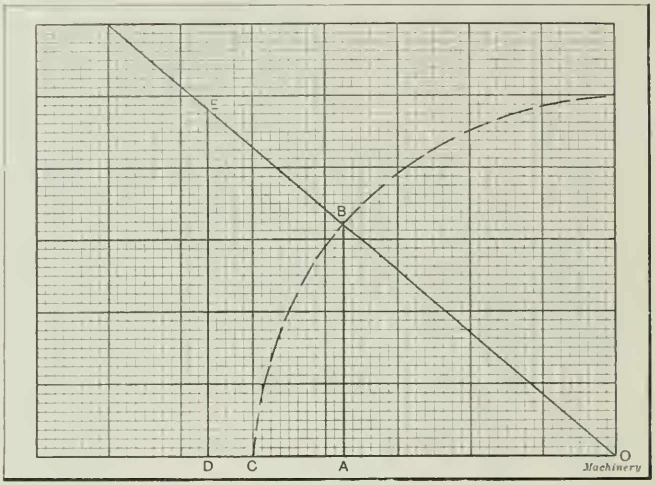


Draftsman's Pen arranged to enable it to be set quickly for drawing Lines of Various Thicknesses to enable these settings to be obtained, a line being marked for each required thickness of line. This method proved so successful that all of the draftsmen adopted it.

Detroit, Mich. Paul P. Vlasek

SUBSTITUTE FOR PROPORTIONAL DIVIDERS

The copying of a drawing to a reduced scale can readily be done without the use of proportional dividers. The device for doing this work is made from a piece of cross-section paper. First lay off any horizontal distance *OA*, and then find a radius *OC* so that the ratio of *OC* to *OA* is equal to the ratio of reduction required; with this radius strike an arc *CB* of indefinite length. Then at the point *A* erect a perpendicular intersecting the arc at *B*. Now draw a line through points *B* and *O*. This gives the means of making the reduction. To use the device, take off a distance on the large drawing with the dividers. Assume that this distance is equal to *OE*. Lay this off on the diagonal line, then the required distance reduced to scale will be found by dropping a perpendicular to *D*. This can be done with the aid of the vertical lines on the cross-section paper without any construction. *OD* is then the required distance. The basis for the method is the geometrical theorem that similar sides of similar triangles are proportional.

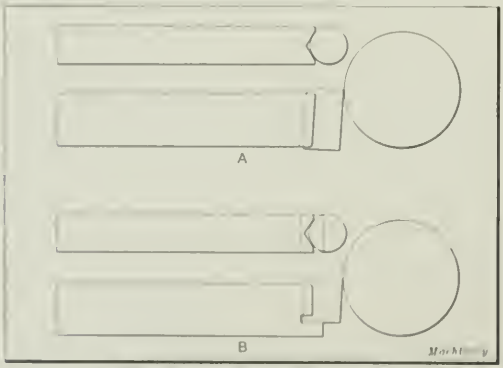


Using Cross-section Paper for making Drawings at a Reduced Scale

Owego, N. Y. Sidney K. Eastwood

SIMPLE RADIUS TOOLS

The making of a radius tool is a job on which some mechanics spend a great deal of unnecessary time, and to make such a tool by some of the methods in general use is indeed a tedious task. The following describes a way in which such tools can be made very quickly and still obtain the required degree of accuracy. Referring to the illustration, any piece of stock which can be conveniently held in the toolpost is shaped with a vee on one end as shown at *A*. Then a piece of steel is turned to the proper radius; drill rod of the required size can often be used. This piece of steel which forms the cutter is then hardened and sweated onto the holder.



Simple Method of making Radius Tool

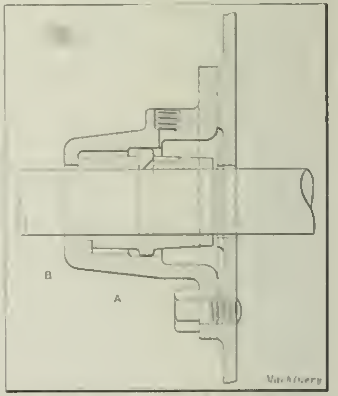
The best method of sweating is to tin both the cutter and the shank, after which they are placed together and a little heat applied with the soldering iron until they are joined firmly together. I have seen tools of this character made with cutters as small as 1/16 inch radius, and the temper of such small cutters was not injured in the least. If there is fear of drawing the temper, the cutter should be hardened but not drawn, heat from the sweating operation being relied upon to draw the temper to the required point. A further precaution to avoid drawing the temper of the cutter consists of merely tinning the holder and when this method is followed, it will usually be found that the two pieces will sweat together quite readily.

If the sweating is properly done, the tool will stand any ordinary thrust without damage. If, however, there is any fear of the union obtained in this way not being sufficiently strong, the tool may be made as shown at *B*. Here it will be seen that a vee is cut in the end of the shank, as in the preceding case, but that a shelf is left at the bottom of the vee to afford additional support for the cutter. Constructed in this way the cutter is supported by the shelf and there is no possibility of its breaking.

Hartford, Conn. S. Victor Brook

SELF-ALIGNING BUSHING

I was interested in reading an article by Charles C. Anthony in the September number of Machinery, entitled "Cast Iron and Brass Bushings," and this reminded me of a special self-aligning bushing which I recently designed. The feature of this bushing is the provision which is made for allowing it to adjust itself automatically to the alignment of the shaft. This was made necessary by the fact that the bearing was used on a washing machine, the bearing housing usually being supported by a sheet metal tank which was so flexible that if some method of automatically regulating the alignment had not been provided, it would not have operated efficiently.



Self-aligning Bushing for Shaft Bearing

The bushing is supported in the bearing housing by a spherical faced flange *A* which engages a finished surface in the housing. The bushing is prevented from turning by means of a projection *B* on the housing which enters a slot in the bushing. The bushing adjusts itself for any misalignment in the shaft by simply oscillating in conformity with surface *A*.

Chicago, Ill. William H. Kellogg

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

COOLING OVERHEATED PHOSPHOR-BRONZE BEARINGS

J. A. W.—In a pamphlet published by a firm manufacturing gas engines, I found the statement that water should not be used to cool off a phosphor-bronze bearing that had become overheated, but no reason was given. Will you kindly tell me what the danger is?

A.—This caution is given by manufacturers for the reason that overheated phosphor-bronze will crack when suddenly cooled by dashing water over it. In case of overheating such bearings it is safest to let them cool down slowly.

PITCH DIAMETERS OF DRIVING AND DRIVEN CHAIN SPROCKETS

L. O. N.—Will you furnish data of the allowances made by makers of driving chain sprocket pitch diameters when the sprocket is the driver and when it is driven? I understand that the practice is to differentiate the pitch diameters of sprockets, making them slightly larger or smaller, depending on whether they are to be used as drivers or as driven wheels.

A.—The desired data is not available. Apparently, there is no agreement of practice. The Lehigh Car Wheel & Axle Works, Catasauqua, Pa., maker of face-hardened sprockets, informs us that it makes no difference between driving and driven sprockets.

MAKING JEWELERS' SAW BLADES

Q. C. T.—I would like to know how the teeth are cut in small jewelers' saw blades. These are made with varying numbers of teeth to the inch, some of which are extremely fine. The appearance of the saw under the magnifying glass would lead one to believe that the teeth were milled, but the blades are so extremely small and delicate that it would seem impossible to hold them for milling. In addition, the extremely low price at which they are sold, less than ten cents per dozen for most sizes, would indicate that some very quick method of manufacture must be employed. These saws are hardened full length and the temper color is plainly shown on the finished blade.

Suggestions from readers of methods for making these saws are requested.

BORING A SHAFT WITH A TREPAN DRILL

R. E. L.—In a nearby forge plant, 10-inch shafts 10 feet long are bored to a diameter of 8 inches, and in the process a core is cut out about 6 inches diameter and 10 feet long which is used for another shaft or other purposes. Can you furnish details of the tools used for this boring?

A.—The shaft is bored with a trepan drill or in other words a drill that cuts an annular groove leaving the center intact. It is virtually a pipe drill having cutting teeth on the end and fitted with lubricating tubes which furnish lubricant under heavy pressure for the purpose of cooling the cutting edges and forcing the chips out as fast as formed. Details of these tools would, no doubt, interest readers, and any one who can furnish same is invited to communicate.

COMPOUND INDEXING

W. W.—The following rule is given for computing the number of holes required for indexing by the compound method: Factor the number of divisions required; select two circles of holes at random on the same index plate for trial, and factor the difference; then draw a line under these two sets of factors. Now factor the number of revolutions required of the index crank to make one revolution of the index-head spindle, and place these factors under the line. Factor the number of holes in each circle chosen for trial and place these also under the line; then cancel similar factors above and below the line. If all factors above the line cancel, the division is possible with the two circles chosen. The product of the factors remaining below the line will be the number of holes to move forward in one of the circles, and backward in the other. *Example:* Divisions required, 154; circles chosen, 33 and 21; number of turns of crank on index head, 40. Factoring as mentioned, we have:

$$\begin{array}{r}154 = 2 \times 7 \times 11\\ 33 - 21 = 2 \times 2 \times 3\\ \hline 40 = 2 \times 2 \times 2 \times 5\\ 33 = 3 \times 11\\ 21 = 3 \times 7\end{array}$$

After cancellation it will be found that the factors 3 and 5 will remain below the line; hence, 3 × 5 = 15 holes is the number that the index pin is moved forward in the 21-hole circle and backward in the 33-hole circle to get the required division. What is wanted is an algebraic solution or the mathematical reasoning which leads up to the cancellation shown. On what principle is this method founded?

A.—The method for finding the movements for compound indexing is based upon the principle that the difference between two moves obtainable on the index plate equals the required division. A certain number of holes moved forward in one circle and the same number of holes moved backward in another circle gives a movement which could not be obtained by any one index circle. To prove the method mathematically, proceed as follows: Let X be the number of holes sought. Other quantities are as in the given example. Now a movement of X number of holes forward in the 21-hole circle and X number of holes backward in the 31-hole circle equals $\frac{1}{154}$ of a revolution of the work, or:

$$\frac{X}{21 \times 40} - \frac{X}{33 \times 40} = \frac{1}{154}$$

$$\frac{X}{40}\left(\frac{1}{21} - \frac{1}{33}\right) = \frac{1}{154}$$

$$\frac{X}{40}\left(\frac{33 - 21}{21 \times 33}\right) = \frac{1}{154}$$

$$\frac{X}{40 \times 21 \times 33} = \frac{1}{154(33 - 21)}$$

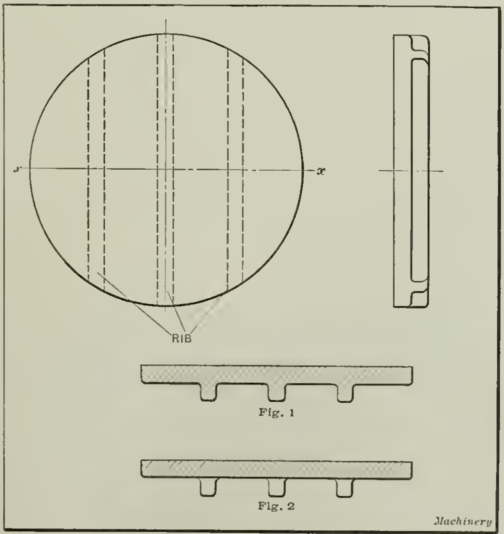
This shows that if the factors of 40, 21 and 33 are cancelled against the factors of 154 and (33 — 21), the factors not cancelled in the denominator of the first member, when multiplied, will equal X.

In the given case, after cancellation:

$$\frac{X}{3 \times 5} = 1, \text{ or } X = 15.$$

DRAFTING CROSS-SECTIONS OF RIBS

W. A. D.—To settle a dispute among a few members of our drafting force, will you kindly inform me as to which is the correct method for cross-hatching the section x-x of the accompanying drawing. A claims that Fig. 1 is hatched, while B disputes this and claims Fig. 2 is correct. Both parties have agreed to abide by your decision which, we presume, will be in accordance with the best drafting practice.



Figs. 1 and 2. Drafting Cross-sections of Ribs

A.—According to practically universal drafting practice, the ribs should be cross-hatched as shown in Fig. 1. If the ribs lay beyond the plane x–x the drawing Fig. 2 would be correct, but it is not when the intersection plane passes through the ribs as in this case.

HOW SHOULD THE GRAIN RUN?

C. H. Mc C.—A question recently arose in our shops as to the proper way to order the material for certain tools which we use. These tools have blades shaped on the end like a twist drill, the blades being ½ by 2 by 2¼ inches in size, as shown in Fig. 1. We were in doubt as to the proper way to order the material; *i.e.*, with the grain running in the direction of the line *AA* or the line *BB*. We have been ordering material ⅝ by 2⅜ inches in size, but I should like to know whether we ought to have ordered material ⅝ by 2⅛ inches in size. In the former case, the grain of the steel in the finished blade would run in the direction of the line *BB*, while in the latter case the grain runs in the direction *AA*. Any information on this point will be greatly appreciated.

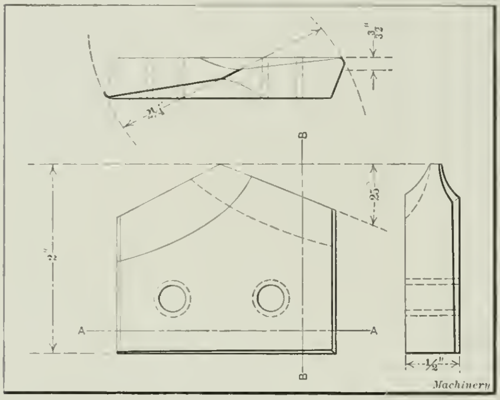


Fig. 1. Type of Tool to be made and Two Possible Ways for Grain to run

Answered by A

In reply to question by "C. H. Mc C." in regard to the proper direction for the grain of the steel in tools of the type which he illustrates, there is no question in the writer's mind—although his opinion may be considered entirely theoretical—that the blanks for these tools should be cut off from the bar as shown at *C* in Fig. 2 rather than as shown at *D*. That is to say, the grain should run in the direction *AA*. When cut in this way, the grain of the steel in the tool is running crosswise—the grain of the steel in the bar naturally running lengthwise—and when the tool is in use there is a tendency to close up the grain of the steel instead of opening it up as would be the case if the blanks for the tools were cut off as shown at *D*. In this connection it may be of interest to know that flat forming tools for forming and relieving eccentrically relieved cutters would be distorted far more in hardening if the blanks were cut off from the bar as shown at *D* than would be the case if the blank were cut off as shown at *C*. This is a point of exceptional importance because in most cases such tools cannot be ground after hardening.

Another point of interest from a manufacturing standpoint is the way in which the blanks for the tools shown in Fig. 1 can be machined on the sides. The thickness of the stock need be only 1/16 inch over size and this would ordinarily be entirely inadequate, even on high-speed steel, owing to the decarbonization of the steel to a depth of at least 1/32 inch, which necessitates grinding away this amount of metal from the surface after the hardening operation has been performed. But as high-speed steel is very expensive it is possible to grind the pieces on a magnetic chuck, provision being made for tipping the chuck both lengthwise and crosswise, as shown in Fig. 2 at *E*. In this way the same result is obtained as would be possible if the thickness of stock used had been ⅛ inch over size. The saving of material effected in this way will be readily appreciated when the broad flat sides of the cutters are considered. The width of the stock used should be ⅛ inch over size, the amount of material removed on each side being shown at *C* in Fig. 2. In this way the benefit of having the point of the tool 3/32 inch below the outside of the bar from which it was cut can be obtained.

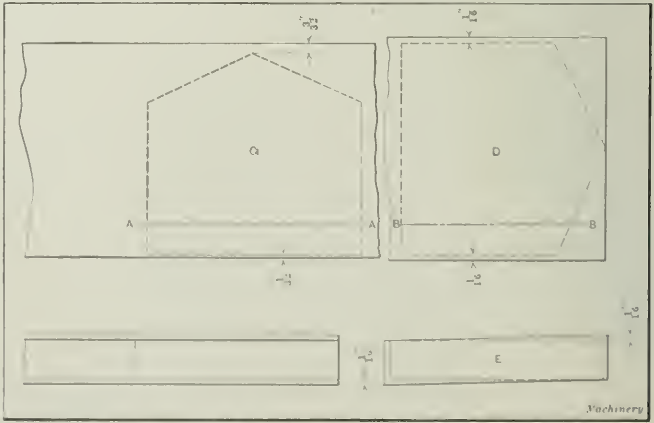


Fig. 2. Proper Way for Grain to run and Suggestion in regard to making Tools

PRICES OF SECOND-HAND MACHINE TOOLS

A. L. F.—Can you give me some quotations of prices obtained for second-hand machine tools in good condition? If so, please quote a few.

A.—Prices of second-hand machine tools vary widely, depending on what "good condition" is interpreted to mean. Good condition to one prospective purchaser might be anything but good to another. It all depends on the point of view and the use to which the purchaser intends to put the machine. The following are some prices quoted on the equipment of a New York City concern manufacturing light machinery that was built in large lots to gages and micrometer measurements:

No. 0 Brown & Sharpe plain milling machine, overhanging arm, four-step cone, 6-inch by 20-inch table	$125
Brown & Sharpe manufacturing type slab milling machine, overhanging arm, vise, three-step cone, 6-inch by 19-inch table	175
Brown & Sharpe manufacturing type slab miller, overhanging arm, vise, three-step cone, 6-inch by 30-inch table	225
Garvin plain milling machine, overhanging arm, four-step cone, 5-inch by 31-inch table	100
Pratt & Whitney Lincoln type slab milling machine, 30 inches between housings, 6-inch by 32-inch table	125
Hendey tool-room lathe, 12-inch by 5-foot, double friction countershaft, taper attachment, draw-in attachment, 9-inch four-jaw chuck	265
Bradford lathe, 14-inch by 6-foot, hollow spindle, compound rest, chuck	175
Pratt & Whitney lathe 16-inch by 9-foot, hollow spindle, compound rest, attachment	260
Mechanics Machine Co.'s 12-inch upright drilling machine	35
Dwight Slate single spindle sensitive drill	30
Prentice Bros. drilling machine, 20 inches swing, wheel and lever feed	50
Brown & Sharpe No. 1 full automatic screw machine, 5/16 inch capacity	100
Cleveland full automatic screw machine, 5/16 inch capacity	125
Warner & Swasey hand screw machine, 1 inch capacity	125
National-Acme automatic screw machine, ¾ inch capacity, four spindles	650
Bliss No. 74½ straight sided geared press, 14 inches stroke	770
Farrel double-action toggle drawing press, 6 inches stroke drawing punch, 3¼ inches stroke blank holder, 19 inches between uprights	400

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

MODERN GRINDING MACHINES

A complete line of these machines is being built, which comprises sizes ranging from a capacity of 24 to 60 inches between centers, with a swing up to 16 inches. The most noteworthy feature of the design is the arrangement of the gearing for obtaining the speed and feed changes, which is contained in a single gear-box. All gears are in mesh at all times, and the required gears are engaged with their shafts by a patented ball drive clutch. In this way an unusually compact construction is secured.

The Modern Tool Co., Erie, Pa., is now building a line of self-contained grinding machines equipped with individual motor drive or single pulley drive, as required. The design of these machines represents an exhaustive study of this particular class of equipment extending over a number of years; and the result is a heavy machine of rigid construction which is well adapted to withstand the class of service required of grinding machines of this type. Features exclusive to the grinding machines built by the Modern Tool Co. are included. This line of grinding machines comprises sizes ranging from a capacity of 24 to 60 inches between centers, with a swing up to 16 inches. Fig. 1 shows the front view of the 12 by 24-inch plain grinding machine, and referring to this illustration it will be seen that all levers and handwheels are located where they are within easy reach of the operator. The economy of floor space resulting from the compactness of the construction and simplicity of the mechanism will be apparent from this illustration.

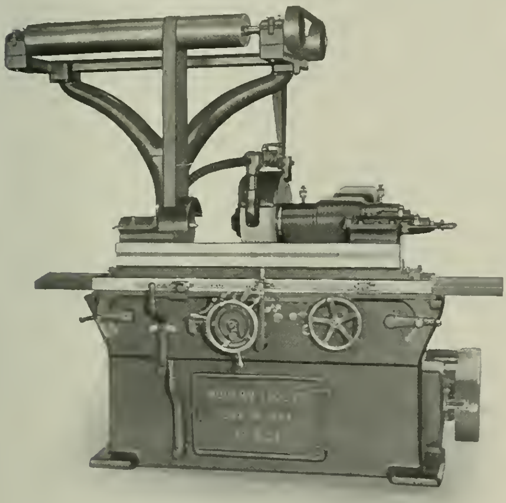


Fig. 1. Front View of "Modern" Grinding Machine

The table is provided with power traverse, which is controlled by means of a lever mounted at the left of the table handwheel, and when power is applied to the table the handwheel is disengaged and remains stationary. When the power traverse is disconnected from the table, the handwheel is simultaneously re-engaged for traversing the table by hand. The machines are equipped with automatic cross feed which can be set for a reduction of any amount from 0.0005 inch to 0.005 inch at either or both ends of the table reverse. This feature of feeding automatically on one end only is especially advantageous when grinding against a square shoulder. The feed is automatically thrown out when the work has been ground to size; a positive stop is provided for use when feeding the wheel by hand and when the production of duplicate work is required. An auxiliary feed can be supplied for bringing the wheel automatically into the work when the table is not being traversed, which is especially desirable when the work is short and can be covered by the full width of the wheel. The advantage of this feed is evident on this class of work, as it allows the operator to change the work dog while the machine is in operation, and the feed is automatically thrown out at any predetermined point. The cross feed handwheel has a collar which is graduated in 0.0005 inch spaces, and is in plain view of the operator. The automatic cross feed is adjusted by the movement of a lever to the point desired, as indicated on a graduated dial plate, and may be instantly changed to any feed while the machine is in operation. Another feature of note is the variable "tarrying device," by which the pause at each end of the stroke can be regulated.

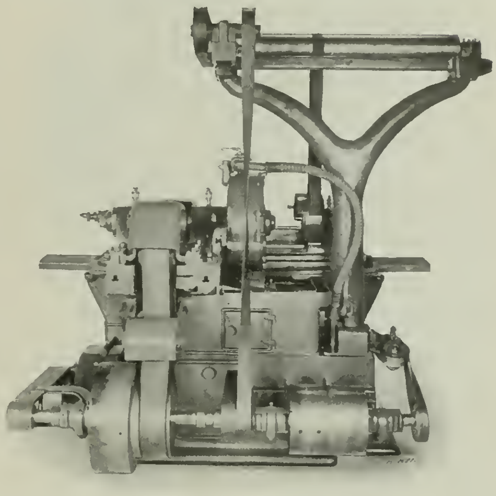


Fig. 2. Opposite Side of Machine shown in Fig. 1

The base of the machine is of massive proportions and has cross ties which insure absolute rigidity. V and flat guides are used throughout, such guides being used on the sliding table, swivel table and under the wheel stand. This insures a perfect alignment of all parts subject to the most wear. The base rests upon three points, preventing cross strain and insuring perfect alignment of the machine. These machines are provided with a powerful drive, and a large well proportioned spindle which runs in bearings of ample size. The wheel spindle is made of alloy steel, specially heat-treated, ground and lapped to the required size; it is

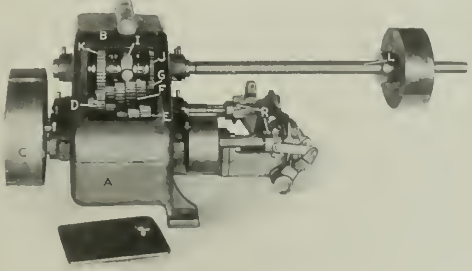


Fig. 3. Arrangement of Gears which provide the Feed and Speed Changes

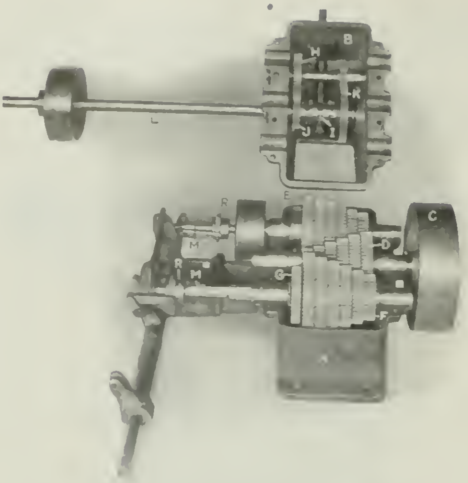


Fig. 4. Gear-box shown in Fig. 3 opened to show Arrangement more clearly

3¼ inches in diameter and runs in phosphor-bronze bearings 8¼ inches long. These bearings are the same length on each side of the driving pulley and are provided with sight-feed oilers which deliver a liberal supply of oil to the boxes at all times. The spindle is driven by a 6-inch belt which runs over large diameter pulleys, furnishing ample power to the grinding wheel. The wheel stand is of massive proportions, as may be seen by referring to Fig. 2. The wheel stand, which has a broad spread, slides on V and flat ways and is held down by gravity; but it is also provided with a safety gib to prevent lifting under abnormal conditions. The wheel center has a long, large bearing on the spindle, and will take any of the recognized standard grinding wheels. The regular wheel used is 18 by 2 inches in size, but wheels as large as 6 inches face and 24 inches in diameter may be used on the 12-inch machines; and wheels of 6 inches face by 30 inches in diameter may be used on the 16-inch machines, as special requirements demand.

The headstock is entirely belt driven, which gives an absolutely smooth movement to the work and eliminates all chance for chatter. It is fitted to the swivel table by means of V and flat ways, and is held in position by a hooked clamp bolt. The headstock spindle is hardened and ground and runs in bronze bearings adjustable for wear, being lubricated by means of a sight-feed oiler. The footstock is fitted to the swivel table in the same manner as the headstock, and the footstock spindle is held in any position by a spring, or it may be set positively against the work and locked. The work centers on the headstock and footstock are directly over and between the guides of the table, a construction which eliminates the weight and strain necessarily present where the work centers are outside and overhang their bearings. The wheel truing device is mounted on the footstock and is adjustable for all diameters within the range of the machine, so that the wheel can be trued up without removing the work from the centers. The steadyrests furnished with these machines are universal in all their movements. These are equipped with positive stops for grinding duplicate parts, have a very wide range, and are capable of delicate adjustment

These self-contained machines have twelve work speeds ranging from 12 to 250 R. P. M., and six table feeds from 22 to 104 inches per minute, which cover every range within the capacity of the machines. The work speeds and table feeds are entirely independent of each other, making it possible to obtain a correct table feed for any work speed. All the speeds and feeds are controlled by levers on the front of the machine, and are derived from one gear-box, which is an entirely separate unit. All gears are in mesh at all times and are engaged with the shaft by a patented ball-drive clutch which effects a quick and safe change that can be made instantly while the machine is running at any speed. This gear-box, in addition to occupying a very small space, is so located as to be easily and readily inspected. While the operating mechanism of the gear-box represents a departure from established practice in designing grinding machines, it is not an experiment. It was designed a number of years ago by Mr. C. N. Payne, and has been in successful operation for several years in the Modern Tool Co.'s factory. In this time it has been thoroughly tested out, not only as an individual unit, but also in combination with the grinding machines.

The arrangement of gears by which the speed and feed changes are obtained is shown in Fig. 3. The gears are enclosed in a case and run in oil, the case being located on the base of the machine. The gear-box proper consists of two parts, the lower one *A* forming an oil-tight container for the lubricant and serving as the support for the three shafts. The upper part *B* carries the two shafts and gears for doubling the work speeds. The power is supplied from the main driving shaft on the back of the machine by belt to pulley *C*. The change speed device consists of three series of gears shown at *D*, *E* and *F* in Fig. 4. These gears are journaled in a case composed of the parts *A* and *B*, Fig. 1, and are at all times in mesh and run at constant speed. The center series of gears *D* are the drivers, and on the end of the shaft is the driving pulley *C*. The series of gears *E* controls the table feeds, and the series *F* controls the work speeds. The gear *G* meshes with gear *H* shown in the top of the case. The positive jaw clutch *I* engages the gear *J*, giving six changes of work speeds, and six additional changes of speeds are obtained by clutch *I* engaging the gear *K*. Clutch *I* is keyed to the shaft *L*, and on this shaft the gears *J* and *K* are mounted loosely.

A more detailed view of the construction of the ball drive clutch, which operates the table feeds and work speeds, is shown in Fig. 5. The series of gears *E* and *F* are made with hardened ball pockets, and are brought into positive action and locked individually with the (driven) shaft *M* by the ball *N* being forced into the ball pocket *O* in the hub of any gear by the flat cam *P* operated through the (driven) shaft *M*. The ball openings *Q* in the shaft are contracted at their inner ends, and the balls are larger than the contracted ends of the openings, so as to be retained in the openings and be in position to permit the turning of the gear on the shaft when the balls are in contact with the contracted ends and the cam has forced any one of the other balls into engagement with a gear. In Fig. 5, the flat cam *P* is shown attached to its shifting ring and yoke *R*.

"Modern" self-contained grinding machines have a single constant speed drive, which reduces the cost when equipping the machines with motors. The main drive is in the rear of the machine and runs at constant speed. Power is applied either from the lineshaft as shown in Fig. 1, by a single belt, or by direct motor connection.

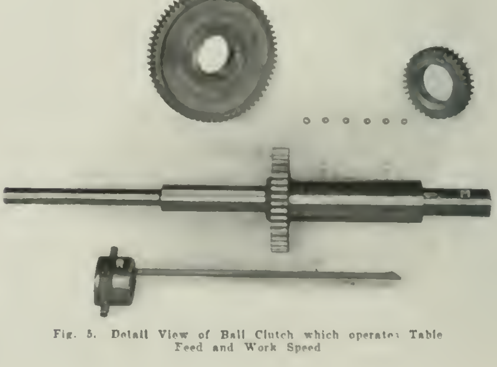


Fig. 5. Detail View of Ball Clutch which operates Table Feed and Work Speed

WALKER ROTARY DISK AND SURFACE GRINDER

Increased production and greater accuracy are secured through the provision of an accelerated speed and feed mechanism on this machine. The work speed is accelerated as the wheel approaches the center; and the horizontal feed of the wheel is correspondingly increased to maintain a constant rate of 3/8 inch per revolution of the work. The speed and feed are correspondingly retarded as the wheel recedes from the center. Specially constructed bearings prevent overhang of the ram occurring at any point of the stroke.

The noteworthy features of the rotary disk and surface grinder which has been added to the line of the Walker Grinder Co., Worcester, Mass., are the provision of an accelerated speed mechanism, by means of which the speed of the work and also the feed automatically accelerates as the wheel approaches the center of the work, or is retarded as the wheel recedes from the center; and the fact that the ways for the wheel-slide or ram are extended out from the frame of the machine in such a way that the ram never overhangs its bearings. The variable speed feature is obtained through an Evans cone located inside the frame of the machine.

The grinding wheel slide or ram is provided with V-bearings of ample size, which are oiled automatically by rollers in oil wells in the bearings. The under side of the ram is furnished with projections to which the grinding spindle bearings are bolted in a suspended position. These bearings are lined with hard bronze bushings which are adjustable, and lubrication is by means of the ring oiling system. The spindle pulley is made in the form of a drum of sufficient length to provide for the full stroke of the ram, this pulley or drum carrying a belt which runs over the driving pulley on the main shaft of the machine. The grinding wheel is held on the tapered end of the spindle by the well-known Walker system of internal tapered iron center with an inserted nut at the end; and the wheel may be mounted or removed from the spindle without requiring the use of a wrench. While this is being done the spindle is firmly held by means of a pin or spanner. The end thrust of the spindle is taken by a collar which is held against the shoulder of the spindle by means of a cap nut provided with a hardened steel button. On the main driving shaft *A*, Fig. 3, on which the pulley *B* which drives the wheel-spindle is mounted, there are also the pulley *C* which drives the variable speed mechanism, and a pulley for driving the water pump. It will be seen that the tight and loose pulleys are mounted at the end of this shaft and attention is called to the way in which these pulleys are completely enclosed except for the necessary belt opening. This opening is further protected by means of the curved shipper slide *D*, which is held down by a cap-screw and spring *E* to prevent it from rattling. This belt shipper is operated by the foot treadle shown at the front of the machine in Fig. 1. It will be evident from the preceding description that the machine is completely self-contained.

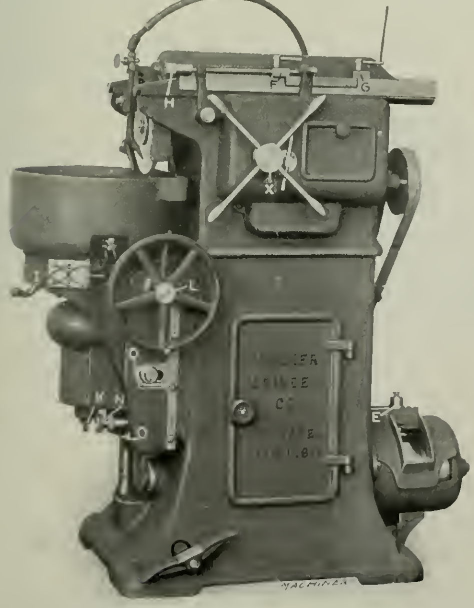


Fig. 1. Walker Rotary Disk and Surface Grinder

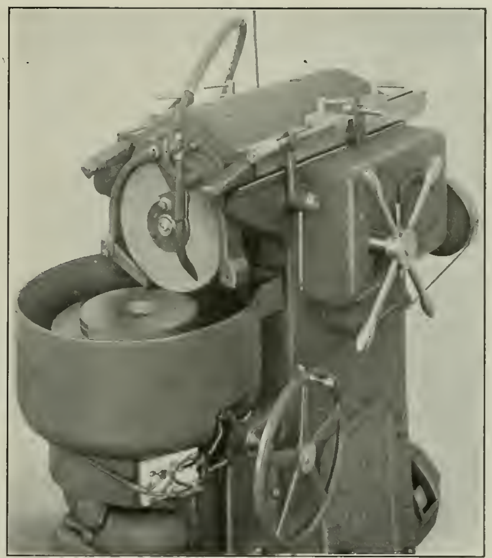


Fig. 2. View of Magnetic Chuck, Wheel, etc., of Machine shown in Fig. 1

There is no particular novelty in the design of the reversing mechanism which consists essentially of the well-known arrangement of bevel gears with a positive load and fire type of clutch between them. The reversal is obtained by a pivoted lever which is operated by the dogs *F* and *G* on the ram, as shown in Fig. 1. Referring to this illustration, it will be noticed that a scale is provided which is laid out in "hole diameters" and "disk diameters," so that one dog is set to reverse the ram when the wheel reaches the hole at the center of the disk, while the other dog is set to reverse the ram when the wheel has reached the periphery of the work. The machine is provided with an automatic stop device which can be brought into operation after the wheel has passed beyond the work. It is brought into action by a slight movement of the knurled sleeve *H* which comes into contact with the upper end of a bellcrank lever at the end of the stroke, thus operating a suitable train of mechanism to stop the clutch in the neutral position, with the result that the ram is brought to rest. The work-spindle clutch is then thrown out of engagement by means of the lever *I*, Fig. 1, which is located in a convenient position for the operator. The machine is now at rest and the finished piece can be removed from the magnetic chuck and a fresh blank substituted in its place. After this has been done, the lever *I* is thrown back to the operating position to start the work in motion, after which the sleeve *H* is pulled back and the clutch is then automatically thrown into engagement by the action of a spring plunger. An instantaneous hand stop is also provided, the design of which is of a standard form.

The work-spindle is not subjected to any side thrust, and so it is practical to have this spindle journaled in split babbitted boxes. The spindle is supported on a hardened steel button *J* held in a solid cup *K* which is kept filled with oil, the arrangement being shown in Fig. 3. The knee is mounted on a vertical slide and pivoted on the sleeve *L*. The horizontal elevating shaft passes through this sleeve and delivers power to the vertical feed-screw *M* by means of bevel gears, the thrust of this vertical feed-screw being carried by a ball bearing. Referring now to Fig. 4, we are in a position to give a detailed description of the mechanism provided for tilting the knee of the machine for grinding concave or convex surfaces as may be required; or for locating the knee in position for grinding flat surfaces. This is accomplished by means of the adjusting screw *N*, which enters a tapped hole through a boss on the lower part of the knee, the screw being held by a check-nut as shown. The operation of this device will be obvious to any mechanic, the principal feature of this tilting knee being the method adopted for quickly setting it back into position for grinding a flat surface after it has been set over for grinding concave or convex work. This result is obtained by means of the hardened steel screw *O* and the button *P*, the screw *O* being permanently set to adjust the machine for grinding flat work when this screw is in contact with the button *P*. In case of wear, the screw *O* can be adjusted. When it is desired to grind a concave surface it is merely necessary to loosen the check-nut and turn down screw *N* until the required angularity has been obtained, as indicated by the scale *Q*. When it is desired to grind a convex surface, it is necessary to swing the hardened steel button *P* to one side by means of the small handle in this button, the result being that the screw *O* is allowed to swing nearer the vertical slide when the adjusting screw *N* is loosened. In this way the proper angularity for the convex surface is obtained. When it is required to set the machine back for grinding a flat surface, it is merely necessary to swing the button *P* back into position and bring the screw *O* into contact with it

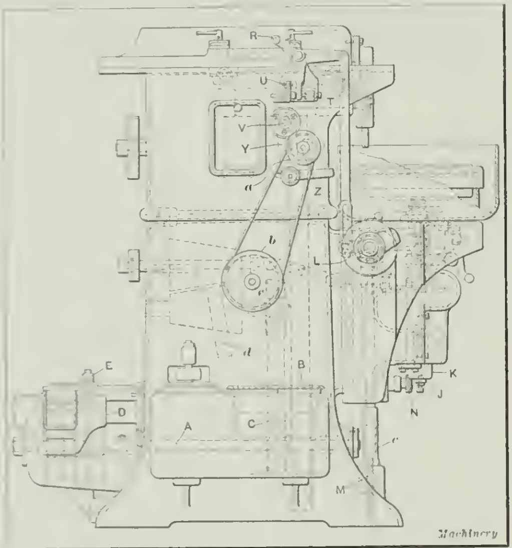


Fig. 3. Complete Side Elevation of Left-hand Side of Walker Grinder

The arrangement of the automatic vertical feed is shown in Fig 5. This mechanism is located on the opposite side of the machine from the longitudinal feed mechanism, and is also operated by dogs mounted on the edge of the ram. These dogs run under the roller *R*, thus transmitting motion down to the ratchet and pawl *S* which operate the vertical feed. The dogs are faced with hardened steel wedges to prevent them from wearing, and the usual form of shoe is provided on the ratchet wheel *S*, this shoe being set to lift the pawl out of engagement with the teeth when the work has been ground to a predetermined thickness It will be seen that the lower end of the rocker arm on which the roller *R* is mounted swings between a spring plunger on one side and a knurled screw *T* on the other The screw *T* has a cylindrical graduated head which enters a recess, and a knurled check nut is also provided for binding the screw in place When the rocker arm is in contact with the set screw *U* and the knurled headed screw *T* is tightened down onto the rocker arm, the roller *R* clears the dogs, with the result that there is no feed movement. By backing off the knurled headed screw *T* one graduation on its cylindrical head, a feed motion corresponding to one tooth on the ratchet *S* is secured; backing off two graduations results in picking two teeth on the ratchet wheel, etc. Each ratchet tooth corresponds to a feed of 0.0005 inch. It will be noted that the automatic feed can be operated at both ends of the stroke of the ram, that it is positive in action and that the function of the spring plunger at the lower end of the rocker arm which carries the roller *R*, is merely to draw back the feed pawl on the ratchet *S*.

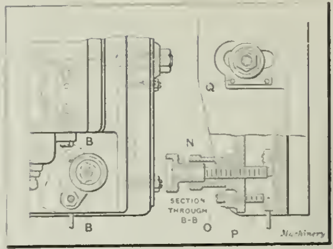


Fig. 4. Partial Side Elevation showing Adjustment for grinding Concave and Convex Work

The ram is driven by a train of feed-gears, the last of which is mounted on the pinion shaft *V*; and this pinion meshes with the rack *W* on the ram. The pilot wheel on the opposite side of the machine—shown at *X* in Fig. 1—is attached directly to the shaft *V* which has a transverse motion equal to a little more than the width of the feed-gears. The result is that when the pilot wheel *X* is pushed over, it slides the shaft *V* along and throws the automatic feed-gears out of mesh, so that the ram can be operated by hand. Around the pinion shaft *V* at its outer end there is a swinging arm *Y* which is provided with a boss and bearing for the shaft *Z*, on one end of which there is mounted a flanged pulley *a*, Fig. 3, the shaft *Z* carrying a gear which engages with a gear carried on the pinion shaft *V*. The lower end of the arm *Y* is provided with a stud which extends through a slot in the column of the machine, and a pull lever is attached to this stud to provide for setting the arm *Y* in any required position. The arm is then clamped in place by means of a nut on the stud. Both the rack pinion and the gear on the shaft *V* which meshes with the gear on shaft *Z* are of double width so that these gears are always in mesh regardless of whether the shaft *V* is in position to give power or hand feed to the ram. The flanged pulley *a* is connected by a belt to pulley *b* which is carried by a short shaft *c* journaled in a box mounted on the column of the machine. On the inner end of the shaft *c* there is provided a suitable mechanism for moving the friction belt *d* between the variable speed cones which are shown dotted in Fig. 3. It will be noted that the movement or location of the friction belt *d* is entirely controlled by the position of the ram, and that should the pinion on shaft *V*

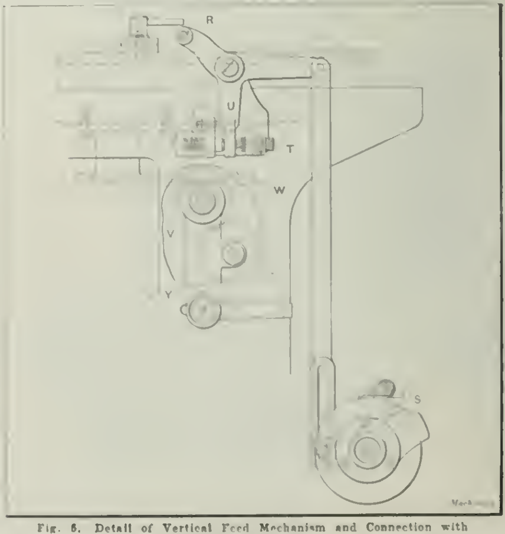


Fig. 5. Detail of Vertical Feed Mechanism and Connection with Variable Speed Device

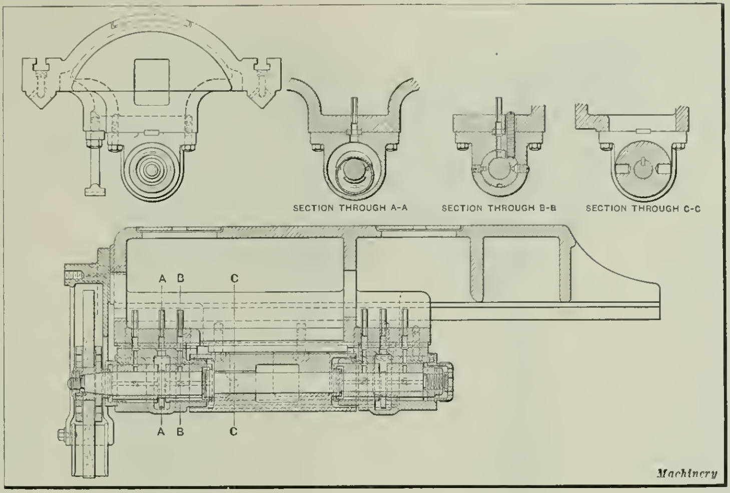


Fig. 6. Detail of Ram and Cross-sectional Views of Spindle Bearings

be thrown into mesh with the automatic feed-gears, out of synchronism with the speed changing cones and the ram, the proper timing would be automatically adjusted at the end of the stroke. This is accomplished by the slippage of the belt running over the pulleys *a* and *b*, which happens in case the friction belt *d* on the variable speed cones reaches the limit of its movement prematurely. It will also be noticed that when using the hand feed, the belt running over the pulleys *a* and *b* can be slackened by simply loosening the nut on the stud carried by the arm *Y*, in this way disconnecting the variable speed mechanism. The connection from the Evans cone to the work spindle is through the universal jointed rod; the connection to the horizontal feed has been described.

The mechanism for maintaining the proper work speed for all positions of the wheel, and a uniform horizontal feed of the wheel per revolution of the work, is the means of securing better results in both the finish and accuracy of the work. The horizontal feed of the wheel is at the rate of 3/16 inch per revolution of the work, the rate of feed being accelerated in exact proportion to the increase of work speed as the wheel approaches the center of the work; and the feed is retarded in the same manner as the wheel recedes from the center. If the feed were not accelerated to correspond with the increased speed of the work there would be no gain in production; and if neither the speed nor the horizontal feed were accelerated as the wheel approached the center of the work, the wheel would follow a spiral path of uniform pitch, as in the case of machines of this type which are not equipped with the variable speed and feed mechanism. Having less work to do as it approaches the center of the disk, as well as a proportionally greater time to do it, the tendency would be for the wheel to cut deeper at the center of the disk, thus causing the work to be finished with a slightly concave surface.

The water pump is of the usual form, and the design and construction of the lower part of the machine requires no special explanation, with the exception of calling attention to the guard *e* which fits loosely around the outside of the elevating screw for the knee, thus protecting the screw from grit. Attention has already been called to the safeguard over the tight and loose pulleys. Guards are also provided which cover the extensions of the V-bearings for the ram, so that danger of damaging these bearings with grit is eliminated. The machine is equipped with a Walker magnetic chuck which can be furnished in various sizes from 8 to 12 inches in diameter. The pump supplies a liberal amount of water for cooling the work. The machine takes grinding wheels 10 by ⅝ by 1¾ inch in size with a feed of fully 3/16 inch per revolution of the work. When feeding toward the center, the speed of the work increases 100 per cent in 5 inches travel of the ram, and grinds over a surface of 400 square inches per minute. The floor space occupied is 3 by 5 feet, and the net weight of the machine equipped with a 12-inch chuck is about 2000 pounds.

CLEVELAND MODEL G AUTOMATIC SCREW MACHINE

This machine is made in two sizes, one of which has a spindle capacity of 3/8 inch and a milling stroke of 3 1/2 inches; the other has a spindle capacity of 5/8 inch and a milling stroke of 4 1/2 inches. Work can be done in one operation on this machine which ordinarily requires two operations to finish it. Simultaneously with the working of the regular turret and cross-slide tools, work is done on the cut-off end, which is ordinarily performed by a second operation.

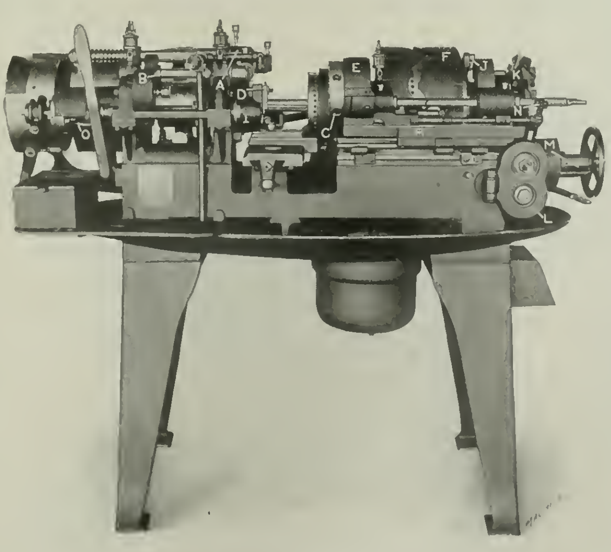


Fig. 1. Cleveland Model G "Automatic" fully equipped for completely finishing Both Ends of Work

To meet the demand from manufacturers requiring a high-speed automatic screw machine particularly adapted for long runs on small work, the Cleveland Automatic Machine Co., Cleveland, Ohio, has added to its line the Model G machine which is illustrated and described herewith. This is made in two sizes, one of which has a ⅜-inch spindle capacity and a milling stroke of 3½ inches, while the other has a ⅝-inch spindle capacity with a milling stroke of 4½ inches. On many classes of work it is desirable to have a larger spindle capacity, and to meet this requirement the ⅜-inch machines can be furnished with an actual spindle capacity of ½ inch, while the ⅝-inch machines can be provided with actual spindle capacities of ¾ inch or ⅞ inch, the length of the milling stroke in both cases being standard. The spindles run at very high speed to give the proper cutting speed for any size of bar within the capacity of the machines. Fig. 4

and the accompanying table show typical classes of work for which this machine is adapted, and the rate of production which can be attained in manufacturing these parts from brass or steel.

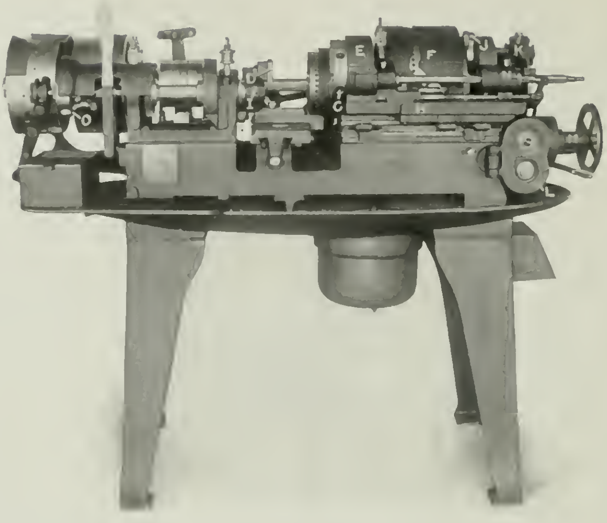


Fig. 2. Machine shown in Fig. 1 without Slotting Attachment and Secondary Spindle for performing Operations on Cut-off End of Work

The machine is designed to handle a great variety of work and is capable of completely finishing the parts which it produces. It performs in one operation what is almost universally done in two, and without any additional time being required. Simultaneously with the working of the regular turret and cross-slide tools, what is ordinarily a second operation is performed on the cut-off end of the work. In addition to the slotting or slabbing operation, which can be done on either or both ends, the cut-off end of the work may be shaved, counterbored, drilled, reamed or chamfered, thus completely finishing the piece ready for use. The finished work is ejected into a compartment separate from the chips.

The simplicity of the design and accessibility of all parts of Cleveland "automatics" are well known throughout the manufacturing world; for this reason they are particularly easy to operate, and the new Model G machine is no exception to this rule. The machine is constructed on similar lines to the regular plain machine of this company's manufacture, all movements being controlled by direct acting cams which are of the drum type, and extremely simple to make. A standard set of cams is furnished with each machine, by means of which any job within the capacity of the machine may be produced; and cams of various shapes may be quickly made for a variety of work. Figs. 1, 2 and 3 show the different combinations of attachments which are available. Fig. 1 shows the full attachment machine which is capable of completely finishing both ends of the work, as previously described. Fig. 2 illustrates the same machine without the slotting attachment and without the secondary spindle for performing operations on the cut-off end of the work. Fig. 3 shows the machine with the turret mechanism removed, which can be done in a few minutes, thus converting it into a most serviceable machine for plain work, with a milling capacity of 5½ inches long for the ¾-inch machine, and 10 inches long for the ⅝-inch machine.

In Fig. 1, *A* is the slotting attachment, and *B* the shaving attachment carrying a secondary revolving spindle for finishing the cut off end of the work. This spindle is driven by a belt direct from the counter shaft on the ¾ inch machine, and by gears from the main spindle on the ⅝-inch machine. The work is carried to the slotting and shaving attachments by a conveyor held in the turret *C*, this conveyor being fitted with a spring collet which grips the work just as it is separated from the bar. The shaving, counterboring, drilling, reaming or chamfering on the cut-off end of the work is performed during the time the regular turret and cross-slide tools are doing their work, so that the piece is finished all over in the same length of time that would ordinarily be consumed in the first operation. Double cross-slides are provided, the front and rear slides having independent control. Forming tools may be carried on each of these slides and both tools may operate at the same time or independently as desired, the cutting off being accomplished by means of a tool held in arm *D* which swings down from above and cuts off the work. This independent cut-off attachment in no way interferes with any of the other tools either on the cross-slide or in the turret.

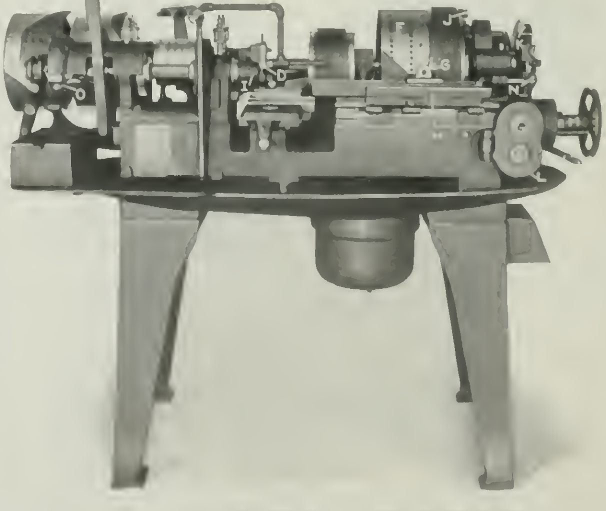


Fig. 3. Model G Cleveland "Automatic" with Turret Mechanism removed

The turret head *E* is carried on a longitudinal slide which receives its motion from the hardened steel cams on the drum *F*. There is a cam for each turret tool and the stroke of the turret may vary to suit the length of cut required by each tool. In Fig. 3 *G* is the bracket carrying a roll upon which the tool feed cams operate. This bracket is adjustable along the top of the slide *H* to any position, and the turret may thus be adjusted close to or away from the chuck hood *I* to suit short or long work. The indexing of the turret from one hole to the next consumes but 1/5 second and is entirely independent of the longitudinal position of the turret. This is accomplished by means of five cams *J* mounted on the end of the turret cam drum *F*, which may be adjusted to any position around the drum. Any number of holes may be skipped when not needed, thereby saving the time ordinarily consumed by the idle stroke of the turret, and all movements of the turret are under such complete control on account of the adjustments described that the idle movement is negligible. The feed and idle movement of the machine are controlled by cams *K* which are adjustable to any position around the periphery of the disk upon which they are mounted.

Feed change gears are provided which enable the operator to obtain a rate of feed suitable for any kind of material which the machine is required to handle, whether it be

RATE OF PRODUCTION ON CLEVELAND MODEL G AUTOMATIC IN PARTS PER HOUR

Part	Brass	Steel	Part	Brass	Steel	Part	Brass	Steel
A	400	180	M	400	180	Y	450	200
B	140	70	N	600	300	Z	350	120
C	600	240	O	300	120	a	400	120
D	600	180	P	450	140	b	600	200
E	550	250	Q	500	240	c	1000	400
F	520	240	R	240	60	d	720	250
G	200	45	S	600	250	e	375	120
H	450	150	T	750	300	f	100	45
I	240	60	U	300	120	g	400	180
J	420	180	V	450	180	h	650	300
K	1600	750	W	360	120	i	400	80
L	180	65	X	1200	300	j	250	100

Machinery

brass rod or steel of any description. These change gears are mounted at *L* and are covered by the hinged guard. The positive pressure rotary oil pump is provided with a self-contained overflow, and this pump delivers a large volume of oil at heavy pressure. A greater pump capacity than is actually needed has purposely been provided. The distribution of cutting oil to the tools has been given much attention in this machine, oil feed being supplied to each tool hole in the turret, allowing a stream of oil to be delivered to the center of each tool wherever practicable. The piping which conveys the oil to the turret tools is shown at *N*, and individual streams of oil are also supplied to the slotting saw, the tool held in the shaving spindle and the cross-slide tools. This individual stream system allows the highest speeds and feeds to be employed and increases production to a wonderful extent. The balanced chuck operating fingers *O* at the rear of the spindle insure prompt opening and closing of the chuck, regardless of how high the spindle speed may be.

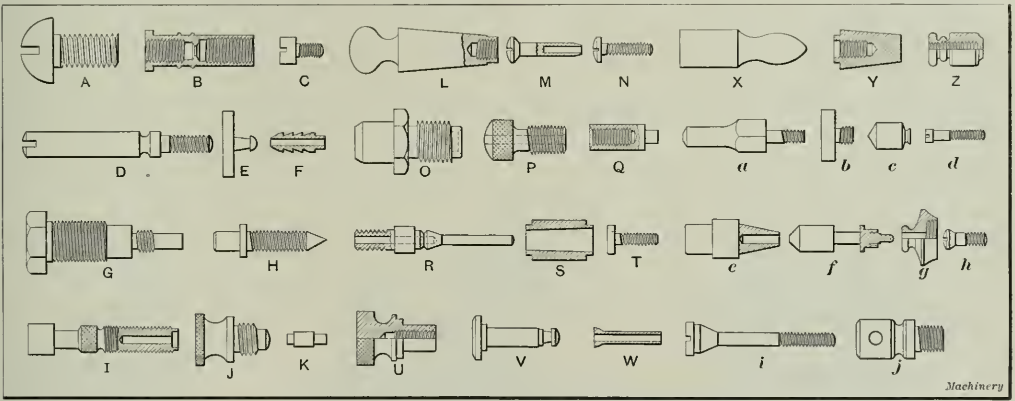


Fig. 4. Typical Examples of Work done on Model G "Automatic." Rate of Production for each Piece is given in Accompanying Table

The machine may also be equipped with a high speed drilling attachment, giving the correct speed for any drill regardless of how small its diameter may be. This attachment may easily be applied to the machine at any time in a few minutes. On all machines, the hardened tool steel stud on which the turret is mounted is made with a hole through the center, ground to exact size ready to receive the driving shaft of the attachment. The revolving drill holder is held in one of the tool holes in the turret and gears connect this holder with the central driving shaft. One or more revolving holders may be used at the same time, all being driven from the central shaft. In cases of deep drilling, the drill may be backed out several times to clear the chips. This machine, which is exceptionally universal and adapted to all classes of work, is capable of holding sizes to within 0.0005 inch on the diameter and length, and will give continuous service with little attention on account of its extreme simplicity.

The following is a summary of the important features of this machine: 1. All working parts are readily accessible. 2. Setting up and changing from one job to another is extremely simple. 3. It does not require any great skill to make or change the shape of the cams. 4. All attachments are easily placed in position and just as easily removed. 5. The turret indexing mechanism is extremely simple; it indexes from one hole to the other in 1/5 second and vacant turret holes may be skipped. 6. An individual oiling system is provided which insures having oil on the cutting edge of the tools at all times. 7. The machine can handle exceptionally intricate work because of the various attachments which can work in combination. 8. The work is separated from the chips in all cases where the parts to be made are not over 1½ inch long on the ⅜-inch machine and 2 inches on the ⅝-inch machine. 9. A second operation is done away with on almost any shaped piece, because of the shaving attachment. 10. The machine is convertible from a turret to a plain machine and *vice versa*. 11. It is possible to slot both ends of a piece if desired. 12. The length of the turret stroke and the rate of feed are variable to suit each tool held in the turret.

BRAZING STELLITE TO MACHINE STEEL

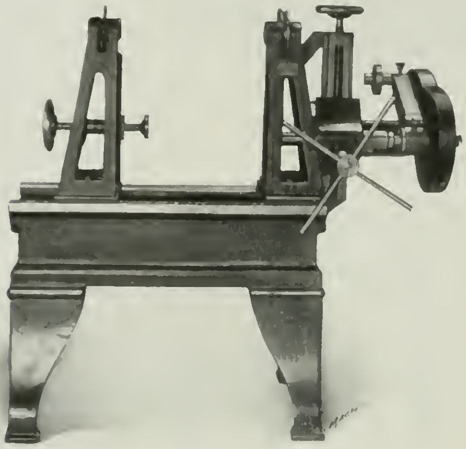
The high cost of stellite has in many cases made it out of the question to use tools made entirely of this metal, while its brittleness has been a drawback in holding stellite bits in tool-holders fitted with the usual form of set-screw for holding the bit in place. In order to overcome the difficulties resulting from these two causes, the Ready Tool Co., 654 Main St., Bridgeport, Conn., has been conducting experiments in the attempt to either weld or braze a small stellite cutter to a machine steel shank. Obviously this would be the means of overcoming the difficulties which the high cost and brittleness of stellite have thrown in the way of its practical application.

A great many kinds of brazing material and fluxes were tried and various methods of welding were experimented with, but these proved unsuccessful for a long time. It seemed to be impossible to find any brazing material that would hold to stellite, the brass of the spelter rolling off as if the stellite had been greased. Welding was found no more satisfactory owing to the rapid expansion and contraction which took place in the metal, and also to the fact that when melted by the oxy-acetylene flame stellite becomes alloyed with the steel so as to seriously impair its cutting efficiency.

After many months of experimenting it was found that a number of factors were responsible for the lack of success which had accompanied the attempt to secure stellite to steel by the methods referred to. All of these factors were important and all of them had to be taken into consideration before the difficulty was finally overcome. In the first place a special brazing material was necessary and this material had to be used in conjunction with a special brazing flux. In addition to this, it was found necessary to heat the work to a certain specified temperature in order to get the spelter to flow properly, and at the same time not to penetrate into the stellite tool. After this information had been obtained it was found possible to braze stellite bits onto machine steel shanks with perfectly satisfactory results.

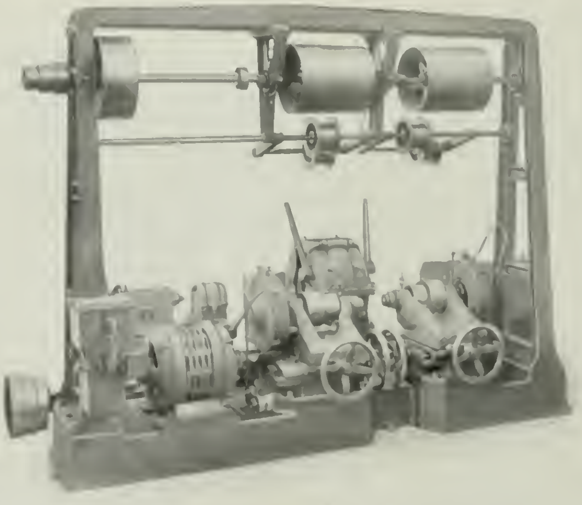
FAY & SCOTT BALANCING MACHINE

The accompanying illustration shows a combination balancing and drilling machine built by Fay & Scott, Dexter, Maine. The combination in a single machine of means for testing the balance of a wheel and then drilling to correct for any error in balance is naturally the means of greatly increasing the speed at which this work can be done. Where a plain balancing machine is used in connection with the drill press, it is obviously necessary to first determine the "heavy side" of the wheel and then take the wheel to the drill press on which the excess metal is removed. But as great care must be taken to avoid removing too much metal, it is generally necessary to shift the work back and forth between the balancing machine and drill press several times. Using this machine a man can balance forty flywheels in ten hours.



Fay & Scott Combination Balancing and Drilling Machine

On the new Fay & Scott balancing machine, the mandrel carrying the wheel to be balanced is supported on hardened steel, knife-edge disks 6 inches in diameter. These disks are mounted in ball bearings so that they turn very freely to show slight errors in the balance of the work. The bed of the machine is of box section and carries a tailstock, which may be adjusted for flywheels of different face widths. The position of the headstock is fixed. The drill spindle has an in and out movement of 4 inches, this movement being controlled by a rack and pinion and operated by hand. A steadyrest is mounted on the tailstock, opposite the drilling spindle in the headstock; this steadyrest is screwed up against the flywheel before the drilling operation is started, thus holding the wheel firmly in place. The capacity of the machine is for flywheels up to 42 inches in diameter, and the minimum diameter of wheels that can be drilled is 13 inches. The vertical adjustment of the drill head is 14½ inches. The machine occupies a floor space of 65 by 25 inches and weighs 900 pounds.



Springfield Car-wheel Grinder for truing Steel or Chilled Cast-iron Wheels

SPRINGFIELD CAR-WHEEL GRINDER

The latest addition to the line of grinding machines made by the Springfield Mfg. Co., Bridgeport, Conn., consists of the No. 5 car-wheel grinder which is illustrated and described herewith. In designing this machine particular attention has been paid to the development of structural features capable of withstanding the hard usage to which machines of this type are subjected, and to the development of a design in which all operating mechanism is readily accessible. The machine is suitable for grinding steel or chilled cast-iron wheels mounted on axles of standard gage, the capacity being for wheels from 28 up to 44 inches in diameter. The grinding or truing of a pair of car wheels on this machine can be done on their own axle journals or on dead centers, as will be necessary in grinding truck wheel axles. It will be seen from the illustration that the machine is self-contained and driven by one belt from a main lineshaft; or by an individual motor according to the requirements of different users. An important point is that a crane can pass over the machine to lift the wheels in and out.

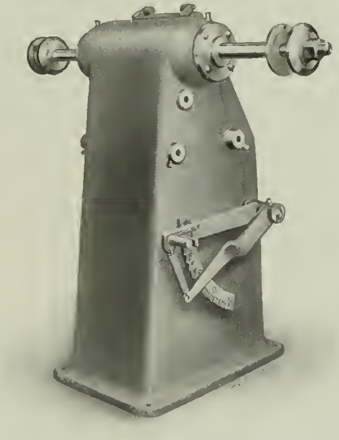
A clutch operated by hand levers from either side of the machine facilitates stopping the car wheel axle instantly at a point where the opening or gap in the gear is directed upward, thus permitting the removal of the axle and wheels. The widely spaced driving pinions are driven by one common shaft to insure their relative position at all times, and also to provide for overlapping the gap in the driven gear. Three different work speeds are obtainable for rotating the axle, and the operation of the grinding wheel heads traveling parallel with the axle is by hand. The feed is also by hand, large feed-screws running in long nuts being provided, with the end thrust taken by ball bearings. The slide bearings are long and narrow with adjustable taper gibs to provide compensation for wear. The grinding wheel spindles are driven by belts from overhead drums, and automatic tightening idlers insure the maintenance of the proper belt tension. The cone pulleys on the spindles provide two changes of speed for the wheels, and the grinding wheel spindles are carried in bronze bushed bearings of ample size. The heads can be swiveled to provide for grinding tapered work.

The tailstocks are of heavy construction and provided with large sleeves and feed-screws. As previously mentioned, the dead centers are used for grinding truck wheels and "wabble centers" are used to prevent side motion when the wheels are supported on the journals of their own axles. The journal rests are provided with different sizes of half shells which are adjustable for slight differences in the diameter of the journals. There is a pump which delivers an ample supply of water to keep the work cool, part of the bed being formed into a supply tank to which the cooling water is returned. It will be seen that hoods are provided over the wheels which confine the spray, thus preventing it from being thrown onto the operator and floor. Particular attention has been given to the subject of lubrication, and those bearings subjected to severe service are ring oiled. The principal dimensions of the machine are as follows: capacity for grinding car wheels from 28 to 44 inches in diameter; length of axles, up to 7 feet 10 inches; diameter of axle journals up to 6 inches; size of grinding wheels, 18 by 2½ by 2½ inches; available wheel speeds, 1040 and 1350 R. P. M.; speeds of axle driving gear, 4.2, 5.3 or 6.5 R. P. M.; floor space occupied, 6 by 14 feet; power required to drive machine, approximately 20 horsepower; net weight of machine, including motor and accessories, 18,000 pounds.

GARVIN AUTOMATIC TAPPING MACHINES

The three machines shown in the accompanying illustrations are recent products of the Garvin Machine Co., Spring and Varick Sts., New York City. The machine shown in Fig. 1 is known as a 1-2 combination automatic tapping machine; this is essentially the No. 2 machine of this company's manufacture, equipped with a No. 1 auxiliary head. This combination meets the demand for a machine for tapping work with two holes, the sizes of which differ to such an extent that it would not be practical to have both heads of the same capacity. Referring to the illustration it will be seen that the No. 1 head can be operated by either a lever or foot treadle, while the No. 2 head is operated by a lever. Each head is independent of the other. Fig. 2 shows a machine known as a No. 1-2-X combination automatic tapping machine which consists of the No. 1 and No. 2-X heads mounted on a single machine. Both heads are treadle operated so that both of the operator's hands are left free. The No. 2-X head of this machine is of greater capacity than the No. 2 head on the machine shown in Fig. 1.

Fig. 3 shows a machine styled the Garvin 2-X four-spindle automatic tapping machine. It will be seen that the spindles are operated in pairs which are controlled by independent levers. The two spindles on the right-hand side of the machine are used for rough-tapping, while the two spindles at the left are reserved for finishing. The work consists of a deep hole in a tool steel part, the material making it necessary to rough-tap the hole before finishing, and this is done without requiring the work to be set up a second time. This result is obtained by the transverse slide which enables the fixture to be moved along to bring the work into position under the finishing spindles after the roughing operation has been performed. The general operation of these machines is the same as that of the regular Garvin automatic tapping machines, the spindles being fitted with two frictional pulleys running in opposite directions, and after the tap is once started the operation is automatic, the hole being tapped to a predetermined depth which is controlled by an automatic trip which stops and reverses the tap.



F. E. Wells No. 10 Polishing Machine with Spindle carried in Ball Bearings

F. E. WELLS POLISHING AND GRINDING MACHINE

The No. 10 ball bearing polishing machine illustrated herewith is a recent addition to the line of F. E. Wells & Son Co., Greenfield, Mass. This machine is designed to be driven from a shaft attached to the ceiling of the floor beneath that on which the ma-

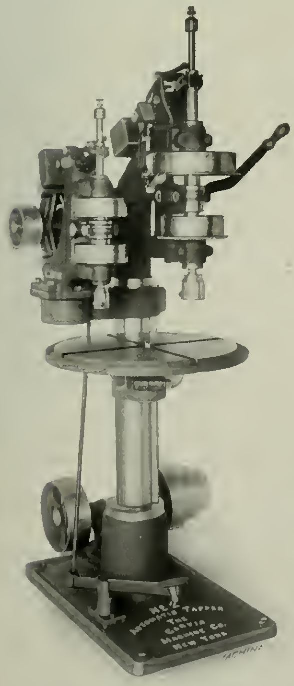


Fig. 1. Garvin No. 1-2 Combination Automatic Tapping Machine

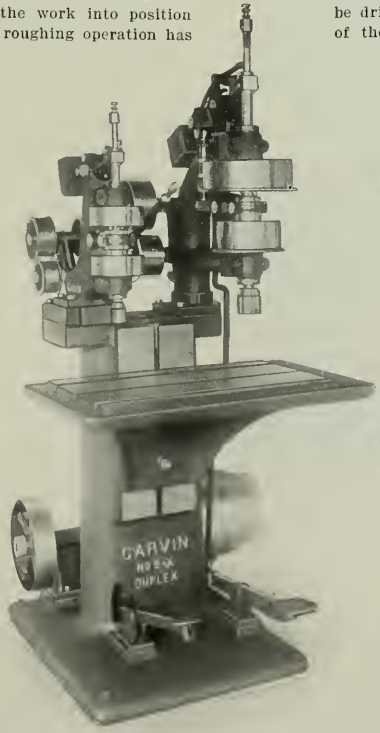


Fig. 2. Garvin No. 1-2-X Combination Automatic Tapping Machine

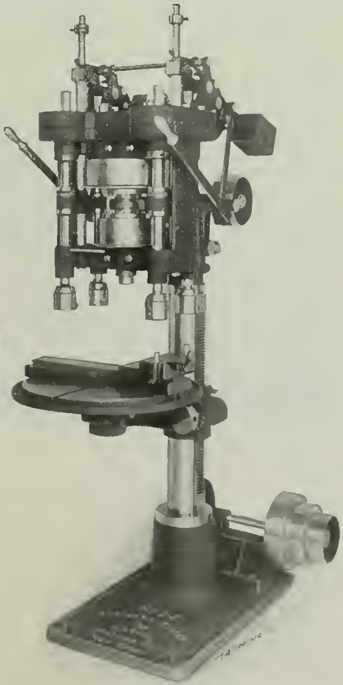


Fig. 3. Garvin No. 2-X Combination Automatic Tapping Machine

chine is set up, but in the case of single-story buildings, the driving shaft may be placed in a trench and its bearings supported by floor stands. Having the belt completely enclosed in this way is an important means of providing for the safety of the operator. The idler pulley for tightening the belt when it is required to start the machine is located inside the bed. This pulley is operated by the handle seen at the side of the machine, which is raised to bring the idler into contact with the belt to engage the drive; and to stop the machine, it is merely necessary to lower the handle. The spindle runs in SKF ball bearings which are carefully enclosed to provide for the exclusion of dust and grit. When so desired, tapered bronze bearings which are ring-oiled may be supplied in place of ball bearings. This machine is also equipped for grinding, in which case the spindle is shorter so that the grinding wheels are located close to the bearings. The principal dimensions of the machine are as follows: diameter of spindle, 1¼ inch; height of spindle from floor, 36 inches; size of base, 17 by 22 inches; and net weight of machine, 510 pounds.

A No. 11 ball bearing grinding machine is another recent product of this company. This is similar to the No. 10 machine except that it is arranged to be driven by an overhead belt. As in the case of the No. 10 machine, the spindle is mounted in SKF ball bearings, this form of mounting assuring maximum transmission efficiency with a corresponding reduction in the cost of power and maintenance. The principal dimensions of this machine are as follows: diameter of spindle, 1¼ inch; total length of spindle, 36½ inches; projection of spindle at each side of machine, 7 inches; height of spindle from floor, 36 inches; and net weight of machine, 425 pounds.

NEHLS PYROMETRIC PASTE

A means of measuring high temperatures, based on the same principle as that of the Seiger cones, has recently been developed by the Carl Nehls Alloy Co., 248 Brush St., Detroit, Mich. This consists of different metallic salts which are made up in mixtures that will melt at various specified temperatures ranging from 220 to 1330 degrees C. This method of measuring temperatures is intended to replace more costly pyrometers and also for the purpose of checking the indications of pyrometers. For the latter purpose, the pyrometer and a mixture of salts of a known melting point are placed in the furnace together. When the salt melts it shows that the temperature of the furnace has reached a specified point, and the indication of the pyrometer should correspond; otherwise the instrument is in error and should be corrected accordingly.

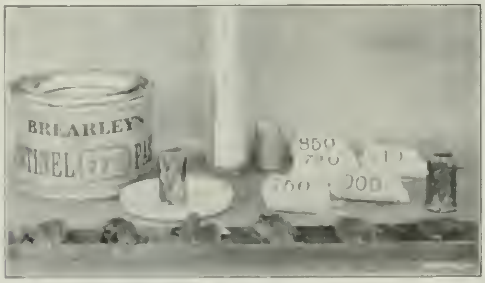


Fig. 1. Nehls "Sentinel" Pyrometers and Paste

In use, these metallic salts are cast into solid cylinders 7/16 inch in diameter by 3/4 inch in length, as shown in Fig. 1. Each cylinder is wrapped in paper on which its correct melting temperature, in degrees C, is marked. For all temperatures below 485 degrees C or 932 degrees F, these cylinders or "Sentinel pyrometers" as they are called, can be used in an air-tight glass tube of the form shown. In this way, the same salt can be used over and over again, but where this method is not feasible, by placing the cylinder on a small porcelain saucer the melted salt is prevented from running over the floor of the furnace in which it is used.

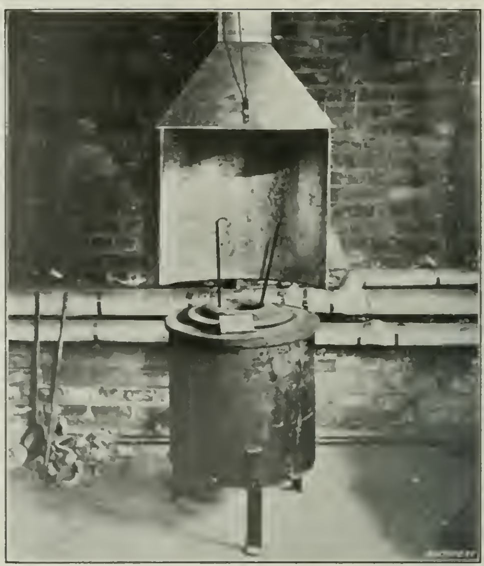


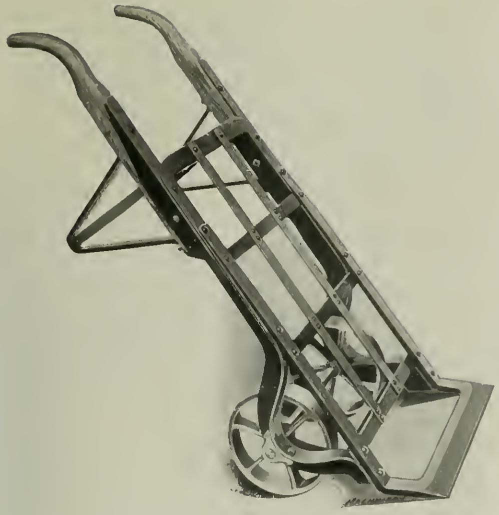
Fig. 2. Method of using "Sentinel" Pyrometers

These salt mixtures are also made in the form of paste, a sufficient quantity of paste to make several hundred determinations being packed in a tin, as shown. Daubs of different pastes of various melting points can be placed along a steel bar and inserted in the furnace, retort, flue or other point where it is required to make a temperature determination, and by noting which paste melts and which does not, the temperature may be determined, this temperature lying between the melting point of the paste which does not melt and that of the paste with the highest melting point which was reduced to the liquid state.

In the heat-treatment of tool steel, paste with a melting point corresponding to the temperature at which it is required to quench the steel is selected, and some of this paste is daubed on the tool, which is then placed in the furnace and its temperature raised until the paste melts. This shows that the steel has been heated to the required quenching temperature and the tool is removed from the furnace and plunged into the oil bath or other quenching medium. Another handy use of "Sentinel" cylinders is shown in the illustration Fig. 2. Two tubes or pipes are plugged at the bottom and "Sentinel" cylinders of different melting temperatures are dropped into these tubes. Rods are then placed on the tops of the cylinders and when the furnace has been heated sufficiently so that the cylinder with the lower melting point fuses, the rod on that cylinder drops. When one rod has dropped in this way and the other has not, it shows that the temperature of the furnace lies between the melting points of the two salts that were chosen. This difference may be only 10 degrees. The method referred to is found particularly useful in determining the temperature of molten metal, salt bath furnaces and numerous other classes of heating equipments.

EDWARDS STEEL TRUCKS

Reference to the accompanying illustration will show that the Edwards truck which forms the subject of this article is made entirely of steel, with the exception of the handles which are steam-bent timber. The axle bearings are supported by the U-shaped frame, which is one continuous piece and gives the maximum strength and rigidity. The frame is made of 2½ by ¾ inch angle steel; and the cross bars are of 1½ by ¾ inch steel T-sections. All joints are riveted, with the exception of the handles and the axle bearings, which are bolted



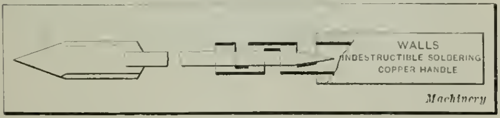
Edwards "General Purpose" Steel Truck

to the frame. In the event of a handle being broken, a new one can be quickly substituted; but as the handles are of straight grained wood reinforced with angle steel, it is very seldom that such an accident occurs. The handles are varnished and the remainder of the truck is painted black. A noteworthy feature of the design is that the wheels are located inside the body of the truck so that they will clear anywhere where there is room for the body of the truck to pass.

It is claimed that the increased durability of these trucks over those made of wood is so great that the elimination of breakage and upkeep expenses will pay for the truck in a year. The truck illustrated is what is known as the "general purpose" truck for use in factories, warehouses, etc. The same form of construction is followed in the "barrel and general cargo" truck, and the "cotton" truck made by this company. The latter truck is especially adapted for handling bales and similar heavy packages. Further particulars may be had from the Edwards Mfg. Co., Cincinnati, Ohio.

WALLS SOLDERING COPPER HANDLE

With the view of overcoming the difficulty experienced through the splitting or burning of the wooden handles of soldering coppers, T. P. Walls Tool & Supply Co., 83 Walker St., New York City, has introduced the handle which forms the subject of this description. It will be seen that this handle consists of a metal sleeve which projects out from the handle proper that is made of wood. This metal sleeve which receives the shank of the soldering copper is cut and formed in a die so that the shank is a forced fit in the sleeve as shown. Forcing the shank into the sleeve places the sleeve in tension which gives it a very tight grip on the shank, it being claimed that this grip is almost as secure as if the two parts were welded together. This projecting metal sleeve protects the handle from being burned, while the wooden grip prevents it from getting too hot. This effect is further augmented by the hollow handle which allows air to circulate through it. Handles of this type are made in three sizes, known as Nos. 1, 2 and 3, which have capacities for soldering copper ranging from 1 to 6 pounds in weight.

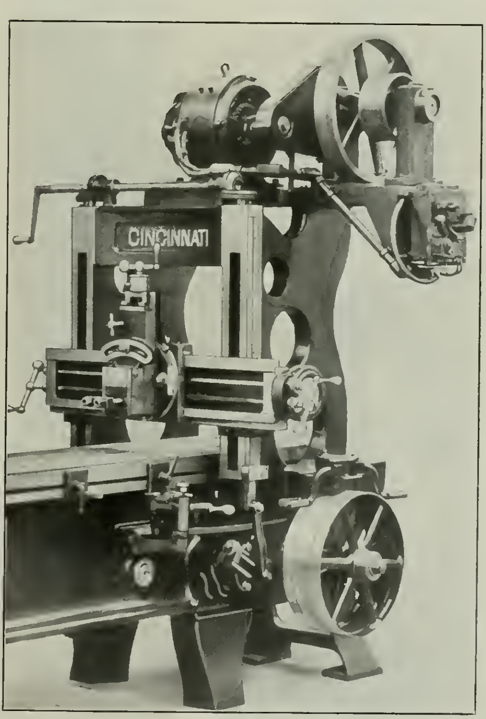


T. P. Walls Soldering Copper Handle not easily burned or broken

MOTOR DRIVE FOR CINCINNATI PLANER

In the January, 1909, number of MACHINERY, reference was made to a 22-inch planer which was then a new product of the Cincinnati Planer Co., Cincinnati, Ohio. This company now makes announcement of a machine of quite similar design with the exception of the fact that it is equipped with the arrangement of individual motor drive shown in the accompanying illustration. The machine is entirely self-contained and completely wired in conduit; and the starting box is attached as shown in the illustration, making a very neat and simple installation. The upper driving shaft runs in bronze bushed ring-oiled bearings which are fastened to a top plate that carries the motor and starting box. This makes the drive a complete unit, and mounting the starting box at the extreme end of the plate—on the outside of the belts—eliminates the necessity of reaching between the belts to start the machine—a practice which may result in injury to the operator. All gears are also adequately covered.

The bed is bored to receive the driving shaft bearings which are internally ground. The loose pulleys are bushed with self-oiled bronze bearings, and micrometer collars are provided for both the horizontal and vertical feeds. The large feed gear at the end of the rail is of improved design in which the flat spring and pawl have been dispensed with. Nothing but the operating handle is exposed. Because of the ease of manipulation and rapidity of operation, this machine is especially adapted for manufacturing small duplicate parts, as well as the ordinary run of planer work. It is also particularly well suited to the requirements of trade and technical schools.



Arrangement of Motor Drive for Cincinnati Planer

LANGELIER SEMI-AUTOMATIC MULTIPLE TAPPING MACHINE

The No. 2 semi-automatic multiple spindle tapping machine illustrated in Figs. 1 and 2 is one of the recent additions to the line of the Langelier Mfg. Co., Providence, R. I. This machine is adapted for tapping practically any number of holes grouped within a five-inch circle and arranged on almost any layout. Ample power is provided for driving as many as sixteen ¼-inch taps, or their equivalent, in cast iron. The machine is semi-automatic in operation and may be readily attended by the same grade of help usually employed to operate single spindle tapping machines, as the duties of the operator are reduced to merely placing the work to be tapped in the locating fixture, starting the machine by tripping the foot treadle and then removing the finished work. In addition to the multiple head furnished with each complete machine, additional heads—each having a different layout of spindles—can be used interchangeably, so that the machine is adapted for tapping a great variety of parts.

The tapping spindles are of the crank type, driven from a common driving plate without gearing; and the spindle driver is carefully balanced to eliminate practically all noise and vibration when the taps are running at their normal cutting speed. The spindles are machined from solid alloy steel bars, after which they are heat-treated and carefully ground to size. The chucks were designed by the Langelier Mfg. Co. for taking straight-shank tanged taps. The spindles are located with extreme accuracy on fixed centers and run in hard phosphor-bronze bushings. Each spindle is fitted with a special compensating device which allows individual taps to follow their own leads; and by this means every hole is tapped with clean cut threads. This compensating feature also permits of simultaneously operating taps of different pitches, and insures uniformly accurate and interchangeable work. Each tap is kept properly lubricated by letting a thin film of oil run down to it, the oil for this purpose being delivered from the reservoir casing which is clamped around the multiple head. Oil is delivered to the casing from the large oil reservoir at the right hand side of the machine.

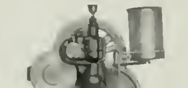


Fig. 1. Front View of Langelier No. 2 Semi-automatic Tapping Machine

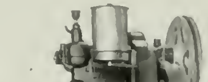


Fig. 2. Side View of Langelier Tapping Machine showing Arrangement of Drive

The machine proper consists of a rigid cast-iron column which is mounted on a table supported by legs of the form shown. This column carries the main vertical spindle which drives the tapping head. The main spindle is driven through spiral and spur gearing by a set of three grooved pulleys mounted side by side at the back of the machine near the top, the arrangement being clearly shown in Fig. 2. These pulleys are grooved to receive a ½ inch built up round leather belt, this form of belt being adopted because it permits of a very sharp reversal of the taps without shock; and also because the amount of floor space occupied by the machine is less when using a round belt than would be the case if a flat belt were employed. The inner of the three pulleys drives the taps forward and actuates the mechanism which raises the table at the proper rate for the pitch of taps which are being used. The outer pulley reverses the taps, and also lowers the table at twice the tapping feed. When the taps are clear of the work or jig, the machine is stopped automatically and the operator is given just sufficient time to take out the tapped piece and replace it with a fresh blank. The belt is then shifted mechanically, driving the taps forward and feeding the table up, this cycle of operations being repeated over and over and timed to secure the greatest practical tapping speed. The middle one of the three grooved pulleys is an idler or loose pulley to which the belt is shifted to stop the machine. The shifting of the belt is controlled by a pilot gear which derives its motion from the change gears shown at the left-hand side of the machine in Fig. 1. T-slots are provided on this pilot gear which carry adjustable dogs that operate the belt shifting fork. One dog simply shifts the belt to the idle pulley and stops the machine. The other dog shifts the belt to the outside pulley and reverses the motion of the taps and table. Adjustable stops are provided which may be accurately set to prevent loss of time from over-travel.

To start the machine the operator simply trips the foot treadle. This shifts the belt from the center or loose pulley to the inner or driving pulley and at the same time places the belt shifter in position to be engaged by the reversing dog which shifts the belt to the outer or reverse pulley. The position of the dog which shifts the belt to the loose pulley is fixed, but the reverse dog is set to suit the thickness of the work which is to be tapped. On the inside face of the pilot gear which carries the tripping dogs there is a face-cam which actuates the rise and fall of the table, this movement of the table corresponding with the pitch and speed of the taps. When it is necessary to place taps in the spindles or remove them, the knee which carries the table must first be lowered. The friction disk is graduated and after the change has been made care must be taken to bring the pointer back to the same graduation on the disk in order to bring the table back to its original position. The principal dimensions of the machine are as follows: maximum distance between table and tapping chucks, 5 inches; distance from center of main driving spindle—which coincides with the center of the tapping head—to the face of the column, 3½ inches; diameter of driving pulley, 9 inches; power developed by driving motor, ¼ horsepower; diameter of grooved pulley on motor spindle, 5½ inches; total height of machine, 61 inches; floor space occupied, 22 by 20 inches; height of table from floor, 44 inches; and size of table, 5 by 8 inches.

LANDIS CHASER GRINDER

The chaser grinder which is illustrated and described herewith has recently been perfected by the Landis Machine Co.,

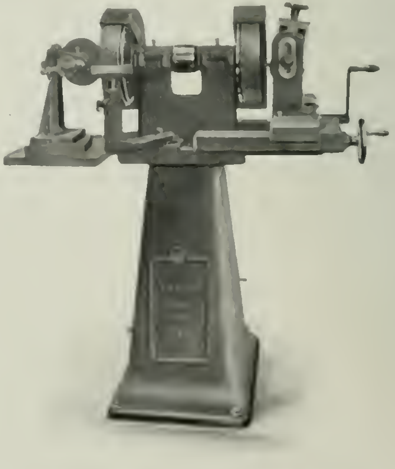


Fig. 1. Landis Threading-die Chaser Grinder

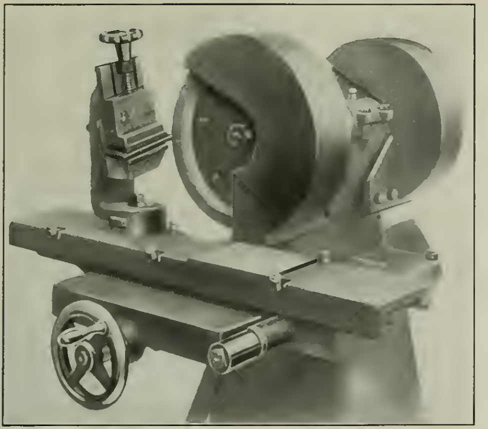


Fig. 2. Close Side View of Grinder Head

Inc., Waynesboro, Pa., for grinding thread-cutting dies, the machine being particularly adapted for grinding the threading die manufactured by the Landis Machine Co. The machine is duplex in that it is equipped with an attachment for grinding all sizes of Landis chasers, and a device for sharpening the disk cutters of roller pipe-cutting machines. It may also be used to advantage in grinding lathe, planer and shaper tools.

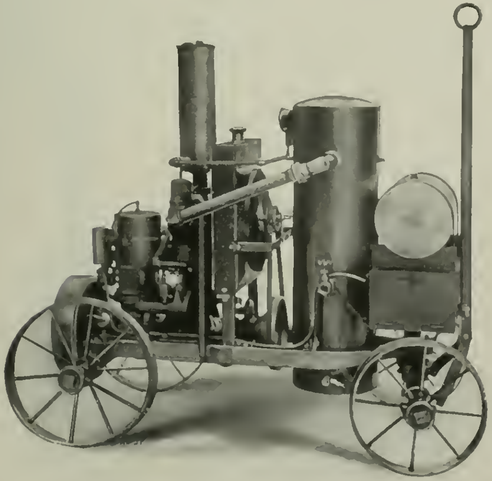
The chaser grinding attachment has adjustment in both horizontal and vertical planes with suitable graduations for controlling the lead and rake angles. Both the transverse and longitudinal feeds are in horizontal planes, which is a feature that tends toward increased accuracy. The table is gibbed at both sides and finished with an overhang to protect the guides from emery dust.

The disk cutter grinding attachment is also adjustable vertically and horizontally and is operated by hand. An adjustable rest is also provided to facilitate handling miscellaneous work. The rigid construction, guarded wheels, ease with which the machine can be operated, and its universal adaptability are features which will commend this machine to the attention of the experienced mechanic.

INGERSOLL-RAND PORTABLE AIR COMPRESSOR

The small portable air compressor driven by a gasoline engine, which is illustrated and described herewith, has been developed by the Ingersoll-Rand Co., 11 Broadway, New York City, to meet the requirements of industries that use compressed air in small quantities. The equipment is especially intended for the use of contractors who have temporary work requiring the use of air tools. The compressor being portable and self-contained, is admirably adapted for this class of service. It is driven by a single-cylinder gasoline engine which is direct-connected to the compressor with both pistons working on the same crankshaft. The engine is of the two-cycle type, its design following closely along the lines of standard marine engines. The air compressor is the Ingersoll-Rand Co.'s standard type known as the "Imperial XII," and has a capacity for delivering 45 cubic feet of air per minute at a pressure of 90 pounds per square inch. Cooling is provided for by a gear-driven pump and an automobile type radiator which serves both the compressor and gasoline engine cylinders.

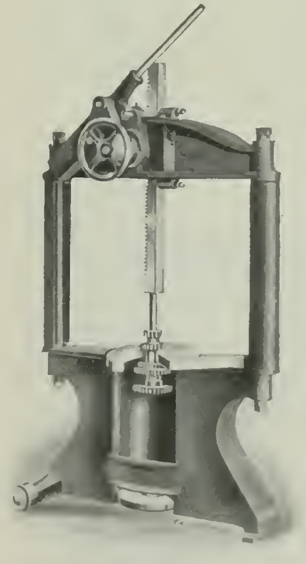
The frame, axles and wheels of the truck are of steel, and the front axle is connected to the frame by a swivel connection to provide for turning corners, etc., while sufficient vertical movement is provided to accommodate the wheels to inequalities of the road over which the truck is pulled without straining the frame. The air receiver is tested to 300 pounds per square inch and fitted with a safety valve, pressure gage and the necessary piping outlets, etc. The receiver is mounted at one end of the frame and a gasoline tank with a capacity of 15 gallons is supported on top of the tool-box as shown. The complete outfit weighs 1600 pounds and can be easily pulled about by hand, although it may be fitted with thills and single-tree for hitching a horse to haul it about, if desired.



Ingersoll-Rand "Imperial XII" Portable Air Compressor

ATLAS ARBOR PRESS FOR AUTOMOBILE WORK

The Atlas Press Co., 314 North Park St., Kalamazoo, Mich., which is the successor to the G. T. Eames Co., has recently placed upon the market a No. 26 and a No. 28 arbor press which are particularly adapted for automobile work. The design and construction of these presses has been worked out in a way to combine high power and rigidity. Several improvements have been applied, among which the following may be mentioned. The swinging plate over the opening in the base of the press may be instantly adjusted for any size of work; the bearing on the ram is exceptionally long; and the front of the press is accessible from any point. A lock is provided on the ram so that it may be held in any desired position. The rigid construction of these presses makes them well suited for handling heavy work in automobile factories, repair shops, etc.

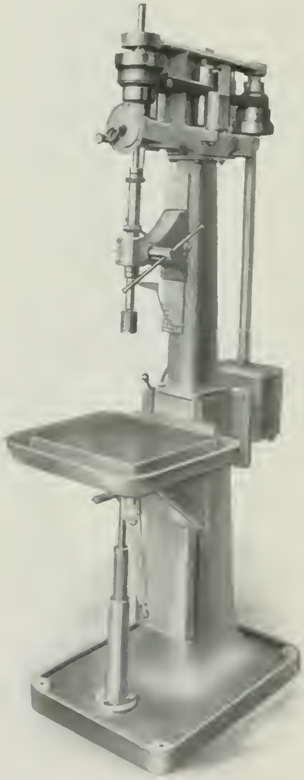


Atlas Arbor Press especially adapted for Automobile Work

SIPP MACHINE CO.'S SENSITIVE DRILL PRESS

In using many sensitive drill presses, where the variation in the size of the holes to be drilled is such that frequent changes must be made in order to obtain the proper cutting speed in each case, a considerable loss of time is inevitable in shifting the belt; and the elimination of this difficulty has been given careful consideration in designing the line of sensitive drill presses which have recently been placed upon the market by the Sipp Machine Co., Paterson, N. J. Referring to the illustration, it will be seen that there is a pair of four-step cone pulleys at the top of the machine, and the belt is shifted to any of the steps on these pulleys by turning the small crank handle which will be seen at the front of the head. This handle rotates over an index dial which is graduated to show the number of revolutions per minute at which the spindle runs with the belt on each of the cone pulley steps. The speed changes obtained in this way cover a range which provides suitable speeds for drills from the smallest up to 29/32 inch in diameter; and the driving pulley may be arranged to run at 380 revolutions per minute for driving carbon steel drills, or at 525 revolutions per minute when high-speed drills are to be used in the machine.

It will be noticed that the belt is perfectly straight—without twists or turns—which is the means of adding materially to its life as there are no excessive strains put on either edge of the belt. Long idler pulleys on the slack side of the belt provide for keeping it at the proper driving tension. Convenience of operation has been carefully considered in providing means of control for all parts of the machine, and reference to the illustration will show the successful way in which this result has been attained. Both the crank for raising and lowering the table, and the lever which operates the shifter on the main driving belt, are within easy reach from the front of the machine so that there is no need for the operator to leave the working position.



Sipp Sensitive Drill Press

The spindle is made of steel, accurately ground to size; and a ball thrust bearing takes the thrust of the spindle. An improved form of spindle oiling device in which there are no oil holes to clog provides adequate lubrication at all times, and there is an adjustable stop collar which can be set for any required depth of hole. The spindle driving cone pulley runs on ball bearings which take the entire belt pull, thus relieving the spindle from all strain. It has already been mentioned that idler pulleys take up the slack in the belt to maintain a satisfactory driving tension. One of these idlers is fixed, while the other is carried on a swinging arm and is pressed against the slack side of the belt by a light spring which maintains the required belt tension. It will be seen that the table is provided with an oil groove of ample capacity and that the sides of this oil groove are inclined—a feature which facilitates the removal of chips. The telescopic table elevating screw avoids the necessity of boring a hole in the floor. The table is rigidly locked to the base by means of a gib. The principal dimensions of the machine are as follows: maximum distance from table to spindle 32½ inches; diameter of spindle, ⅞ inch; traverse of spindle, 14¾ inches; taper hole in spindle, Morse No. 2. These machines are built with from one to eight spindles.

NOBLE & WESTBROOK MARKING MACHINE

A marking machine for graduating and numbering beveled fuse caps in a single operation, has recently been placed on the market by the Noble & Westbrook Mfg. Co., Hartford, Conn. This machine is of simple construction, easy to operate and it is said that the accuracy of the work is all that can be desired. The graduating die is carried in a holder keyed to the shaft. As the mark is made, the shaft revolves with the die and winds up a spring which returns the work-holder to the proper position for marking the next piece as soon as the contact of the die with the work is broken. The shaft runs in adjustable bronze bushings and the work is held in the proper relation to the die by means of accurately cut gears, the impression being obtained through foot pressure applied by the treadle. Means of adjustment are provided so that the depth of the impression may be regulated to 0.01 inch. This machine is not only suitable for graduating fuse caps, but it could be employed on any beveled surface, such as micrometer collars of machine tools, etc. It could also be used to put lettering on beveled surfaces instead of graduations. The rate of output is very satisfactory, as it is only necessary to turn the handwheel once to complete marking the work.

Noble & Westbrook Machine for marking Beveled Fuse Caps

ECLIPSE ROLLER BEARING DRILL CHUCK

A roller-bearing drill chuck which can be tightened, ready to start drilling, with the thumb and forefinger, without requiring the use of a key or wrench, is the latest product of the Eclipse Machine Co., Elmira, N. Y. The saving of time effected through the use of a chuck of this kind on high-speed drilling machines, screw machines and other machines of which hard accurate work is required will be evident without requiring any detailed discussion of this feature. As tightened ready to start drilling, the chuck takes a grip on the drill which effectually overcomes the possibility of its dropping out from vibration; and then when the drilling operation begins, the jaws are tightened automatically by the resistance of the cut so that the grip is always proportional to the severity of the work being done by the drill. After the drilling

Fig. 1. Eclipse Roller Bearing Drill Chuck

operation has been finished and it is required to remove the drill, the chuck opens without noticeable resistance.

Having explained the features of this tool so far as its use is concerned, we will turn our attention to the way in which it operates. The shank *A* may be either a straight or Morse taper, according to the requirements of the machine. Referring to the cross-sectional view shown in Fig. 2, it will be seen that the shank enters a socket in the head *B*. Through the opposite end of this head there is a hole which is tapped to receive the threaded shank of the thrust member *C*, which has three grooves cut in it to receive projections *D* on the upper ends of the chuck jaws. It will be noticed that the mechanism is enclosed by the chuck body *E*, the ring *F* and the hood *G*, these three parts being screwed together to form a single unit which surrounds the chuck mechanism, the body being grooved to receive the jaws. In order to reduce the frictional resistance, rollers *H* are provided, these being of such a size that they are equivalent to ball bearings ⅜ inch in diameter. It will be seen that the outer faces of the chuck jaws are tapered to correspond with the taper on the inside of the hood *G*.

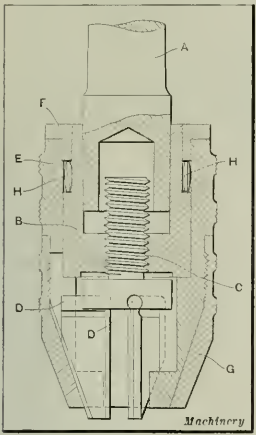


Fig. 2. Cross-sectional View of Eclipse Drill Chuck

When the operator desires to put a drill in the chuck he takes hold of the knurled chuck body *E* between his thumb and index finger, thus holding it stationary. The shank *A* and head *B* which is secured to it are rotated by the drill spindle and this rotation of the head *B* around the threaded shank *C* results in forcing down the thrust member and chuck jaws. Owing to the taper of the jaws engaging the hood *G*, the jaws are forced in, thus securing a grip on the shank of the drill. Then when the drill starts cutting, this grip is increased according to the resistance offered to the cut.

WALTHAM CUTTER GRINDER

The cutter grinding machine illustrated in Figs. 1 and 2, which is a recent product of the Waltham Machine Works, Newton St., Waltham, Mass., is designed for the purpose of grinding all kinds of angular cutters which are not over 2½ inches in diameter. The cutter to be ground is clamped in position on one end of the work-spindle, and an index plate is attached to the opposite end of the spindle. This arrangement gives more room for the grinding wheel and affords a positive means of indexing.

Fig. 1 shows the machine arranged for grinding the faces of the teeth or "gumming" as it is sometimes called. The grinding wheel is carried by a hardened steel spindle which runs in ball bearings. After the teeth have all been ground on the face, the cutter is mounted on the arbor in the reverse position to finish the grinding. In Fig. 2 the machine is shown adjusted for grinding one angle of a 60-degree angular cutter. The tooth to be ground is on the center of the axis of the spindle; and the cutter-holding spindle can be swiveled in a vertical plane to give the required relief.

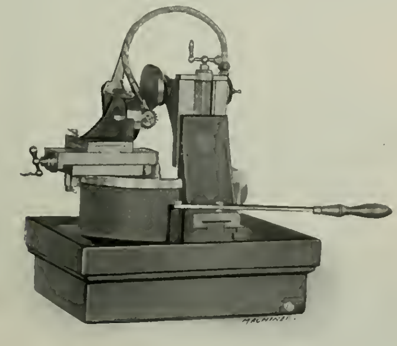


Fig. 1. Waltham Cutter Grinder arranged for "gumming" Face of Teeth

The principal features of the design of this machine are as follows: A water pump and reservoir are provided to deliver a copious flow of cooling water to the tool, and an adjustable hood prevents the water from being thrown on the operator or floor. The hand indexing device is rapidly operated and a large dial provides for accurately setting the slide to the required angle. The grinding slide is furnished with adjustable stops in each direction, and this slide also carries a bracket with idler pulleys so that the machine can be driven from above and still have the vertical adjustment relative to the grinding wheel slide. While this machine is particularly adapted for grinding the cutters used on the Waltham thread milling machine, it may be used to advantage in grinding all kinds of angular milling cutters with ground cutting edges. The base is 14 by 19 inches in size and the weight of the machine is 182 pounds.

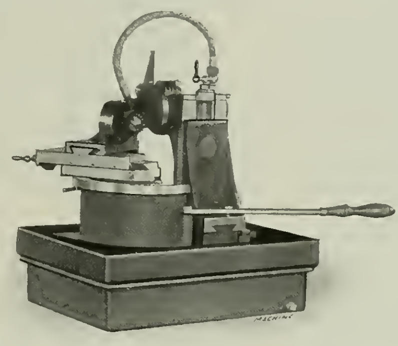
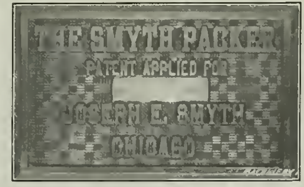


Fig. 2. Waltham Cutter Grinder adjusted for grinding One Angle of a 60-degree Angular Cutter

FEDERAL NAMEPLATES

The Federal Nameplate & Novelty Co., 732 Federal St., Chicago, Ill., has recently perfected a process for the manufacture of metal nameplates for use on machinery, etc. By this process the design stands out in bold relief and it is claimed that by having the letters and design raised instead of etched into the surface, a far more durable plate is secured and one which possesses a higher publicity efficiency. The plates are made of a special metal mixture which is hard enough to prevent the surface from being easily defaced. These plates are made of any required size and thickness and can be finished with a copper, brass or silver finish, as required. They are given a high polish and are not readily tarnished.



Federal Nameplate with Raised Letters

HOBART CIRCULAR SAW GUARD

An adjustable circular saw guard, which possesses several noteworthy features, has recently been developed by Mr. Hobart W. Curtis, foreman of the pattern department of the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn. Fig. 1 shows the guard in the working position; in Fig. 2 it is shown raised vertically to clear the saw; and Fig. 3 shows the guard swung over to one side so that it is entirely out of the way.

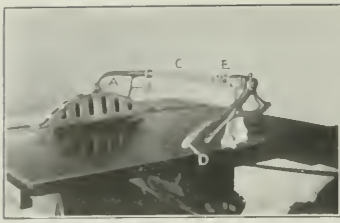


Fig. 1. Hobart Saw Guard in Working Position

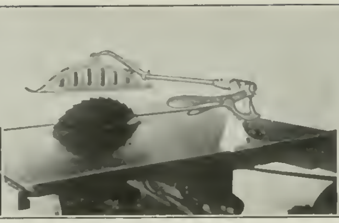


Fig. 2. Guard partially raised from Saw

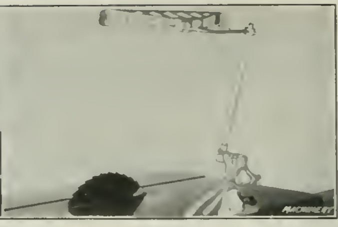


Fig. 3. Guard swung back out of Operator's Way

Referring to Fig. 1 it will be seen that the guard swings on the pivot *A*, while it is prevented from swinging far enough to hit the saw by means of the chain *B*. The vertical position of the arm *C* which supports the guard is regulated by the handle *D* that actuates the ratchet and pawl for the purpose of locating the guard at the proper height from the saw. It will also be noted that the arm *C* is pivoted at *E* so that the guard may be swung back when not in use, as shown in Fig. 3. The guard proper is made of aluminum, while the other parts are of steel or iron. The guard may be quickly adjusted to any of the positions shown in the illustrations.

WILLMARTH RADIAL DRILL

The Willmarth Tool Works, 1516 E. Thirty-second St., Cleveland, Ohio, has placed on the market the radial drill shown in Figs. 1 and 2. The design of this machine represents a departure from the established practice in building machines of this type and several advantages are claimed for this form of construction. The most prominent feature is the way in which the head and arm are moved to locate the spindle for the holes that are to be drilled. Referring to the illustrations it will be seen that the head rotates about a bearing on the arm, while the arm rotates about the column in the usual way. This affords a double swivel motion which enables the spindle to be easily located for any hole within the capacity of the machine. The bearing of the head on the arm is 17 inches in diameter and is provided with an annular ring on the inside for holding it central; and a heavy pivot bolt serves to hold the two members together. A powerful eccentric clamping mechanism locks the head in place on the arm.

The column is of the post and sleeve type. The post has a heavy lower portion which extends up to the top member that is securely bolted to it, the construction being one which affords ample stiffness. The column sleeve telescopes over the post and has a bearing at both the top and bottom in addition to a ball thrust bearing at the lower end, making it an easy matter to swing the arm into any required position. The sleeve is equipped with a powerful binding clamp at its lower end, and when this is tightened it produces essentially the equivalent of a solid column. The arm is a heavily ribbed cylindrical section which affords ample rigidity. It is raised or lowered by means of gearing at the top, which actuates a coarse pitch screw hung on ball bearings. Eight changes of speed are available, ranging from 35 to 375 revolutions per minute, these changes being arranged in geometrical progression. Four changes are obtained by the cone pulleys and the other four by the back gearing which is provided in the spindle driving gears. Provision is made for handling tapping operations by means of a jack shaft in the head, which runs at high speed and drives through an arrangement of powerful ring clutches. These clutches are self-adjusting and operated by a lever at the front of the machine, which makes it an easy matter to start, stop or reverse the spindle. The spindle is made of special steel; it is accurately ground to size and equipped with a ball thrust bearing. The hole is No. 5 Morse taper.

The feed mechanism consists of a selective gear-box which drives a worm and wormwheel that transmits the motion to the feed pinion. Six changes of feed are provided, ranging from 0.006 to 0.027 inch per revolution of the spindle. Any of these rates of feed may be instantly obtained by operating a dial located on the front of the feed-box. A quick-return handwheel is carried on the end of the feed pinion shaft.

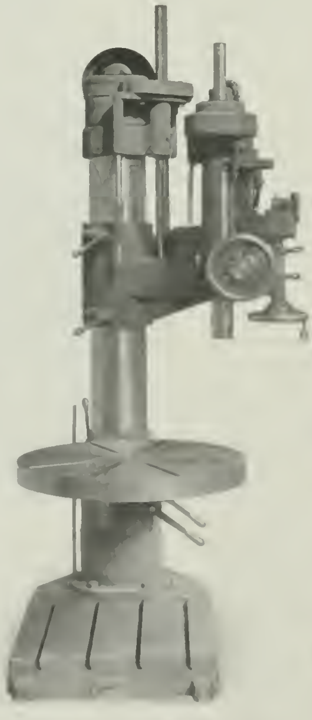


Fig. 1. Front View of Willmarth Radial Drill

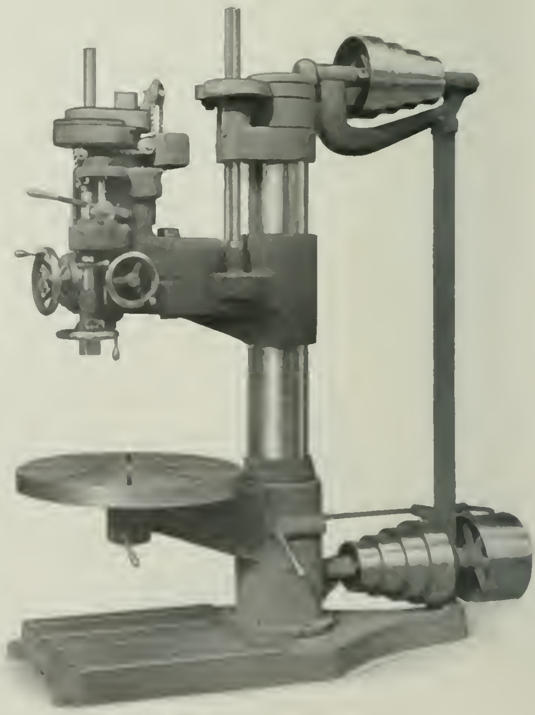


Fig. 2. Side View of Machine shown in Fig. 1

All bearings are bronze bushed and particular attention has been paid to the provision of adequate oiling facilities. No cast-iron gears are used in the machine, the gears being of steel, bronze or "semi-steel," according to the service which is required of them. All gears are fully guarded to provide for the safety of the operator. The machine is usually equipped with a round table of the form shown in the illustrations, but other styles of tables can be provided if required. The principal dimensions of the machine are as follows: Capacity to drill to the center of a circle 48¾ inches in diameter; maximum distance from spindle to base, 52½ inches; maximum distance from spindle to table, 27 inches; vertical traverse of spindle, 11¼ inches; vertical traverse of arm on column, 28 inches; total height of machine, 96 inches; and weight of machine, 3500 pounds.

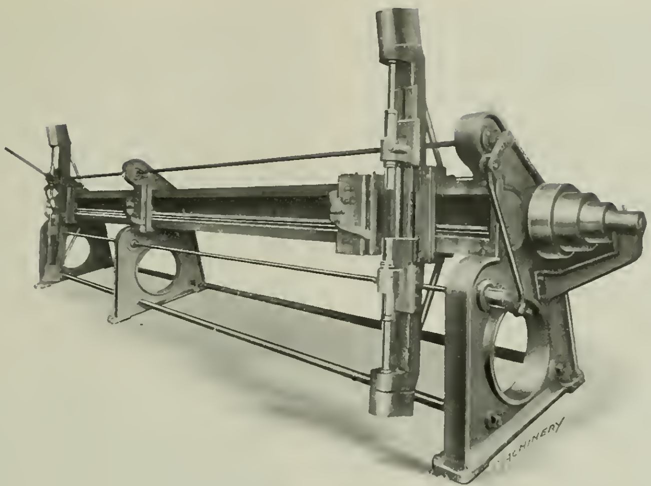


Fig. 1. Valley City Four-spindle Drilling Machine

VALLEY CITY MULTIPLE SPINDLE DRILLS

Fig. 1 shows a four-spindle drilling machine which has recently been placed on the market by the Valley City Machine Works, 12-16 Campau Ave., Grand Rapids, Mich., and Figs. 2 and 3 show front and rear views of a thirty-four-spindle machine which is another recent product of this company. These machines are particularly intended for drilling holes in pipe, the drilling operations being performed on opposite sides of the pipe simultaneously. It will be seen that the machine consists essentially of a rail supported by the required number of legs, with the drill spindle brackets carried on the rail. The rail is set at an angle which enables the operator to handle the work with the least amount of manual effort. In addition to acting as a support for the drill spindle brackets, the rail also carries self-centering clamping jaws which are operated by a splined shaft, worm gears and a rack and pinion. All spindles are adjustable both in regard to their center distances and vertical position, the vertical adjustment being for the purpose of compensating for differences in the lengths of the drills.

On the four-spindle machine which is 20 feet long, the feed is obtained by a hand lever at the left-hand end of the machine. On the thirty-four-spindle machine, power feed with automatic stop is provided for each gang of spindles. A sliding movement of the clamping jaws is imparted by the horizontal lever to the right, by which means the work can be moved longitudinally to different positions for drilling any multiple of seventeen or thirty-four holes.

NEW MACHINERY AND TOOLS NOTES

Gap Grinder: Queen City Machine Tool Co., Cincinnati, Ohio. A machine of the standard type built by this company, except that the design has been modified to provide a gap and suitable water guard.

Threading Die: Conant & Donelson Co., Conway, Mass. This die has a hexagonal shaped guide which can be turned with an ordinary monkey wrench, making it possible to use the die for cutting over threads in places where there is not sufficient room to use a die stock.

Drilling Lathe: Lodge & Shipley Machine Tool Co., Cincinnati, Ohio. An oil well tool drilling lathe designed for the special purpose of drilling slip sockets by power. The boring is accomplished by mounting the bar in the heavy drill slide or by using a flat drill.

Portable Grinder: N. A. Strand & Co., Chicago, Ill. A grinder intended for both internal and external work, which is arranged to give changes of speed suitable for the different sizes of grinding wheels employed. The connection between the machine and grinding wheel is by a flexible shaft.

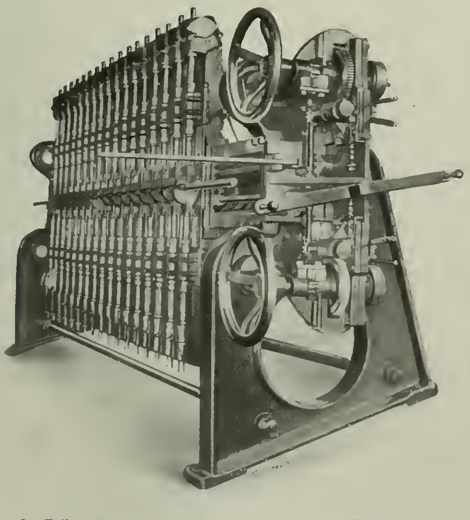


Fig. 2. Valley City Multiple Drilling Machine with Thirty-four Spindles

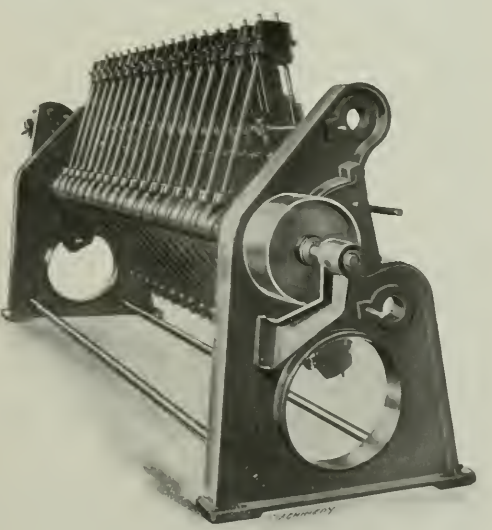


Fig. 3. Opposite Side of Machine shown in Fig. 2

Power Press Safeguard: Safety Engineering Co., Schofield Bldg., Cleveland, Ohio. This guard consists of a plate which is actuated from a cam on the shaft of the press, the plate traveling down in advance of the ram. Any obstruction over ⅛ inch in thickness prevents the plate from dropping far enough to enable the clutch to be engaged.

Patternmaker's Tool Chest: Union Tool Chest Works, Rochester, N. Y. This chest is fitted with five drawers and a top compartment. It is furnished with a leather shoulder strap for use in carrying the chest, in addition to a handle at the top. The chest is sufficiently strong to carry the class of tools which are used by patternmakers.

Reversing Motor Drive for Boring Machine: Electric Controller & Mfg. Co., Cleveland, Ohio. This device is particularly designed for machining short arcs on the boring mill, as it does away with the loss of time incident to carrying the table through a complete revolution for each cut, which takes place in a very small part of the revolution.

Lock Washer: National Umbrella Frame Co., 30th and Thompson Sts., Philadelphia, Pa. A lock washer of the split and warped ring type with a corrugated bearing surface which, it is claimed, is superior for this purpose to a lock washer with upset ends, owing to the fact that a more uniform bearing surface against the nut and backing is secured.

Slotting Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. A heavy-duty, rack-driven slotter which is equipped with reversing motor drive, independent fast power traverse in both directions, push button control and operating levers on both sides of the machine. All levers are connected to prevent engagement of conflicting motions.

Pneumatic Forging Hammer: H. Edsil Barr, Erie, Pa. A light pneumatic hammer which operates on the same principle as a steam hammer. The anvil or die block is cast solid with the housing, which is reinforced on the inside and designed to support the cylinder. The valve is operated by a foot treadle so that both the workman's hands are at liberty.

Baling Press: Tempus Reclaiming & Mfg. Co., 441 N. 3rd St., Philadelphia, Pa. A portable press for baling metal scrap, tangled wire, turnings, etc. This press is particularly adapted for use in stamping works and similar plants where a large amount of the class of material referred to accumulates. The press is mounted on casters so that it may be moved about.

Projectile Turning Lathe: Niles-Bement-Pond Co., 111 Broadway, New York City. A heavy 30-inch lathe equipped with a 35-horsepower individual motor, which is particularly adapted for turning armor-piercing projectiles of all sizes up to 14 inches in diameter. The machine has been made exceptionally heavy in order to withstand the severity of the service for which it is intended.

Heavy Geared Head Lathe: Bridgeford Machine Tool Works, Rochester, N. Y. This machine is equipped with single pulley drive, and fifteen changes of speed, which are in geometrical progression, are available. Individual motor drive can be easily applied if so desired. The headstock gears run in oil and all shafts are bronze bushed. The swing is 33 inches over the ways and 22 inches over the carriage.

Triplex Hydraulic Pump: Watson-Stillman Co., 192 Fulton St., New York City. A line of high pressure hydraulic pumps which are driven by an individual motor mounted on an extension of the base. These pumps are of the triplex, single-acting type and the motor drive is direct connected. The construction has been worked out along lines which insure the maximum rigidity and maintenance of alignment.

Duplex Milling Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. A machine designed for automobile work but adapted for a wide range of milling operations where face mills can be used. The heads are mounted on vertical slides with the spindles opposed to each other, and an arbor may be mounted in both spindles and fitted with a cylindrical cutter to adapt the machine for slabbing operations.

Hydraulic Valve: Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. A five-way hydraulic valve designed to overcome the difficulty experienced by operators of double-acting hydraulic equipment in obtaining the desired pressure control. This valve is of the five-way, high and low pressure, double-acting balanced poppet operating type, and is said to be particularly well adapted to meet the requirements for which it was desgined.

Oxy-acetylene Welding Equipment: H. G. Davis, Springfield, Mass. A high-speed machine for automatically welding the seams of steel tanks, etc. The machine consists of two telescoping standards which support an I-beam from which two welding blow pipes are hung over the revolving table. This table is entirely independent of the mechanism controlling the welding torches. It has four radial arms provided with clamps for holding the work.

Sixteen-inch Lathe: Von Wyck Machine Tool Co., Cincinnati, Ohio. A semi-quick-change gear lathe designed to meet the requirements of general manufacturing plants. This machine is built with either a three-step cone and double back gears or a four-step cone and single back gears. The feed-box gives four quick changes and is so arranged that only six loose gears are required to provide for cutting threads ranging from three to forty-two per inch.

Heavy Cutting-off Machine: George Gorton Machine Co., Racine, Wis. A cutting-off machine with a blade of the internal tooth type which has a capacity for cutting off any bar stock which can be passed through a circle 12¼ inches in diameter. The machine is equipped with a stock rack and trolley which has a measuring device to provide for cutting off pieces of specified lengths or for duplicating cuts. The bar to be cut is clamped in place by power.

Keyseating Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. A vertical spindle keyseating milling machine which is said to be the first of its type built in the United States. The claim is made for this type of machine that better bearings for the keys are secured and the necessity of providing the clearance for the cutters by using a separate machine is done away with. A machine of this type is particularly valuable where short keyseats have to be milled.

Drilling Machine: Baker Bros., Toledo, Ohio. An automatic drilling machine for high-speed production. This machine automatically brings the work under the drill, advances the tool into the work, withdraws the tool and removes the work from the spindle without requiring any attention on the part of the operator. It is merely necessary to depress the treadle to drill each piece of work, so that a production of eight 1-inch holes per minute—including the chucking of the work—is maintained.

Automatic Sand Blast Machine: W. W. Sly Mfg. Co., Cleveland, Ohio. A machine particularly adapted for sand blasting small castings, which consists of a rotating table, half of which is constantly enclosed in a chamber in which the sand blast nozzles are located. The machine is built in five sizes which have table diameters ranging from 6 to 12 feet. The pieces to be sand blasted are set on the table and rotated under the nozzles which are arranged to blast all of the work uniformly.

Dial Measuring Gages: Randall & Stickney, 248 Ash St., Waltham, Mass. Two dial gages which are characterized by the simplicity of their design and construction. One of these gages is mounted on the support which carries a platen on which the work is placed preparatory to gaging. The platen is adjustable in all directions. The other gage referred to is adapted for testing the accuracy of a variety of work where a dial test indicator is required. The dial on both instruments is graduated to 0.001 inch, and metric gages can be furnished if required.

Electric Crane Trolley: Northern Engineering Works, Detroit, Mich. The most notable feature of this trolley is the care which has been given to the provision of safeguards at all danger points. The gearing is entirely enclosed, no gears are overhung and the hoisting gear case is made a part of the trolley, insuring rigidity and alignment of the gearing. Access to the gear case is had by lifting off the top half of the case. The trolley-travel gear case is of the same general construction. The wiring is of the latest type, being enclosed in steel conduits. A double system of electrical and mechanical brakes is used.

* * *

FAIR PLAY IN GETTING FOREIGN BUSINESS

Gov. Curtis Guild, of Massachusetts, sounded a warning note at the "Made in America" dinner of the Pilgrim Publicity Association in Boston. "To our shame," he said, "it must be admitted that, while most Americans have seen in this awful pestilence of bloodshed an occasion for sorrow, sympathy and acts of charity and mercy, some Americans have seen in it only an opportunity to imitate the action of birds of prey. Our commercial honor is in the limelight. We shall emerge from this war either with the hate or with the love of Europe—its hate if we take a mean advantage of Europe's disadvantage, its love if, ministering to its needs, we conduct our legitimate commerce in a spirit of manliness and integrity." He cited several cases of commercial dishonesty in filling orders.

* * *

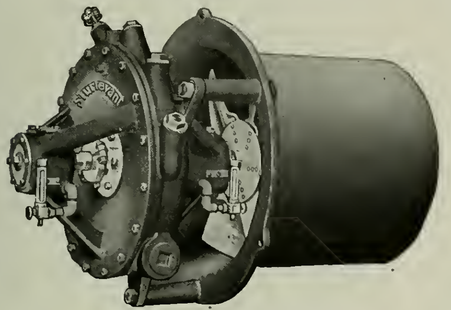
CORRECTIONS IN GRINDING ARTICLES

Errors of statement appeared in the article, "Crankshaft Grinding," August, 1914, in regard to the feed. The feed of 0.02 inch several times mentioned should obviously have read 0.002 inch. An error in regard to the hardness scale of Norton wheels was implied in the article, "Data on Surface and Cylindrical Grinding," in the December number, the implication being that an L wheel was softer than an N wheel. But the Norton hardness scale runs upward with the alphabet, and thus L wheels are softer than M and N wheels.

STURTEVANT TURBO-UNDERGRATE BLOWER

Turbo-undergrate blowers are now often employed in power plants where the chimney draft is insufficient to secure efficient combustion. Their use increases the rate of combustion and thereby increases the horsepower of the boilers, this increase ranging from 20 to 100 per cent according to conditions before the blower was installed. Additional advantages accruing from the use of turbo-undergrate blowers are that a cheaper grade of coal can be successfully burned, thus effecting an economy in the cost of fuel; and that a peak or emergency load can be carried without requiring extra boiler capacity. The blower is set in the boiler brickwork and can be easily installed without tying up the power plant.

The turbo-undergrate blower shown in the accompanying illustration is a recent addition to the line of the B. F. Sturtevant Co., Hyde Park, Boston, Mass. The turbine of this set is of practically the same design as the standard turbines built by this company. The bearings are provided with the ring-oiling system of lubrication, and the provision of a floating metallic stuffing-box makes it impossible for steam to get into the bearings. The casing is made very large which eliminates back pressure and tends to lower the steam consumption. The oil reservoir for the bearings when once filled, will last for weeks without further attention.



Sturtevant Turbo-undergrate Blower

As in other designs of Sturtevant undergrate blowers, no ball bearings are employed, as experience has shown that the heat from the steam is apt to dry out the oil in the bearings and cause the balls to crack. An ideal nozzle control is provided, there being from one to six nozzles in use, according to the amount of steam required. The fireman can shut off any number of nozzles in order to obtain just the required amount of steam, and as a result high efficiency and minimum steam consumption are made possible. These blower sets are made in four sizes which have fans 14, 18, 22 and 26 inches in diameter, respectively.

* * *

SAFETY AND SANITATION CONFERENCE

A safety and sanitation conference was held in connection with America's Second Exposition of Safety and Sanitation at the Grand Central Palace, New York City, December 14-19. Each day of the conference was devoted to various phases of a chosen topic, as follows: Municipal safety day, fire prevention day, industrial safety day, transportation day, health day and employes' day. The program comprised a large number of papers, moving picture films and other instructive means of promoting industrial safety.

The exposition included 138 distinct exhibits made by railroads, manufacturers and inventors. On Thursday, December 17, the award of commemorative, bronze, silver and gold medals and grand prizes was announced at a luncheon in Delmonicos. Prof. F. R. Hutton, in giving the names of those to whom the prizes and medals were awarded, called attention to the two classes of exhibits to which awards were made. In one class are railroads, for example, with which transportation is the main object and safety a by-product. In the other class, safety is the principal object, inventions and devices having been made whose object is directly to prevent the occurrence of accidents.

PERSONALS

A. C. Cook, sales manager of Warner & Swasey Co., Cleveland, Ohio, sailed December 5 for a European business trip.

L. M. Waite, vice-president of the Fitchburg Machine Works, Fitchburg, Mass., sailed for a European business trip December 5.

Howard C. Murphy, draftsman at the United States Armory, Springfield, Mass., has been transferred to the Naval Torpedo Station at Newport, R. I.

Frederick A. Brower has been made manager of the Oswego Machine Works' New York City business with office in the Singer Bldg., 149 Broadway, New York City.

William M. Amidon, for fifty years employed in the toolmaking department of the Millers Falls Co., Millers Falls, Mass., has retired at the age of eighty years, still in good health.

Edward Blake, Jr., formerly manager of the J. T. Slocomb Co., Providence, R. I., has bought an interest in the Erving Mills near Greenfield, Mass., manufacturers of crepe paper goods and paper napkins.

George K. Atkinson, formerly with John Steptoe Shaper Co., Cincinnati, Ohio, and later manager of the Modern Machine Tool Co., of Cincinnati, has associated himself with the Steinle Turret Machine Co., Madison, Wis.

Francis Auberty and Capt. P. Gautard, engineers representing the French government, have been in this country for some weeks placing orders for machine tools, small tools and accessories for the government arsenals of France. They expect to be here several weeks longer.

Thomas F. Fournier, formerly efficiency engineer of the American Locomotive Co., and later district engineer of the Lamson Co., has been appointed chief engineer of the Becker Milling Machine Co., Hyde Park, Mass. Mr. Fournier will also direct the sales policy of the company.

Charles G. Smith, president and general manager of the Pittsburg Emery Wheel Co., Rochester, Pa., read a paper entitled "The Increased Efficiency in Economy Obtained by the Introduction of Safety Devices in Grinding Practice" before the Detroit Foundrymen's Association, December 10.

Heinrich J. Freyn has resigned as third vice-president of H. Koppers Co., Chicago, Ill. Mr. Freyn is a member of the American Iron & Steel Institute, the American Society of Mechanical Engineers, the American Institute of Mining Engineers, etc., and resides at 5201 Harper Ave., Chicago. He has not yet announced his plans for the future.

Mrs. Frances A. W. McIntosh, formerly publicity manager of several industrial concerns, and well known in advertising circles, has resigned the position of automobile editor of the *Buffalo News*, Buffalo, N. Y., which she held for two years. Mrs. McIntosh has resumed her former work of advertising and catalogue compilation at 2200 Main St., Buffalo.

Kate Gleason, secretary and treasurer of the Gleason Works, Rochester, N. Y., has won the distinction of being the first woman admitted to the membership of the American Society of Mechanical Engineers. Miss Gleason took a mechanical engineering course in Cornell University and received practical training in the plant of her father, William Gleason, in building, estimating and selling machinery. At present she is reorganizing the Ingle Machine Co. Her specialty is designing gearing and estimating on same.

W. E. Welborne of Riga, Russia, is at present in this country in an endeavor to locate manufacturers of machine tools who wish to be actively represented in Russia. Mr. Welborne has been in this country since the latter part of October, and expects to stay here for a couple of months more. He has been instrumental in placing several large orders for machine tools with the Russian government so far, but is more desirous of establishing permanent connections with machine tool builders in this country to represent them in Russia. Mr. Welborne's address in New York is Hotel McAlpin.

* * *

OBITUARIES

Morris G. Condon, senior member of H. B. Underwood & Co., Philadelphia, Pa., died December 3.

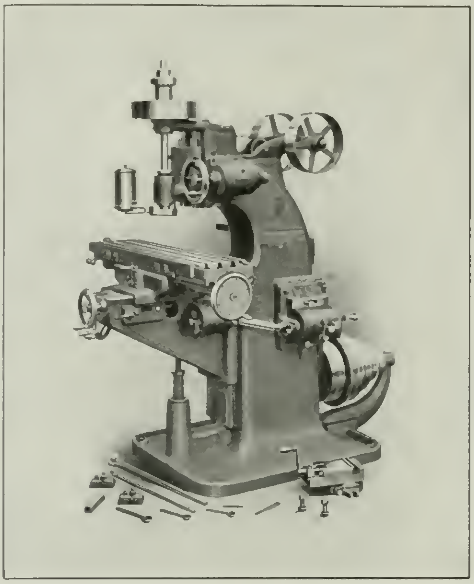
Alexander Harvey, secretary and treasurer of the Detrick & Harvey Machine Co., Baltimore, Md., died November 22.

Georges Bouillon, Paris representative of the Norton Co., Worcester, Mass., was killed in battle. Details and time of death not reported.

Lyman F. Gordon, president and treasurer of the Wyman & Gordon Co., Worcester, Mass., manufacturer of drop-forgings, died December 20, following an illness with rheumatic fever, aged fifty-three years. Mr. Gordon was born in Worcester and graduated from the Worcester Polytechnic Institute, mechanical engineering course, in 1881. In 1883 he formed a partnership with H. Winfield Wyman for the manufacture of drop-forgings. He was married in 1889 to Miss Prue Cox, and is survived by the widow and two children.

H. H. Frary, inventor of the Frary automatic wood turning lathe, died November 9 in Berlin, N. Y., aged eighty-seven

No. 1



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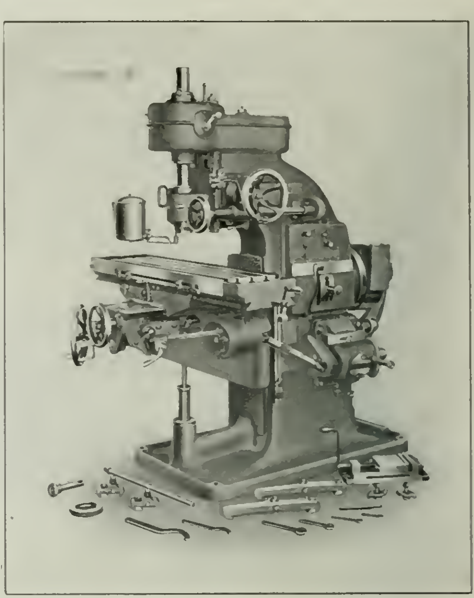


If You Do Milling This

Vertical Spindle Milling Machines can be used to advantage in most shops. Have you ever carefully considered their possibilities in your shop? Perhaps there are many jobs now done expensively and inefficiently on horizontal machines that could be done better and more quickly by vertical milling. Look around and see. For the average shop we have machines that meet requirements in vertical milling. Fine jig and die work, tool jobs, manufacturing parts of various sizes, even to the heaviest jobs usually handled in the average shop, can be done on

Brown & Sharpe Vertical Spindle Milling Machines

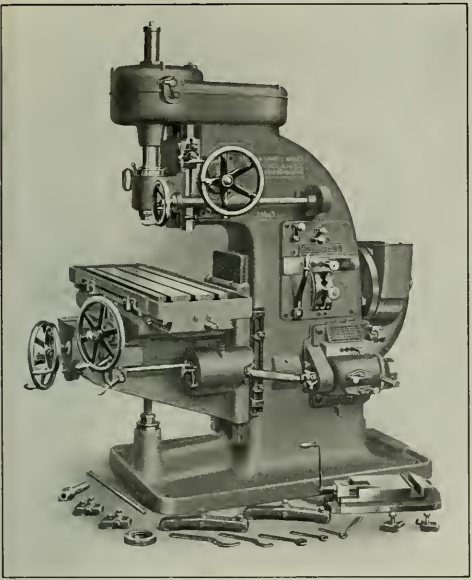
Our No. 1 machine is well adapted to fine die work, profiling, and manufacturing small pieces. It is cone driven and a series of spindle speeds ranging from 80 to 1000 R. P. M. gives a wide range of usefulness in this kind of work. Nos. 2 and 3 have a constant speed drive which furnishes ample power and adapts them to a motor drive. Sturdy design gives the necessary rigidity, and high production on medium and heavy milling is assured.

The No. 5 machine will handle work of unusual weight. The table sets solidly on the machine bed, the vertical adjustment being made by raising or lowering the entire

BROWN & SHARPE MFG. COMPANY

OFFICES: 20 Vesey St., New York, N. Y.; 654 The Bourse, Philadelphia, Pa.; 626-630 Washington Blvd., Chicago, Ill.; 305 Chamber of Commerce Bldg., Rochester, N. Y.; Room 419 University Block, Syracuse, N. Y.
REPRESENTATIVES: Baird Machinery Co., Pittsburgh, Pa., Erie, Pa.; Carey Machinery & Supply Co., Baltimore, Md.; E. A. Kinsey Co., Cincinnati, O., Indianapolis, Ind.; Pacific Tool & Supply Co., San Francisco, Cal.; Strong, Carlisle & Hammond Co., Cleveland, O., Detroit, Mich.; Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; Perine Machinery Co., Seattle, Wash.; Portland Machinery Co., Portland, Ore.

No. 3



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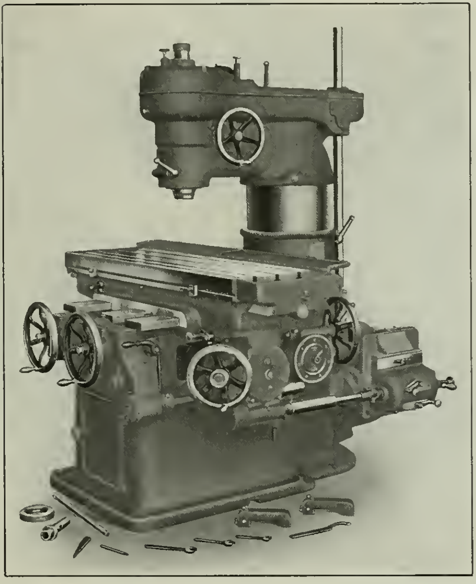

Line Will Interest You

head which can be clamped rigidly in position. Handy control so necessary to the best results in vertical milling is assured by the convenient arrangement of all operating parts. Speed and feed changes are made in the same easy, efficient manner as on our horizontal milling machines.

A consideration of the possibilities of this line will doubtless lead to a substantial reduction in your milling costs. Write for literature fully describing our line.

"Practical Treatise on Milling and Milling Machines"

Have you seen a copy of our new book? It covers the entire field of milling, and is written with the practical needs of the shop man in view. Apprentices, mechanics and shop executives will find it interesting, and valuable for reference. The construction and care of milling machines, the use of attachments, gear cutting, milling spirals, cam cutting, graduating, practical ways of doing difficult jobs, etc., are among its contents. It is a book that will broaden your knowledge of milling practice and increase your efficiency as a mechanic.

Order a copy now — 332 pages—210 illustrations
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PROVIDENCE, RHODE ISLAND, U.S.A.

CANADIAN AGENTS: The Canadian Fairbanks-Morse Co., Ltd., Montreal, Toronto, Winnipeg, Calgary, Vancouver, St. Johns, Saskatoon. **FOREIGN AGENTS:** Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow. F. G. Kretschmer & Co., Frankfurt, a/M., Germany; V. Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway; Schuchardt & Schutte, Petrograd, Russia; Fenwick Freres & Co., Paris, France; Liege, Belgium; Turin, Italy; Zurich, Switzerland; Barcelona, Spain; F. W. Horne, Tokio, Japan; L. A. Vail, Melbourne, Australia; F. L. Strong, Manila, P. I.

READ PAGE 73

years. He had invented a number of machines and devices for making and finishing rolls and knobs for wall maps, and in 1866 he became interested in trying to produce small wood turnings automatically. After many vicissitudes and much discouragement, he finally brought into existence the lathe which is the progenitor of nearly all the automatic variety wood-turning lathes of the present. Among other inventions made was that of a machine for turning wooden shuttle bobbins.

Edward C. Page, vice-president of the Page-Storms Drop Forge Co., Chicopee, Mass., died December 14, aged forty-six years. Mr. Page was prominently identified with the manufacturing business of Chicopee and Chicopee Falls. The Page-Storms Drop Forge Co., one of the largest firms making drop-forgings in Massachusetts, was founded by Mr. Page and Frank F. Storms. Mr. Page received his early education in the public schools and graduated from Williston Seminary. He then became interested in the coal and wood business in Minneapolis, Minn., and after ten years, returned to Chicopee and entered the employ of the Lamb Knitting Machine Co., where he rose to the position of superintendent. He left the Lamb Knitting Machine Co. in 1902 to form the Page-Storms Drop Forge Co., entering into partnership with Mr. Storms. Mr. Page leaves a widow and two sons.

Austin F. Cushman, president of the Cushman Chuck Co., Hartford, Conn., died November 29, aged eighty-four years. He was born in Belchertown, Mass., and in early life learned the trade of carriage maker. He afterward drifted into patternmaking and was employed in various places, the last being the Colts Patent Fire Arms Mfg. Co. of Hartford. In 1862 he began the manufacture of chucks in a small way. The business prospered and in 1872 he built the factory which is now occupied by the company. The Cushman Chuck Co. was organized in 1885 and Mr. Cushman was made president, which position he held until his death. Many years ago he began to lose his eyesight and had been practically blind for the past fifteen or twenty years. While unable to give much attention to the details of the business, he had kept in touch with it and was at all times much interested in its progress. Mr. Cushman leaves a wife and one son, Eugene L. Cushman, the present secretary and treasurer of the company.

EDWARD D. MEIER

Col. Edward D. Meier, past-president of the American Society of Mechanical Engineers, and eminent in the profession, died December 15 at the home of his daughter in New York City, aged seventy-three years. He was born in St. Louis, Mo., and received a preliminary education in the country schools and then entered the Washington University of St. Louis. He spent four years at the Royal Polytechnic College, Hanover, Germany, and returned to the United States in 1862 and began his engineering career at the Mason Locomotive Works at Taunton, Mass. In 1863 he enlisted in the Union Army and remained in service until the close of the war in 1865. After the war he spent a year as machinist and draftsman at Rogers Locomotive Works in Paterson, N. J., and from 1867 to 1870 he was assistant superintendent and later general superintendent of the Kansas Pacific Ry. During the seventies he was engaged as a consulting mechanical engineer in the designing and building of machinery. In 1882 he began the development of the well-known Heine type of water tube boiler, and from 1885 until his death he was president and chief engineer of the Heine Safety Boiler Co. He was active in the promotion of the Diesel oil engine in the United States, being the first to call the attention of the American mechanical public to the high efficiency of this type of internal combustion engine. Col. Meier was elected president of the American Society of Mechanical Engineers in 1910. He was prominent in the joint meeting of the American Society of Mechanical Engineers and the Verein Deutscher Ingenieure in Germany in 1913, being chairman and spokesman of the party.

CHARLES A. MOORE

Charles A. Moore

Charles A. Moore, president of Manning, Maxwell & Moore, Inc., New York City, died of heart disease on the steamer *Rotterdam* bound for Naples, December 8. Mr. Moore was born in West Sparta, N. Y., September 19, 1845, and educated in Massachusetts. During the Civil War, he enlisted in the Navy and served from 1862 to 1865. At the close of the war, he went into manufacturing in New England with characteristic push and enterprise. Mr. Moore was gifted with great energy and with a magnetic personality and kindly manner, which made him hosts of friends and contributed in no small measure to his great business success. Fifteen years of his early life were spent in New England and then he came to New York City, which offered larger opportunities to ambitious business men. The firm of Manning, Maxwell & Moore, familiarly known in the trade as the three M's, is a noteworthy one. Established in 1873 as H. S. Manning & Co., which title was changed in 1881 to Manning, Maxwell & Moore, the growth of the business has been steady and constant until it is now one of the largest of its kind in the world, with branches in all the principal cities in this country and Europe, controlling the Ashcroft Mfg. Co., Consolidated Safety Valve Co., Hayden & Derby Co., Hancock Inspirator Co., Shaw Electric Crane Co. and the United Injector Co. On the death of Mr. Maxwell, one of the original partners, about twenty years ago, his interest was taken up by his associates, and on the retirement of Mr. Henry S. Manning in 1905 his interest in the firm and its allied companies was sold to Mr. Moore, the sale having been arranged entirely by the two men principally interested, after a partnership of thirty-two years, without taking an inventory. Mr. Moore was one of the most widely known men in the machinery industry, but his interests were not limited to that field, as he also had a large acquaintance in railway, social and political circles. President McKinley and Senator Hanna were among his personal friends, and it is said that the former offered him a position in the Cabinet at his first election. Mr. Moore was a man of strong individuality and great energy; and while credit should be given to Mr. Manning's business ability and to the almost unlimited financial backing of his associates, the success of the firm was largely due to Mr. Moore's individual efforts. For the past four years Mr. Moore had suffered from heart trouble, and while he had not actually retired from the management of his large business interests he gave little attention to them.

* * *

FAKE WAR ORDER BUYERS

One product of the European war is a crowd of fake "buyers" of war supplies and material, who are using up the time of many of our manufacturers. Some of these "buyers" are simply irresponsible people who think they see an opportunity to make money out of the demand for war material, and others are plain gold-brick men. We advise all manufacturers to obtain sufficient cash with any war orders from unknown parties before the order is put in hand, and to get the rest of the money on delivery. This does not apply to legitimate machinery dealers here and in Europe, whose requirements merit careful attention.

* * *

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC.

of MACHINERY, published monthly at New York City, required by the Act of August 24, 1912.

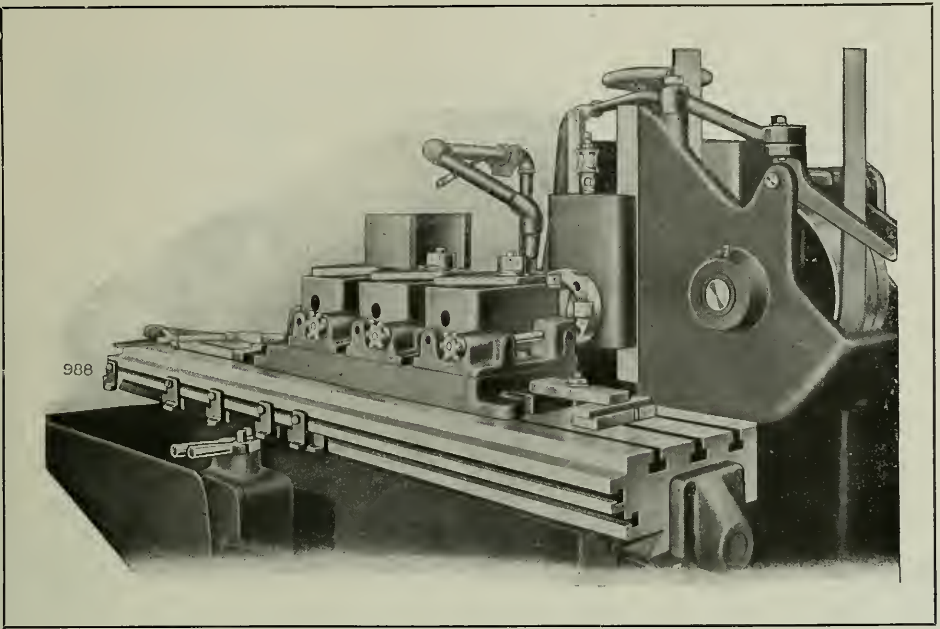
Editor, Fred E. Rogers	140-148 Lafayette St., New York
Managing Editor, None	
Business { Alexander Luchars, President	" " " " "
Managers { M. J. O'Neill, General Manager	" " " " "
Publisher, The Industrial Press	" " " " "
Owners of one per cent or more of the stock:	
The Industrial Press	" " " " "
Alexander Luchars	" " " " "
Matthew J. O'Neill	" " " " "
Fred E. Rogers	" " " " "
Louis Pelletier	" " " " "
H. L. Brown	" " " " "
Erik Oberg	" " " " "

There are no bondholders, mortgagees or other security holders.

MATTHEW J. O'NEILL, General Manager.

Sworn to and subscribed before me this 30th day of September, 1914.

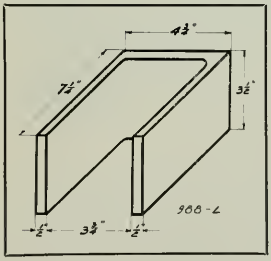
HARRY D. HEALEY,
Notary Public No. 84, Kings County,
Certificate filed in New York County No. 74
(SEAL.) (My commission expires March 30, 1916.)



Make the Cutter Jump the Gaps

ON the ordinary miller, on a job like this, time is wasted cutting air that could profitably be spent in milling. Further, the table has to be returned by hand, wasting more time and the operator's strength.

The Cincinnati Semi-Automatic handles these pieces differently. The cutter is 5″ diameter, runs 61 R. P. M., removing ¼″ stock of tough steel. The cutting feed is 2″ per minute. The gaps are automatically jumped at 102″ per minute. At the end of its travel, the table automatically returns to the starting point at 100″ per minute, and stops ready for the operator to re-chuck, saving time and operator's strength. Running two machines, one operator mills 520 pieces in 10 hours.



Let us show you how the patented features of Intermittent Feed, Power Quick Traverse, Automatic Reverse, and Power Quick Return of Cincinnati Semi-Automatic Millers will reduce your milling costs. Special catalog gives details.

The
Cincinnati Milling
Machine Company
Cincinnati, Ohio, U. S. A.

COMING EVENTS

January 5-7.—Annual meeting of the Society of Automobile Engineers in New York City. Headquarters, Engineering Societies Bldg., 29 W. 39th St. Coker F. Clarkson, secretary, 1790 Broadway, New York City.

January 21-22.—Second National Foreign Trade Convention, in St. Louis, Mo.; object: "Greater prosperity through greater foreign trade." R. H. Patchin, secretary, 64 Stone St., New York City.

March 6-13.—"Made in the U. S. A." Industrial Exposition in Grand Central Palace, New York City. Harry A. Cochrane, manager, National Exposition Co., 200 Fifth Ave., New York City. The "Made in the U. S. A." exposition is being promoted to stimulate American trade with domestic and foreign buyers and to educate the American consuming public regarding American resources.

April 24-May 1.—Second Efficiency Exposition at the Grand Central Palace, New York City. Organized by the Efficiency Society, Inc., 41 Park Row, New York City.

June 9-11.—Annual convention of the American Railway Master Mechanics Association, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

June 14-16.—Master Car Builders' annual convention, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

SOCIETIES, SCHOOLS AND COLLEGES

Massachusetts Institute of Technology, Cambridge, Mass. Catalogue of officers and students, with a statement of the requirements for admission and a description of the courses of instruction.

Pratt Institute, Ryerson St., Brooklyn, N. Y. The notice in the December number on page 348 calling attention to the free working library might have conveyed the impression that it is limited to 1200 books. The library contains over 100,000 books. The circular referred to the applied science room only, this being one of several reference and reading rooms in the library.

Society for Electrical Development, Inc., 29 W. 39th St., New York City, which has been organized for the purpose of promoting the use of electricity in the industries and the home, has issued two booklets entitled, "Household Electricity" and "Electricity in the Home," illustrating the great variety of electric devices on the market, designed to reduce the work of the housewife.

University of Illinois, Urbana, Ill. Circular of the research fellowships in the Engineering Experiment Station. Ten research fellowships have been established, for each of which there is an annual stipend of $500. Four of these were vacated with the close of 1914. Nominations to fellowships, accompanied by assignments to special departments of the Engineering Experiment Station, are made from applications received by the director of the station each year not later than February 1.

NEW BOOKS AND PAMPHLETS

The Water Power Problem in the United States. By Rome G. Brown. 33 pages, 6 by 9 inches. Reprinted from the "Yale Law Journal," November, 1914.

Johnson's New Handy Manual on Plumbing, Heating, Ventilating and Mechanical Refrigeration. By John W. Johnson. 380 pages, 4 by 6½ inches. Published by the author, 850 Cass St., Chicago, Ill. Price by mail, $1.05.

This book, which has passed into the seventh edition, is made of a convenient size to carry in the pocket and is intended for practical everyday use by all classes of mechanics for which it is intended. It is profusely illustrated with diagrams to make the meaning of the text clear; it is devoted chiefly to plumbing, heating, ventilating and refrigerating work and hence has to do largely with piping systems of all sorts.

Casehardening. 47 pages, 6 by 9 inches. 15 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

This book, which is No. 141 of MACHINERY'S Reference Books, contains a complete review of modern casehardening practice, dealing first with the subject in a general way, and then specifically taking up the casehardening practice in the bicycle, automobile and allied trades, the carbonization of shafting and the casehardening of roller bearing parts. One chapter of the book is devoted to new casehardening methods using carbonaceous gas for hardening instead of the usual packing materials. Important chapters to this book have been contributed by Robert H. Grant, the well known ball bearing expert, and F. F. Lake, consulting metallurgist and specialist on steel and its treatment.

Proceedings of Thirteenth Annual Convention of National Machine Tool Builders' Association. Held in New York City October 22 and 23, 1914. Charles E. Hildreth, general manager, Worcester, Mass. 170 pages, 5¾ by 8¾ inches.

The proceedings appear in the usual attractive form. They comprise several general and technical papers and discussions of permanent value as follows: "Establishment of American Banking Facilities in South America," by H. R. Eldridge, vice-president of the National City Bank, New York City; "Reform in Drawing," by E. H. Fish, Worcester, Mass.; "Waste in Hiring and Discharging Employes," by Magnus W. Alexander of the General Electric Co., West Lynn, Mass.; "A Closer Commercial Relationship with Latin America," by James Logan, general manager of the United States Envelope Co., Worcester, Mass. The membership of the association listed is 158.

Machine Shop Practice. By William J. Kaup. 199 pages, 5 by 7½ inches. 163 illustrations. Published by John Wiley & Sons, Inc., New York City. Price, $1.25 net.

This is a manual for apprentices and journeymen machinists, and is intended especially for use in trade, technical and industrial schools. It is a revision of the author's work first published in 1911, the revision of the original work having been made for the purpose of making it more suitable as a school text and uniform with the Wiley technical series. It treats of chipping, filing, scraping, hand-tools, materials of construction, drill presses, planer and shaper practice, lathe practice, cutting tools, boring tools, milling machines, measuring instruments, gearing, grinding, tool steel and system. Each chapter concludes with a number of questions based on the preceding text.

Elementary Algebra. By Erik Oberg. 40 pages, 6 by 9 inches. Published by the Industrial Press, New York City. Price, 25 cents.

This book, which is No. 138 of MACHINERY'S Reference Books, may be said to be a practical treatise on the use of formulas, and the solving of mathematical problems by equations. The subject is in five chapters: The Use of Formulas; The Use of Equations in Solving Problems; Principles of Algebra; Equations of the First Degree and their Application to Mathematical Problems; Quadratic Equations and their Application to the Solving of Problems. The book is intended to make it possible for anyone with a knowledge of ordinary arithmetic to acquire rapidly and without a teacher the fundamental principles involved in the use of algebraic formulas and equations. The subject is treated in the most simple manner possible and only the essentials have been included. Mathematical discussions of merely theoretical interest have been eliminated and the book, therefore, should meet the requirements of men in practical work who desire to obtain a general knowledge of the subject of formulas and equations.

Safeguards for Machine Tools and Power Presses. 56 pages, 6 by 9 inches. 57 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

The prevention of accidents in the industries is a subject which, of late, has been given a great deal of attention by prominent engineers, engineering societies, and well-known manufacturing companies. The books on machine design in the past have given no information relating to the design of safety appliances. A book treating on this subject and containing, in addition, suggestions for preventing accidents, and rules for avoiding injuries should be welcomed by many. The book under review, which is No. 140 of MACHINERY'S Reference Books, contains five chapters headed as follows: Industrial Accidents and their Causes; Safety Devices for Machine Tools; Safeguards for Grinding Wheels; Safeguards for Power Presses; Rules for the Prevention of Accidents. The rules for the prevention of accidents are divided into suggestions and rules for the shop management and rules for employes. These have been collected from many sources, and contain many valuable hints and pointers relating to the safe operation of machinery in shops.

American Export Trade Directory for 1915. 369 pages, 6 by 9 inches. Published by the "American Exporter," 17 Battery Place, New York City. Price, $3.

This directory will be found especially valuable to American manufacturers who are looking at this time for new avenues to foreign trade. It is something more than a mere directory of names, containing information not readily obtainable by the manufacturer who wishes to know the facilities available for handling shipping and financing foreign orders. It makes known the fact that there are in New York City alone no less than seventy-three banking houses dealing in foreign exchange as a specialty. It lists 180 offices in New York City of foreign concerns or merchants. In addition, there are in this city no less than 605 export commission houses doing business with all parts of the world in manufactured articles and general products in the United States. The countries with which each of these concerns does business and the kinds of commodities in which each house deals chiefly are also given. Valuable information is given in regard to steamship lines in foreign service sailing from various American ports. No less than ninety-four American lines are listed as plying from New York to all parts of the world.

American Handbook for Electrical Engineers. Compiled by a staff of specialists under the direction of Harold Pender. 2023 pages, 4¼ by 7 inches. Published by John Wiley & Sons, New York City. Price, $5.

This handbook deals with the subject of electrical engineering and such phases of mechanical and civil engineering as are closely related to electrical engineering practice. In the preparation of this book, an interesting innovation has been made. The subjects dealt with in the book have been arranged alphabetically, and in this way it has been possible to segregate the theoretical discussions from the more practical matter, the handbook having been prepared primarily for the practicing engineer. Hence, in the sections dealing with practical matters only, just so much theory is included as to indicate the general principles. The range of subjects treated is wide, and while the handbook is primarily for electrical engineers, the method of treatment adopted is such as to make the book useful for reference also for mechanical, civil and mining engineers who have occasion to utilize any of the numerous applications of electricity in their special fields. Considerable space has been devoted to matters pertaining to applications of motors in all branches of modern industry. Numerous mathematical tables are also contained and the mathematical sections are clear and concise, the tables are well arranged, and the typographical appearance is a considerable improvement on most handbooks of the past. It is impossible to give an adequate idea of the contents on account of the fact that the subjects are arranged alphabetically, there being hundreds of sections, but it is certain that it is a book which will prove valuable to every electrical engineer and to all others who have to do with the applications of electrical machinery in the industries. As an indication of the wide scope of the handbook, it may be mentioned, however, that the following topics are covered by numerous articles: Mathematics; engineering materials; electricity and magnetism, principles and phenomena; batteries; laboratory instruments and apparatus; commercial electric instruments and apparatus; miscellaneous measuring instruments and apparatus; magnetic and dielectric testing; electric machinery and induction apparatus; control and protective apparatus; miscellaneous electric apparatus and their application; power stations; distribution and transmission; traction; photometry and illumination; industrial applications of electricity; telegraphy and telephony; electrochemistry; mechanical engineering; structural engineering; heat and steam engineering; hydraulic engineering; units, abbreviations and symbols.

NEW CATALOGUES AND CIRCULARS

Federal Name Plate & Novelty Co., 732 Federal St., Chicago, Ill. Circular of "New Process" name-plates made with raised letters and basket-weave pattern backgrounds.

Dalton Machine Co., Inc., 79 E. 130th St., New York City. Circular on the Dalton six-inch metal-working bench lathe supplied with or without column, and for foot power or electric drive.

American Die & Tool Co., Reading, Pa. Small catalogue of punches, dies, tools, etc., for bridge builders, structural iron workers, boiler makers, ship and car builders, automobile manufacturers, etc.

Joseph Dixon Crucible Co., Jersey City, N. J. Mailing card in the form of a barrel, advertising Dixon boiler graphite. The claim is made that boiler graphite reduces fuel consumption, prevents the hardening of scale, and preserves the interior of boilers.

Cincinnati Lathe & Tool Co., Oakley, Cincinnati, Ohio. Circular of the "F-P-M" turret tool-holder for lathes. This turret tool-holder differs from others in that no separate tool-holders are required for small tool bits, the bits being mounted in the turret itself and secured by set-screws.

Industrial Instrument Co., Foxboro, Mass. Bulletins 86 and 91 treating of "Foxboro" differential recording gages and orifice meters for gas, and Foxboro thermometers and thermographs, respectively. Descriptions of these instruments are given, together with reproduction of representative charts obtained by them.

Stow Mfg. Co., Binghamton, N. Y. Circular showing a number of the portable tools made by this company, among which are two-spindle drill, electric breast drill, universal drill, radial flexible boring machine, "Gee Whizz" machine for light drilling, boring, emery grinding, buffing, etc., tool-post grinder and electric hand buffer.

Eclipse Machine Co., Elmira, N. Y. Leaflet descriptive of the "Eclipse" roller bearing drill chuck that provides for an easy grip and insures against the drills slipping. The chucks are made in three sizes with capacities of 0 to 3/16, 0 to 3/8 and 0 to 17/32 inch, respectively. Price lists of the chucks and their separate parts are included.

Harding Distributing Co., Boston, Mass. Catalogue on the "Martell" aligning reamer, a reamer intended for scraping automobile crankshaft bearings. By means of this tool, bearings can be scraped so as to insure absolute alignment in a very short length of time. Bearings of motors can be reamed without removing the motor from the car.

T. A. Willson & Co., Inc., Reading, Pa. Catalogue of shop protection glasses. This catalogue was worked up with the idea of being helpful to men who are up against the problem of selecting proper eye protection glasses. It shows which styles are best suited to different kinds of work, the information being based on a study of actual shop conditions. Under separate headings, the styles most suitable for grinders, machinists, chippers, welders, etc., are suggested.

High-Speed Hammer Co., Rochester, N. Y. Loose-leaf catalogue containing specifications for the riveting machines made by this company, and instructions for operating them. These machines are built with bench base for light work and with pedestal base for average and heavy work. All the styles and sizes can be equipped with motor drive.

American Boiler Life Co., 10 N. Market St., Boston, Mass., is issuing a booklet entitled "Steam Boilers and Boiler Feed Water" that gives in simple, clear language useful suggestions for the care of steam boilers, founded on the experience of the company. The book has been carefully prepared and should be of interest to those in charge of steam boilers.

FEBRUARY MACHINERY 1915

Electric Butt Welding Development

by

Douglas T. Hamilton

THE application of electrical energy has been the subject of more patent specifications than any other one thing, and it has formed the basis upon which some of the greatest manufacturing industries in the world have been built up. One of the many uses of electrical energy directly connected with the metal-working trade is electric welding. But although this kind of welding has been in use for almost twenty-five years, its many advantages have not, until the last few years, been as fully appreciated by the metal-working industry as its general adaptability would seem to warrant.

The first practical electric welding machine was patented by Dr. Elihu Thomson, the father of this art, in 1886. This machine was the culmination of a long series of experiments that started early in 1877.

The Principle of the Electric Welding Process

The principle of electric welding is extremely simple. An electric current of low voltage and comparatively high amperage is employed to fuse or soften the metal at the point of contact, and at the same time pressure is applied to force the particles of the molten metal together. The process is based on the well-known principle that a poor conductor of electricity will offer so much resistance to the flow of an electric current that it will heat, the degree of heat depending upon the volume of current and the resistance of the conductor. In the electric welding machine, a copper conductor carries the current with very little resistance, but as soon as a piece of iron or other metal is placed in the circuit it immediately becomes heated. If the volume of current or amperage is large, and the iron conductor much smaller in cross-sectional area than the copper, the iron will quickly become hot enough to melt. This principle is well illustrated in an incandescent lamp; the copper wires leading to the lamp are good conductors of the electric current, and remain cool, whereas the carbon filament is a poor conductor and becomes so hot that it reaches a state of incandescence.

The pieces to be welded together in an electric welding machine, when clamped in position, complete an electrical circuit which is inadequate to carry the heavy current passing through them without heating. As the heat of the metal increases, the resistance also increases, and the union or weld is thereby accelerated, but the volume of current is decreased.

For information previously published on electric welding, see "Electric Arc Welding" in the July, 1914, number of MACHINERY and articles there referred to.

In other words, as the temperature increases, the current volume usually decreases, a greater volume of current being used at the beginning than at the end of the heating. The heat is confined to the metal between the jaws and a welding heat is reached so quickly that there is very little time for the wasting of current by radiation or conduction. Therefore, practically all the heat is consumed in useful work and the pieces, not having been heated except at the joint, are not distorted or discolored. The chief point that distinguishes electric resistance welding from all other processes is the fact that the heat is generated uniformly in the section being heated, that is, the heat is not applied to the exterior and conducted into the interior. Absolute control is obtained by means of apparatus which will be described later, and the pieces being heated are in full view of the operator so that the action that takes place is always under observation. In this way any trouble caused by uneven contact of the pieces, rust or scale, which will cause the pieces to heat unevenly with a tendency to burn at one or more points, can be controlled instantly until radiation, or conduction, restores the uniformity. Varying temperatures can be obtained and retained for any length of time, and as a rule no flux is required.

Early Developments of the Electric Welding Art

Although the first idea of the possibilities of joining metals by means of an electric current was conceived early in 1877, it was several years later before Dr. Thomson had time to do anything definite in regard to designing and building apparatus for handling the work. It was not until the plant of the Thomson-Houston Co. was removed from Philadelphia to New Britain, Conn., that an idea for a welding transformer was actually put into shape. This, however, was not put into practice until the manufacturing establishment previously mentioned was moved to Lynn, Mass., which was accomplished in the fall of 1883. In the time intervening between 1883 and 1885 Dr. Thomson started to make a welding apparatus in accordance with the plans of years before. At this time he had at his command an alternating-current dynamo which he had built, and he constructed a welding transformer with welding clamps or holders for the pieces to be welded.

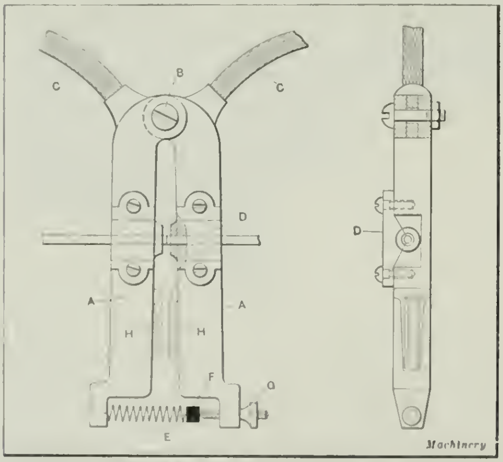


Fig. 1. First Practical Electric Welding Device patented by Dr. Elihu Thomson in 1886

The original experiments were made in the winter of 1885 and 1886, and a larger machine was soon after built.

The first device for electric welding, patented August 10, 1886, is shown in Fig. 1. Referring to this illustration, it will be seen that the apparatus consisted of two arms or clamp-holding bars A, one of which was movable and swung on a joint *B* which when the arms were made from a metallic substance, was insulated by interposing washers and a tube of insulating material, allowing a free movement of the arms but no passage of the current. Heavy cables *C* which preferably were many times the section of the wire to be joined, connected the arms, respectively, with the terminals of the apparatus for carrying the current. The work was held in place by means of clamps *D*, which held it firmly with its abutting ends projecting as shown. The edges of these clamps were countersunk or rounded out so as to leave the small portion in which the metal could upset.

The mechanism for bringing the work into contact as it heated was the spring *E* insulated by a block or insulator *F*, which was acted upon by the screw *G*. Additional means, such as heavy copper contacts *H*, were sometimes provided which automatically connected the arms for the passage of the electric current through them, after the joint between the two wires had been made, and in this way conducted the heat through the body of metal in the arms and removed it from the metals in contact to prevent excessive fusing.

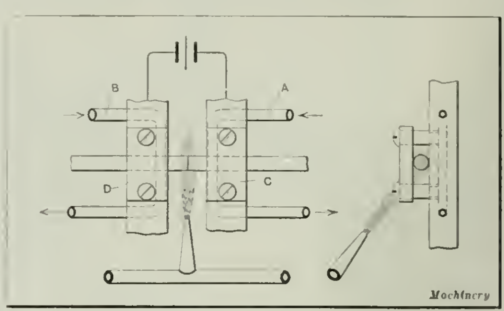


Fig. 2. First Device patented in connection with an Electric Welding Machine for cooling Clamping Jaws

There were several modifications of the arrangement shown in Fig. 1, one of which was to extend the arms *A* down slightly farther and form on the lower ends handles so that the apparatus could be gripped by the hands and the rods brought into contact in this manner, instead of by spring action. Still another arrangement was to place the jaws or clamping arms in a horizontal position, extend one arm out farther than the other, and on this place a weight similar to a beam scale. In this way the metals to be welded were brought into contact by means of the weight which was adjustable along one of the arms. In addition to the methods just described, an apparatus was also built so that the metals to be joined instead of being held in a horizontal position were located vertically and the movable member was arranged in a slide, doing away with the swinging joints of the arms and bringing the metals into contact by means of gravity. With this first apparatus a great variety of trials were made, and some of the results of the work were put into actual use in the works of the Thomson-Houston Electric Co., Lynn, Mass. Wires were joined end to end, steel tools were welded, etc., and one of the earliest applications was the lengthening out of auger bits. This was done by cutting off the square ends from the auger twist and substituting a steel bar of the desired length. Drills were lengthened in the same way, and innumerable demonstrations were made to show the capabilities of electric welding for doing this kind of work.

With this first device it will be seen that no means at all was provided for cooling the clamping jaws, which on heavy work requiring heavy currents soon became heated unless it had sufficient mass to conduct the heat away. This, however, had already been provided for and was covered in another patent taken out at the same time as the previous one, the details of which are shown in Fig. 2. Referring to this illustration, it will be seen that water pipes *A* and *B* were arranged to pass through the clamping jaws *C* and *D*, this arrangement being advantageously used in welding large masses of metal or where the metal to be welded is a good conductor of the electric current, such as copper, etc. Where the pieces to be joined were of unequal size, a torch as shown in the illustration was brought into use, and where the pieces were of the same metal, the flame was applied to the one having the larger section in order to compensate for the difference in heating. This modification of the apparatus was used for welding bars of unequal section, or T-welding, and similar work, which in apparatus of today is done without the torch, and is handled by using different arrangements of the clamping jaws or double transformers.

A means of controlling the current passing through the electrical apparatus for welding was also patented in 1886, and is shown diagrammatically in Fig. 3. This device provides a means for regulating the source of electric current by means of an induction apparatus. In addition this patent also covered improved methods of clamping the work. In Fig. 3, *A* and *B* are the wires which lead from the source of alternating current supply to the coil of insulated wire *C* wound around a ring-shaped iron core *D*. The coil *C* had a number of turns depending on the electromotive force and current that supplied it, and its convolutions depended usually upon the average electromotive force and current strength. The connection between *A*, *B* and *D* was made so that a variable resistance *E* could be inserted in greater or less amount so as to vary the force of the primary circuit current in the coil *C*. The switch *G* was arranged to permit breaking the circuit at will. Around the iron core *D* was wound a few turns of heavy copper cables *H*, giving an almost inappreciable electric current resistance. The ends of the secondary coil were attached to each one of the clamp bearing arms *I* which were also made of a good conducting metal. These were so placed and guided as to have only a slight movement toward and from each other. To provide for this, an insulated flexible plate *J* was used in conjunction with an insulated screw *K* which controlled the movement of the arms. A nut and compression spring shown at the lower end of the clamping jaws permitted the drawing of the arms together as the work approached the welding heat.

In order to manipulate the clamping jaws rapidly they were made as shown to the left of the illustration. The jaws *L* were hinged as shown, and arranged to be set or clamped by means of a movable clamping screw swinging in the frame. The dotted and full lines show the position of these parts relative to each other when clamped and released. The bore of the clamping jaws was made nearly equal to the dimensions of the bar to be clamped, and was countersunk on the inner surface to allow for the excess metal flaring out. The core and primary coil were made in several different arrangements, but the diagram shows the apparatus in its simplest form and the type which was first adopted.

Possibilities of Electric Welding

The applicability of electric welding to the metal-working industry was not realized as soon as its possibilities would seem to have merited, so that a considerable portion of the life of the patents previously described passed by without much extension of the process. At the same time there were false ideas in vogue as to the natural use of electric welding. Exaggerated notions existed and in many cases it was too conservative an attitude which prevented the immediate use of this art. Perhaps the greatest help to the application of electrical processes generally, including electric welding, has been the great extension in recent years of stations for generating and transmitting electrical energy. At the same time, electric welding has extended into many fields and given rise to special industries which are based upon it, so that at the present time this art is made practical use of in many of the important metal-working industries of the world.

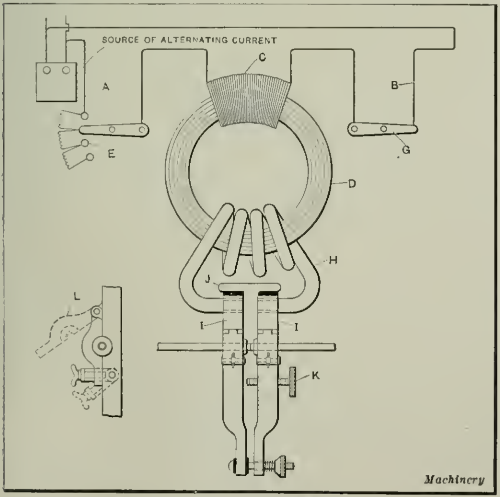


Fig. 3. Means for controlling and regulating Current and Improved Method of clamping Work

When the art was first conceived, however, it was not quickly taken up, although after the first experiments practically no extended experimentation was needed. The process as originally applied and developed was carried on extensively without change in its nature. There have, of course, been improved designs of apparatus and improved construction of welding transformers adapted to particular uses, but a great deal of this work was foreseen from the start and in many cases was provided for. It may also be mentioned, as a matter of history, that since the original patents of electric welding were taken out by Dr. Thomson, there have been a large number—over 150—of patents taken out by the Thomson Electric Welding Co., under which it is now manufacturing its welding apparatus. Patents have been also taken out by a number of other firms and men engaged in this industry, and in fact, the patent records at the present time contain more literature on this subject than is anywhere else available.

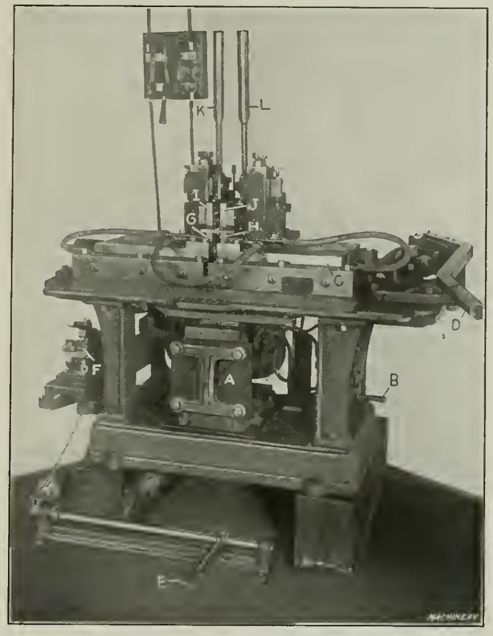


Fig. 4. One of the Latest Electric Butt-welding Machines built by the Thomson Electric Welding Co.

Metals that can be Electrically Welded

Practically all of the metals can be electrically welded as well as all sorts of steel and many of the alloys. In addition, many combinations like high-carbon steel and mild steel, nickel and brass, brass and platinum, etc., cast steel and machine steel and many others, can be handled in this manner. The accompanying table gives a condensed list of the metals, alloys and combinations of metals and alloys that can be electrically butt-welded. Many combinations not given in this table can be welded, but require special apparatus for the purpose. In the last ten years there has been a great development in the manufacture of sheet metal articles and the electric spot-welding art has been found to be much cheaper and better than riveting, especially with the lighter gages of metal. This feature of electric welding will be taken up in a separate article.

Different Applications of Electric Welding

In order to unite different shaped pieces by electric welding machines, it is evident that various types of apparatus had to be devised to handle the work expeditiously and satisfactorily. The process of electric welding has, therefore, been divided into several distinct applications: *viz.*, butt-welding, in which the metals are presented end to end; T- and angle-welding, in which the metal takes the form of the letter T or L; cross-welding, in which the metal is presented in the form of a cross or X; lap-welding, in which the sheets of metal are overlapped, and squeezed or mashed together; seam-welding, either by abutting or overlapping the edges of sheet metal; spot-welding, which instead of riveting metal together joins it by means of an electrically welded spot, one or more spots being welded at a time; point-welding, or projection welding, the joining of metal surfaces by a raised point or projections in which the current is confined or concentrated and the welding takes place only at these points, this process usually being employed in the manufacture of sheet metal; ridge-welding, a slight modification of the point method, in which the current is concentrated by means of a ridge instead of a point, across which a weld is made; upsetting which consists in heating work and then upsetting it to form collars or the like; heating blanks for forgings; bending and working, as well as hardening and annealing; and percussion-welding, especially applicable to the joining of very small wires of the same or different metals. This is a new process and is one of the latest developments in the art. It will be described fully in a separate article.

The Electric Welding Machine

The electric welding machine, although made in several different types, is primarily a mechanical device for transforming an electrical current from high to low voltage and carrying it to copper contact points or jaws. It consists essentially of a transformer, clamping device and a pressure device. Although it is possible to give the transformer a different location from that of the other two mechanical elements, it is rarely done, and most commercial welding machines embody all three elements in the same structure. There are, of course, many special departures from this general form. The mechanical and electrical control may be operated by hand or foot, semi-automatically or automatically. For welding small work, such as wire, spring pressure in forming the weld is usually employed, and the clamping is either by hand or by power. For metals like copper and brass, a weight pressure is usually best. For round and similar sections up to ¾ inch, hand pressures are usually employed. On larger sections hydraulic pressure or pressure obtained through self-contained oil jacks is used.

The butt-welding machine derives its name from the operations accomplished by it. Two pieces of round, square or rectangular shaped stock are placed in the clamping jaws with only ⅛ to ½ inch of metal extending beyond the jaws. The ends of the metal touch each other, and as soon as the electric current is turned on, the abutting ends immediately begin to heat. When the welding temperature is reached, the jaws are brought together by operating a lever, or other mechanical means, and the two ends of the partially molten metal are thus united. Electric welding machines are necessarily more or less special in the construction of their clamps and electrodes, no one machine being suitable for a great variety of sizes or forms of work. Some machines are entirely special and suitable only for the work for which they were built, some are semi-automatic in their operation, requiring the operator only to put in and take out the pieces, while other machines are entirely automatic, the clamping, pressure for welding, and controlling of the current being handled automatically. In addition to butt-welding, several other operations such as T-welding, jump-welding, cross-welding and upsetting can be performed on a butt-welding machine by employing various arrangements of the clamping jaws, as will be described later.

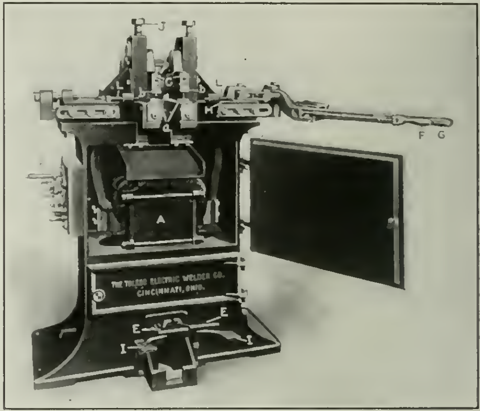


Fig. 5. Butt-welding Machine built by the Toledo Electric Welder Co., Cincinnati

A typical butt-welding machine that embodies all the principles mentioned, and is built by the Thomson Electric Welding Co., Lynn, Mass., is shown in Fig. 4. Referring to this illustration, it will be seen that the transformer *A* is mounted on the base of the machine. The primary coils of the transformer are connected to an alternating-current supply which is regulated by the regulator *B*, and a secondary winding delivers an output of very low voltage (about three to five volts) but heavy amperage to the connecting leads running from the transformer to the clamping jaws. On account of the low voltage required, the secondary windings have the form of a solid copper casting extending through the laminated iron core. The secondary leads are built up of a large number of thin copper strips to afford the necessary flexibility to the motion of the clamping jaws.

METALS, ALLOYS AND COMBINATIONS OF METALS THAT CAN BE ELECTRICALLY BUTT-WELDED

(Thomson Electric Welding Co.)

Metals	Alloys	Combinations of Metals and Alloys
Aluminum	Aluminum Brass	Aluminum to Copper, Brass
Antimony	Aluminum Bronze	Brass to Copper, German Silver, Mild Steel, Wrought Iron, Platinum, Tin
Bismuth	Aluminum Alloyed with Iron	Copper (Cast) to Brass, Galvanized Iron, Wrought Iron, Steel
Cobalt	Brass (Composition)	Copper (Wrought) to Brass, German Silver, Gold, Silver
Copper (Wrought)	Brass (Wrought)	German Silver to Brass, Copper, Gold, Wrought Iron
Gold (Pure)	Bronze (Phosphor)	Gold to Copper, German Silver, Platinum, Silver
Iron (Cast)	Bronze (Silicon)	Iron (Wrought) to Brass, Cast Brass, Cast Steel, Crescent Steel, German Silver
Iron (Wrought)	Fuse Metal	Lead to Tin
Lead	German Silver	Mild Steel to Mushet Steel, Nickel, Stubbs Steel, Tool Steel
Manganese	Gold (Various Alloys of)	Monel Metal to Brass, Galvanized Iron, Wrought Iron
Nickel	Gun Metal	Nickel to Wrought Iron
Platinum	Monel Metal	Platinum to Brass, Gold, Silver, Steel
Silver	Silver (Coin)	Silver to Copper, Gold, Platinum
Tin	Solder Metal	Steel (Mild or Machinery) to Brass, Nickel Steel, Platinum, Tool Steel, Wrought Iron
Zinc	Steel (Alloy)	Steel (Tool) to Mild Steel, Platinum, Wrought Iron
	Steel (Mild or Machinery)	Tin to Brass, Lead, Zinc
	Steel Castings	Zinc to Tin
	Tool Steel (All Grades)	
	Type Metal	

Machinery

The platen *C* moves on ball bearings and the pressure for bringing the two pieces of metal into contact when they have been heated is effected by means of the lever *D* shown at the right. The current is shut off by means of the brake switch operated by the treadle *E*, the switch *F* being located at the left-hand end of the machine. In order to keep the current-carrying members of the machine cool, water is circulated through the secondary terminals and electrodes. The two lower clamping jaws *G* and *H* are held rigidly to the platens of the machine, and when the machine has once been set for certain classes of work, the right-hand platen only is given a movement by means of the toggle-joint lever at the right. The two upper clamping jaws *I* and *J* are brought into and out of contact with the parts being welded by means of the levers *K* and *L*, which operate eccentrics in the head. This particular electric welding machine has a 30-kilowatt capacity, and is capable of handling work up to 1¼ inch round stock, or flat up to 4 inches wide. The time for welding stock which is the limit of the machine's capacity is 15 seconds, and the current consumption is 125 kilowatt hours for 1000 welds. The weight of this machine is 2275 pounds.

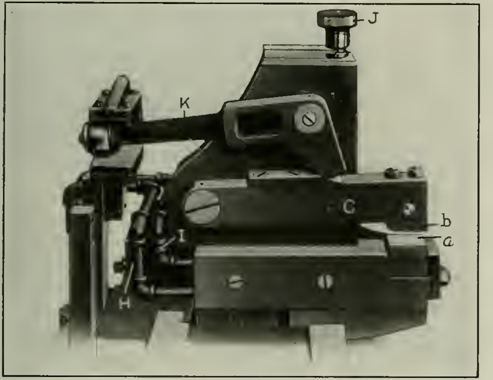


Fig. 6. Details of Clamping Jaws used on Machine shown in Fig. 5

Another type of butt-welding machine which is built by the Toledo Electric Welder Co., Cincinnati, Ohio, and incorporates the fundamental principles of the electric welding machine as first developed, is shown in Fig. 5. It will be seen that the transformer *A* is carried in the base of the machine. The primary coils of the transformer are connected to an alternating-current supply which is regulated by regulator *B*, and the secondary windings deliver an output of very low voltage but heavy current or amperage to the connecting leads running from the transformer to the clamping jaws.

The two lower copper clamping jaws *a* are held stationary, whereas the upper jaws *b* for clamping the work are held in arms that are operated by the foot treadles *E*. By operating the treadles, the two arms *C* are lowered, carrying the copper jaws that hold the work rigidly in position on the lower jaws. When this operation has been performed, the switch handle *F* is depressed, turning on the current, and the lever *G* is drawn in toward the center of the machine. This makes sliding head *H* travel in the same direction, and carries forward one part of the work that is to be welded. Of course, handle *G* is not operated until the extended ends of the work to be welded have reached a white heat or welding temperature. Then sufficient pressure is given to the handle to upset the material and form a perfect weld. The arms carrying the top clamping jaws are released by means of releasing treadles *I*. The movement of the two arms *C* is controlled by eccentric adjusting screws *J* located in each head as indicated.

The lower clamping jaws are cooled by a constant stream of water flowing through the pipes *H* and *I*, see Fig. 6, which adds greatly to the increased life of the jaws. The head of the machine carrying the different operating parts is an iron casting of massive construction. The cam lever *K* is a steel casting which rides upon a hardened steel shoe and reduces wear to a minimum. The small copper jaws held in the arms are the only parts that need to be replaced and are simply cut off from bars of copper stock. The stationary and movable heads are both provided with adjustable slides to take in various lengths of work, and as shown in Fig. 5, carry backing-up stops *L* which serve to hold the work in its proper place and relieve the clamping jaws of considerable strain. All compression on the work is taken on these stops instead of on the jaws themselves, and they enable the perfect duplication of lengths of work. The lever arms can be raised and lowered by means of the eccentric screws *J* shown at the top of the machine, to provide for different sizes of work. In changing over from one job to another, it is only necessary to change the clamping jaws, reset the stops and adjust the eccentric screws controlling the movement of the lever arms.

A number of special electric welding machines have also been built by the Thomson Electric Welding Co., notably those for welding spokes into hubs of agricultural wheels, butt seam welding steel tubing, welding tramway rails in the streets, and making wire fencing and wire mesh for concrete reinforcing. All of these applications demanded a careful study and extended experiments involving construction of machines differing widely in details, not necessary to enumerate here.

Preparing Work for Butt-welding

For butt-welding it is not necessary to prepare the metal especially, although when rusty or covered with scale the rust or scale should be removed from those parts of the pieces which touch, sufficiently to allow good contact of clean metal on the copper jaws. The work preferably should be cleaned with a sandblast or emery cloth. Where there is a large amount of work to be welded, it is sometimes advisable to grind off the ends on an emery wheel to allow a good contact. Scaly forgings should be pickled, and this can be done at a slight cost. The pickling solution should be kept in a wood, stone or lead lined tank, and is composed of five gallons of commercial sulphuric acid (or oil of vitriol) added to 250 gallons of water. This solution takes only a few minutes to remove the scale. After dipping the work, wash off the acid in running water and dip the stock in limewater to neutralize any traces of acid. Fifty pounds of unslaked lime to one hundred and fifty gallons of water is about the right mixture. Both acid and lime solutions should be kept as near the boiling point as possible to get the best and quickest results. When the work is taken from the hot limewater, it dries very quickly, and this forms a thin film of lime on it which prevents rusting.

A good method of heating the acid solution is to run a coil of extra heavy lead pipe to the bottom of the tank and out at the top to carry the steam. Cold acid solution may be used, but it takes much longer to remove the scale and also requires the use of a considerably greater quantity of acid. The cleaning of the work is an important point, as the best results can only be obtained when the stock is clean. The cleaner and better the stock, the easier it is to weld and the less current it takes; there is also less wear on the clamping jaws. The clamping jaws should be kept clean and firmly held in the holders. If dirt or scale is allowed to gather in the socket that holds the jaws, good contact cannot be made.

Another point in butt-welding is that pieces of similar metals should have their welding sections equal; that is to say, the two ends of the stock that come together must be of the same diameter or cross-sectional area. When a large piece is to be welded to a smaller piece, the end of the larger piece should be reduced to the section of the smaller for a length of from 1 to 2½ times the diameter. This applies to round stock, hexagonal stock, flat stock or tubing, and in fact any shape of work that it is intended to butt-weld. If this point is not observed, it is necessary to have a special arrangement of the dies and pre-heat the piece which has the largest cross-sectional area in order to prevent burning the small piece while the large one is heating.

Electric Butt-welding Different Materials

Practically all materials that can be welded by other methods can be electrically welded, and a few metals can be welded electrically that it is impossible to weld satisfactorily by any other means.

Cast iron cannot be commercially welded, except in small sections, as it is high in carbon and silicon, and passes suddenly from a crystalline to a fluid state when brought to a welding temperature. For welding wrought iron or steel, the temperature must be kept below the melting point, and consequently considerable pressure is required. High carbon steel can be welded, preferably with a borax flux, but must be annealed, or better hammered, after welding to overcome the strain set up by applying the heat locally. Good results are hard to obtain when the carbon runs as high as 0.75 per cent or above, and can only be obtained by an experienced operator. When the carbon content is below 0.25 per cent, the operator can always be sure of making a good weld. To weld high-carbon steel to low-carbon steel requires a little experience, and this process will be described later.

Nickel steel can be readily welded, and a small percentage of nickel materially increases the tensile strength of the metal. Wrought iron can be welded to copper, but it is necessary to reduce the cross-section of the copper to equalize the heating. When welding copper to brass, the pressure must be less than when welding iron, but a greater quantity of current is required because of the reduced resistance. The metal is allowed to actually fuse or melt at the juncture, and the pressure should only be sufficient to force out the burnt metal. The fact that the burnt metal is forced out accounts for the good results obtained in welding these materials. The electric current, however, must be cut off at the instant that the ends of the metal begin to soften. This is done by an automatic switch which opens at a predetermined point, found by experimenting with the different diameters and alloys of metal. The sliding head of the machine is actuated by either springs or weights to force the heads together as soon as the metal softens, and this automatically operates the switch. As copper and brass are good conductors of electric currents, a large volume of current at lower secondary voltage is used, and the sliding heads are arranged to move with the least possible friction.

With metals such as lead, tin and zinc, the degree of heat required does not, of course, produce light, and the progress of the heating cannot be watched by the eye as in the case of iron and steel. Therefore the plasticity, softening or fusion is really the index of the heat which the abutted ends have acquired. If the precaution be taken to shape the ends of the sections properly before applying the current and pressure, the joining of lead pipes, end to end, can be easily accomplished. The abutting ends should be beveled so as to expose a smaller section than that of the pipe in order to reduce the cross-section and facilitate quick heating.

Tin welds easily, as does zinc and even such brittle metals as antimony and bismuth. The welding of aluminum, however, is a little more difficult and requires special precautions. For this work automatic welders are generally used, so that the time at which the current is shut off can be very closely regulated. Even magnesium, oxidizable as it is, is readily welded because it melts before reaching the temperature at which it takes fire.

* * *

ELIHU THOMSON, FATHER OF ELECTRICAL WELDING

Dr. Elihu Thomson was born in Manchester, England, in 1853 of Scotch-English parents. In 1858 he came to the United States with his parents, who settled in Philadelphia, Pa. He was educated in the public schools of Philadelphia, and graduated from the Central High School early in the year 1870. Immediately thereafter he entered the Iron Masters' Laboratory as an analyst. His favorite studies when attending school were physics and chemistry. In 1876 Dr. Thomson was appointed assistant professor of chemistry in the Central High School of Philadelphia, and was given the chair of chemistry in the same school which he held until 1880, when he resigned to enter the electric field in which line he has continued since.

The study of electricity always had a special fascination for him and he began his endeavors in this connection with the construction of a frictional machine made from the traditional wine bottle when he was eleven years of age. This was supplemented by batteries, electrical magnets, telegraph instruments, in some of which the bare copper was insulated by the laborious winding of threads around the wire by hand. Having a natural aptitude for construction and for the use of tools, his spare time from other duties was given to the making of such apparatus as needed. In this way he built dynamos, motors, achromatic microscopes and other optical instruments, also a pipe organ. It was a rule with him to construct everything that he needed, performing such operations as grinding the lenses for microscopes and the making of organ pipes, keys, etc., himself. The outlet thus afforded for his mechanical taste led naturally to inventions and gave him most valuable training for his after work. In recent years this taste has found an outlet in the construction of objective lenses for refracting telescopes, a ten-inch glass so made being mounted in his private observatory at his home in Swampscott, Mass.

Dr. Elihu Thomson

In 1880 Dr. Thomson relinquished his professorship in the Central High School in Philadelphia to take charge of the development of the Thomson-Houston electric lighting system, which was based upon patents, some of which were taken out jointly with Prof. E. J. Houston. This industry had been started in Philadelphia in 1879, and was removed to New Britain, Conn., in 1880, when the business of the Thomson-Houston Electric Co. was removed from Philadelphia to New Britain. E. W. Rice, Jr., now president of the General Electric Co., accompanied it as an assistant. In 1883 the works which had been established in New Britain, Conn., were moved to Lynn, Mass. It was in this latter place that the great development of the Thomson-Houston Electric Co. began, due in a large measure to the enterprise of its managing head, C. A. Coffin (for many years president of the General Electric Co.) and to the success of its engineering achievements. This company was merged in 1892 with the Edison General, and the General Electric Co. was formed, with its huge works at Schenectady, N. Y., and Lynn, Mass., also Harrison, N. J., and its offshoots in Germany, France, England and other countries, in connection with which the subject of our sketch actively engaged.

Dr. Thomson had taken out upward of seven hundred patents in the United States alone, many of which are of great importance and have come into extensive use in electric lighting, railways, power transmission, etc. The Thomson meter was given a prize in the Paris meter competition in 1890. There are now upward of two millions of these meters in use here and abroad. His pioneer researches and inventions in the alternating current field and his high frequency work are well known. He is known as the inventor of the electric welding process which is being more and more extensively applied in various metal-working industries. This process was first patented in 1886. How Dr. Thomson came to conceive the idea of electric welding is best told in his own words:

"The idea first came to me when I was preparing for a lecture at the Franklin Institute, Philadelphia, Pa., early in 1877. I had a course of five lectures to give at the institute on electricity, and I chose for my general ground the demonstration of the fact, which was then by no means well recognized, that electricity from whatever source was the same, although it went under different names, such as static, dynamic, magneto, thermo-electricity and animal electricity, etc. My experiments were devoted to showing among other things the convertibility of one so-called variety into another.

"In following up this idea it occurred to me to reverse the functions of the ordinary Ruhmkorff coil, which, as you know, takes a low-tension current from a battery and produces a high-tension spark to the fine wire of the secondary. I fed the fine wire of the coil which discharges from Leyden jars, and took the secondary current from the coarse wire primary. I found that this was of such great volume, that the ends of the wire of the primary, which were free, would stick together firmly on the passage of the discharge through the fine wire secondary, indicating that in the primary a heavy current was passing. The thought came to me that this might be developed into a method for joining metals."

Dr. Thomson was decorated in 1889 for his inventions by the French Government as Officer Chevalier de la Legion d'Honneur, given the honorary degree of A.M. at Yale, D.Sc. at Harvard and Ph.D. at Tufts. He also received many medals and awards, among which was the Rumford medal, and was awarded the grand prize at the Paris Expositions of 1889 and 1900. He is past president of the American Institute of Electrical Engineers, fellow of the American Academy of Arts and Sciences, member of the Institution of Civil Engineers, London, the Americaan Chemical Society, the American Physical Society, the National Academy of Sciences and of many other societies here and abroad. He was also official U. S. delegate to the Chamber of Delegates, Electrical Congress held in Chicago in 1893.

He has been for many years a fellow of the American Association for the Advancement of Science, serving as vice-president of the Columbus meeting, section B, physics, and has been vice-president of the American Physical Society. He was president of the International Electrical Congress at St. Louis, Mo., in 1904, and also president of the chamber of official delegates at this congress. He was elected honorary member of the Institution of Electrical Engineers of Great Britain in 1904, and in 1909 was elected president of the International Electro-Technical Commission, succeeding the late Lord Kelvin in that capacity.

Dr. Thomson was the first recipient of the Edison Medal and also was awarded the Elliott Cresson gold medal conferred by the Franklin Institute, Philadelphia, Pa., for his electrical work.

* * *

HOW MOTION PICTURES ARE MADE

Those not acquainted with the motion picture industry have a very vague idea of its magnitude and how motion pictures are actually made. It is the general conception that a motion picture is one continuous series of photographs, as thrown on the screen, all made at one time. As a matter of fact, this is not the case. Sometimes twenty-five to fifty feet of film is exposed one week, and other portions a week after or sometimes a month later, and even longer than that. The process is to make one master film or negative, which is pasted together after the various parts of the film have been made.

It is the practice of some concerns not to do any rehearsing at all before the pictures are taken. The participants in the play go over the outline in a general way and then depend entirely for their actions upon the director who, with a copy of the scenario before him, tells each one just when he should make his entrance on the stage and what he should say or do. Sometimes it is necessary to go over the particular part from three to four times before just the right attitude on the part of the various players has been obtained. The best of these films is then selected and worked into the master negative. It is claimed that in this way the most natural attitude is obtained and that the pictures do not look "posed."

All parts of the play which are to be taken indoors are taken in booths resembling rooms. Sometimes as many as twenty booths are arranged on one floor at a time. These are open at one end, at which opening the operator with the camera stands. The director sits just beneath the lens and directs the participants by a megaphone. The booth is illuminated by Cooper-Hewitt lamps, with white and red efflorescent reflectors arranged alternately to give the proper light values. Some of the various "stunts" used to obtain lighting effects are unique. For instance, if a grate fire is to be shown, the grate is arranged with two powerful arc lights inside, which throw a reflection into the room. In order to reproduce the effect of the morning sun streaming into a room, two arc lights are located near the ceiling that throw the light through the room similar to the rays of the sun. The paraphernalia that is found in a moving picture studio is unlimited, and ranges from chemical bottles up to miniature houses with all the necessary equipments.

Another important part of this industry is the making of the film. As previously mentioned, a master negative is first made and developed, then pasted together in the proper order. From this are made the positives by passing the master negative through a printing machine together with a strip of unexposed film, which is afterward developed. The method of obtaining the correct printing intensity is to govern the strength of the arc light used for printing, by means of a rheostat, and note the position of this rheostat for various printings. For instance, a very light print is first made and then gradually darker ones until a very dense print is obtained. The reflection of these prints is thrown onto a screen and the one that shows up the best and appears to be the sharpest is picked out. The rheostat is then set at the number at which this print was made and the printing progresses with a uniform density. The developing of the films is handled in a somewhat different manner from that employed for the general run of photographic work, in that the films, which are in a long strip, are wound around a wheel similar to but larger than that used in a squirrel cage, the film being wound in a helical path so that it does not overlap. This wheel is kept continually rotating through a bath of developer by power, and the operator passing from one end of the wheel to the other notes the density of the film by means of a red lamp. When the correct density has been reached, the film is taken out and put into the hypo bath.

In one motion picture establishment where there are many interesting features employed, the apparatus for fixing the films after developing is rather unusual. Previous to the adoption of this device, the operators looked after about four baths each, and their work was to keep the wheels in practically continuous rotation so as to get an equal fixing of the film. It was found, however, that the operators did not give the proper attention to the work, and hence films would come out which were improperly fixed at certain points; it was therefore necessary to devise an automatic means for taking care of this. Instead of rotating the wheels by hand, a mechanism was devised which rotated the wheel for fifteen minutes and then stopped. When the mechanism stopped, a signal, similar to that used on a railroad, dropped so that the operator knew that the film was ready to be taken out of the bath.

Another interesting feature in connection with the making of motion picture films which is not generally known is the fact that to get different effects such as sunlight, moonlight or the effect of a fire, colored glasses are not used, but the film is stained instead. The portions of the film which are to have these effects are taken to a bath where they are immersed in a colored solution; then when this member is pasted onto the "line" of film, the operator does not have to give it any attention to bring the various colors into effect, as this takes place automatically. Every film which is sent out to the motion picture theatres is inspected to see that it has no defects and that it has been properly connected; that is, that the original negative has been properly assembled so that the different acts come in their right sequence. Some manufacturers project their pictures on a screen similar to that used in the moving picture theatre, but it has been found that the eye cannot quickly comprehend or take in a picture as large as, say, eight by ten feet, and also that it is necessary to economize in space; hence, one concern has adopted the practice of projecting its pictures for inspection on a screen about three feet long by one foot high, so that the eye can take in the entire view without strain. This also makes it possible to have a large number of machines in operation at one time in a comparatively small space. D. T. H.

SHOP SYSTEM OF THE AMERICAN MACHINE & FOUNDRY CO.*

A FOLLOW-UP SYSTEM APPLICABLE FOR USE IN BUILDING SPECIAL MACHINERY OR MANUFACTURING STANDARD PARTS

BY EDWARD K. HAMMOND†

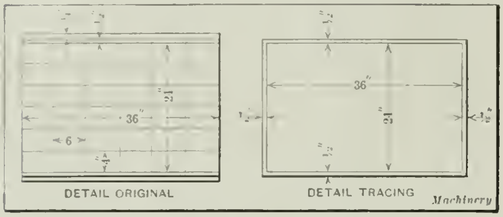


Fig. 1. Diagram showing how Detail Drawings are made on the "Unit Sheets"

THE drafting-room is necessarily the starting point of all machine shop work, but at the plant of the American Machine & Foundry Co., 346 Carroll St., Brooklyn, N. Y., the drafting-room is of more than usual prominence. Not only is it called upon to fulfill the usual function of designing, but it also includes, as a subsidiary department, the production department which has charge of ordering the patterns, castings and material for filling each order that is received, and of determining the best method of machining each part, and the most satisfactory way of routing the work through the factory. The production department also looks after issuing blueprints and material to the factory, sending the necessary jigs and fixtures to each department in which they are to be used and keeping a record of the progress made with each individual order.

As the work handled by this company consists of building high-grade special automatic machinery, the designing is of a diversified character, but there are certain customers for which the same general class of work is constantly being done. For instance, a great many automatic machines for the manufacture of cigarettes are constantly being built. It is obviously desirable for men with previous experience in this class of designing to handle all such work which comes to the factory. In order to make this possible, the drafting-room is subdivided into departments, each of which is in charge of a chief draftsman of wide experience in his particular line of work. Thus, the cigarette machine department is in charge of a man who has designed a great many machines for the automatic manufacture of this particular product, and he has a wider knowledge of the field than any general designer could be expected to possess. We have made reference to cigarette machines, and the parts of a cigarette machine will be considered in describing the shop system which forms the subject of this article, but it must not be inferred that this is the only class of work handled by the American Machine & Foundry Co. This firm is prepared to build any class of automatic machinery and has exceptional facilities for handling such work resulting from years of specialization in this field.

Features of the Drafting-room System

To facilitate handling drawings and blueprints, and in order to effect an economy in the use of paper and tracing cloth, a standard set of sheet sizes has been adopted. The basis of these is the largest sheet, which is 36 by 24 inches in size. This large sheet contains thirty-six "unit sheets" 6 by 4 inches in size, the arrangement being shown in Fig. 1. Individual drawings of each part are made for use in the shops, and as the average machinist finds difficulty in "reading a drawing" this plan is of particular value as it simplifies the drawings as far as possible. The scale of each drawing is determined by the complexity of the design and from one to any required number of the 6 by 4 inch unit sheets are used according to the amount of space required. In making these detail drawings, the draftsman works on a full sized sheet, 36 by 24 inches, blocking this sheet off into spaces of the required size for showing the different parts. These sheets are then traced and blueprints are made from the large tracings, which are subsequently cut up ready to be sent out to the shops.

Another noteworthy feature is that limits are specified in connection with the dimension of *every* part, no matter what degree of accuracy is required nor how much leeway is permissible. This is obviously an important point in reducing the cost of machining operations, as the machinist sees at a glance whether he is required to work with great precision or whether the part is a rough one that can be handled with coarse feeds and high speeds. As far as possible, the practice is followed of keeping certain men who show aptitude for such work constantly engaged in machining those pieces which require a high degree of accuracy, while other men who are temperamentally unsuited to handling accurate work are kept machining parts where less precision is necessary. In this way the men do not waste time striving for a high degree of accuracy where it is not called for. Each drawing also gives the name and number of each tool required to

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* For additional information published in MACHINERY on follow-up systems, methods of routing work through the factory, etc., see also "An Effective Follow-Up System" published in August, 1913, and other articles there referred to.

† Associate Editor of MACHINERY.

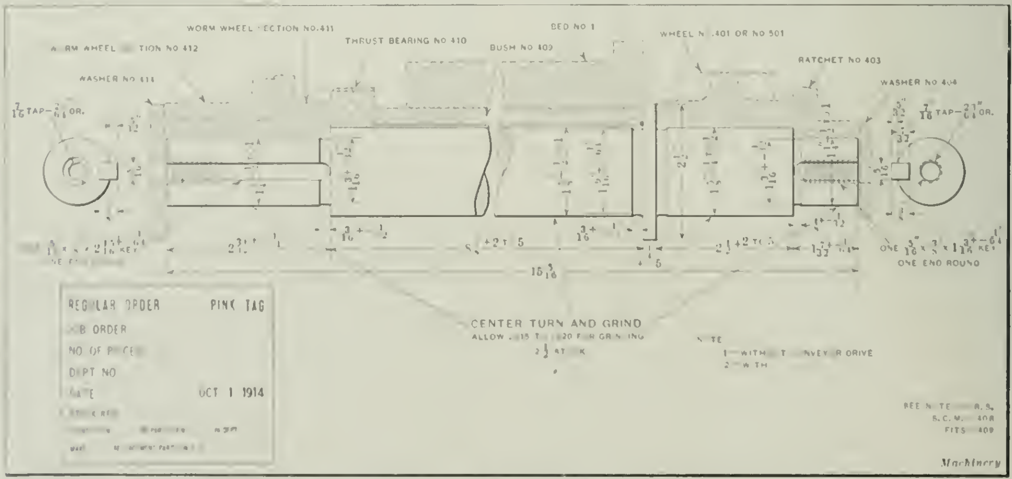


Fig. 2. Typical Detail Drawing, showing how all Limits are specified, the Use of Symbols and Consecutive Numbers for Parts which assemble together, and how a Partial Cross-section of Engaging Parts is shown

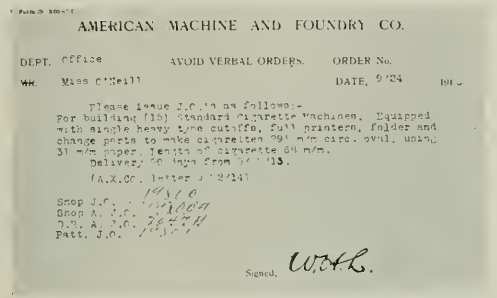
machine the part that is shown on it, so that when the drawing is received work can be commenced without delay.

Each machine is designated by a symbol that usually consists of the initial letters of the name of the machine. For instance, the standard cigarette machine built by this company is designated by the symbol SCM. Each part of this machine is designated by a number, and parts which assemble together in the machine have consecutive numbers. For instance, a certain shaft for use on this machine is designated by the symbol and number SCM-408, while a bushing which is assembled on this shaft has the number SCM-409. The convenience of this method lies in the fact that an assembler looking over his detail drawings is able to tell by the numbers what parts go together. This plan is followed to its logical conclusion by having the detail drawing of each part made with a partial cross-section of those parts which assemble on it, each part being referred to by its symbol and number. This does away with the necessity of giving special instructions to the assembling department. This plan will be better understood by referring to Fig. 2, which shows a detail drawing of a certain shaft and the parts assembled on it. The method of specifying limits of all parts is also clearly illustrated.

The Work of the Production Department

The work of the production department has already been briefly referred to and with that information as an outline the functions of this department will be taken up in detail. When an order is received from a customer, a typewritten copy is sent from the office to the production department, where a memorandum of this order is made out expressed in the symbols and numbers used for designating the machines or machine parts that are called for. Spaces are left for the insertion of serial order numbers, and the memorandum is sent down to the office to have these numbers assigned to the order. The correspondence form for use between different departments, which is shown in Fig. 3, is employed for this purpose. When the memorandum is received in the office the order numbers are inserted and it is returned to the production department, where one of the clerical force proceeds to make out a specification sheet and a list of all parts which must be provided to fill the order, the proper symbols and numbers being applied to the notation of each part.

In the case of new machines of a type that has not formerly been built in the factory, it is necessary to order the patterns for parts which are made from castings, and special forms are provided for this purpose. In the case of standard machines, it is necessary to look up the old patterns preparatory to issuing orders for castings. The system employed in storing patterns and keeping track of them makes this an easy matter. Each pattern is given a number and bears a symbol of the machine for which the part made from it is intended; and the patterns are stored on numbered shelves. The form shown in Fig. 4 is used to keep track of the location of each pattern. Referring to this illustration, it will be seen that the form gives complete information regarding the pattern, its number, symbol and location on the pattern storage shelves. The original cost of the pattern and other useful information is also included on this card. When castings are to be ordered, the pattern is drawn from the pattern storage room and sent to the foundry, together with an order for the required number of castings to be made from it. The form shown in Fig. 5 is used to record the fact that the pattern of a certain symbol and number was shipped to the foundry on a specified date. When the castings have been made and the pattern returned, the date of its receipt is recorded on the card opposite the date on which shipment was made, and the pattern is returned to the pattern storeroom. When both dates on the card are filled, it shows that the pattern has been returned, but if the space for the return date is blank it indicates to the production department that the pattern has not come back. In ordering castings or other material, the form shown in Fig. 6 is sent to the purchasing department requesting the purchase of a specified number of castings.



AMERICAN MACHINE AND FOUNDRY CO.

DEPT. Office AVOID VERBAL ORDERS. ORDER No.

MR. Miss O'Neill DATE, 9/24 191

Please issue J.O.'s as follows:-
For building (15) Standard Cigarette Machines. Equipped with single heavy type cutoffs, full printers, folder and change parts to make cigarettes 29½ m/m circ. oval, using 31 m/m paper. Length of cigarette 68 m/m.
Delivery 60 days from [illegible] '13.
(A.X.Co. letter [illegible] 2/24)

Shop J.O. 19310
Shop A. J.O. 21009
D.R. A. J.O. 26474
Patt. J.O. [illegible]

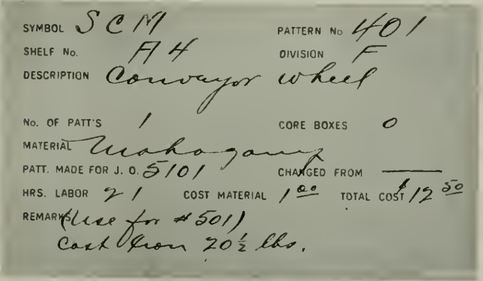
Signed, W.H.L.

Fig. 3. Production Department's Call on Office for Assignment of Order Numbers

When the castings arrive at the receiving room, the production department is notified to that effect. The production department then orders the castings to be sent to whatever department will perform the first machining operation on them, the material requisition form shown in Fig. 7 being used for that purpose, and in making delivery of castings or other material the receiving department uses small tags of the form shown in Fig. 8. These tags are made either pink, blue or yellow, according to whether the material is to be used for a regular order, a repair order or an experimental order. Further reference will be made to these three classes of orders in subsequent paragraphs. As a check on the prompt delivery of material by the receiving department, the production department notifies the department in which the first machining operation is to be performed that the material has been received, the form shown in Fig. 9 being used for this purpose.

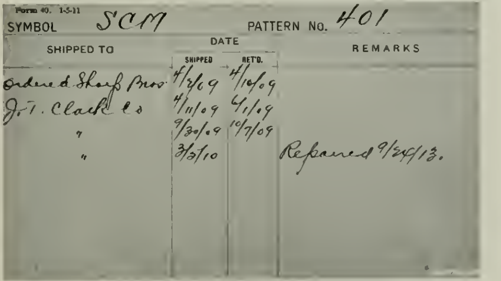
Method of Accounting for Jigs and Fixtures

The production department also has supervision over all jigs and fixtures used in the factory. When the blueprints have been made for a given order, and the necessary material to start the order has been received, the production department sends out the requisite tools to each department in which work is to be done on the order in question. This is only in the case of jigs or fixtures that are used at more or less infrequent intervals. Those that find fairly constant use are kept in the departments in which they are needed to avoid loss of time in transferring them back and forth between the jig room and the factory. The form shown in Fig. 10 is used for keeping track of each tool in the jig room; and it will be seen that spaces are provided for recording complete informa-



SYMBOL SCM PATTERN No 401
SHELF No. A 4 DIVISION F
DESCRIPTION Conveyor wheel
No. OF PATT'S 1 CORE BOXES 0
MATERIAL Mahogany
PATT. MADE FOR J. O. 5101 CHANGED FROM ——
HRS. LABOR 21 COST MATERIAL 1.00 TOTAL COST $12.50
REMARKS (Use for #501)
Cast from 20½ lbs.

Fig. 4. Form used in keeping Record of Location of Each Pattern on Shelves



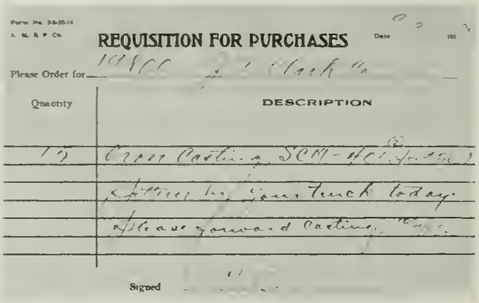
Form 40. 1-5-11

SYMBOL SCM PATTERN NO. 401

SHIPPED TO	DATE SHIPPED	DATE RET'D.	REMARKS
Ordered Sharp Bros	4/2/09	4/10/09	
J. T. Clark Co	4/11/09	6/1/09	
"	9/30/09	10/7/09	
"	3/3/10		Repaired 9/24/13.

Fig. 5. Form used in keeping Record of Patterns sent to Foundry when Castings are ordered

tion in regard to the name and number of each tool, and its proper place in the jig room. The form reproduced in Fig. 11 is used for sending tools out to different shops. As in the case of the pattern records, this form shows at a glance what tools have been returned from the factory and what ones are still outstanding. After the work for which each tool is used has been completed, the work and the tool are sent to the inspection room where the tool is looked over to see that all its parts are complete and in good condition before it is returned to the jig room.



REQUISITION FOR PURCHASES

Date 191

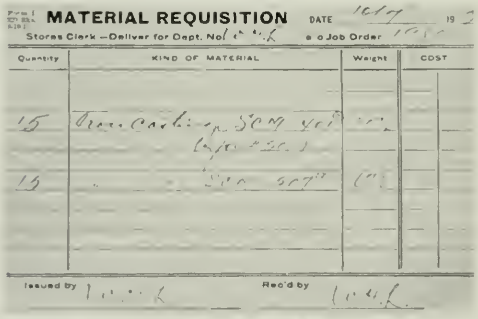
Please Order for [illegible]

Quantity	DESCRIPTION
15	Iron Casting SCM-401 for #501
	[illegible] truck today.
	Please forward Castings [illegible]

Signed

Fig. 6. Requisition Form used in calling upon Purchasing Department for Supplies

It has already been mentioned that the detail drawings of individual parts are made on large sheets from which tracings and blueprints are made, and that the blueprints are afterward cut up into individual sheets. In preparing to send these small sheets, or "cut-ups" as they are termed, out to the factory, the production department stamps them on the back with a rubber stamp, the form of which is shown in the lower left-hand corner of Fig. 2. It will be seen that this stamp gives the order number and the color of the tag to be used; *i.e.*, whether the work is for a regular order, a repair order or an experimental order. The job order, the number of pieces required and the date on which the print is sent out are also given, together with the department numbers in which the work is to be done. These department numbers are



MATERIAL REQUISITION DATE 19

Stores Clerk—Deliver for Dept. No. On Job Order

Quantity	KIND OF MATERIAL	Weight	COST
15	Iron Castings SCM 401 (for #501)		
15	SCM 501		

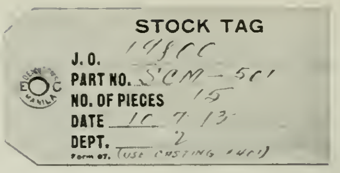
Issued by Rec'd by

Fig. 7. Requisition Form used in ordering Material sent out to Shops

given in the order in which the work is to be sent through them. The blueprints are all sent down to the assistant superintendent, whose first duty is to look over the arrangement of the departments through which the work is to pass, and see that the routing has been specified to the best possible advantage. In the event of its being necessary to make a change in the routing, the blueprint is returned to the production department to have the same change made on the transfer cards. The assistant superintendent also notes the stock to be used in the space entitled "Stock Req.," after which a clerk fills out the material requisition form shown in Fig. 7, upon which the necessary material is ordered. The remaining spaces at the bottom of the rubber stamp are for use in the replacement of work which has been spoiled or of material which has been found defective, and the use of this part of the form will be subsequently explained.

The Operation of the Follow-up System

For use in keeping a record of each order going through the factory, the production department maintains a set of transfer cards, the forms of which are shown in Figs. 12 and 13, these forms being printed on the opposite sides of the same card. It will be seen that the form shown in Fig. 12 provides for keeping a record of the castings that have been ordered, the number that have been received on various dates and the number that have either been spoiled in machining or found defective. Fig. 13 shows the form used for keeping a record of the transfer of work from department to department. This form provides a space for entering the part and job order numbers and the symbol and number of the part, together with the date on which the blueprints were sent out to the factory and the number of parts ordered. In the lower part of the form, spaces are provided for recording the number of parts completed in each department each day, and for the transfer of such work to the succeeding department. Figs. 12 and 13 are the forms used for keeping track of the progress made in machining castings. For keeping track of the machining of other parts, such as steel shafts, etc.—where the material is not a casting—a card printed with the same form as that shown in Fig. 13 is used. This form is printed in black on a yellow card, while the castings record is kept on a form printed in red on a white card. In this way the production department finds it easy to distinguish between the two classes of work.



STOCK TAG

J. O. [illegible]

PART NO. SCM-501

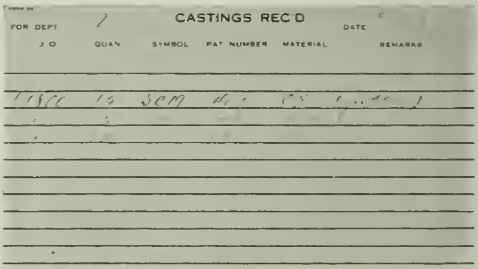
NO. OF PIECES 15

DATE 10-7-13

DEPT. 2

Form 67. (Use Casting #401)

Fig. 8. Tag used in sending Material to Shops



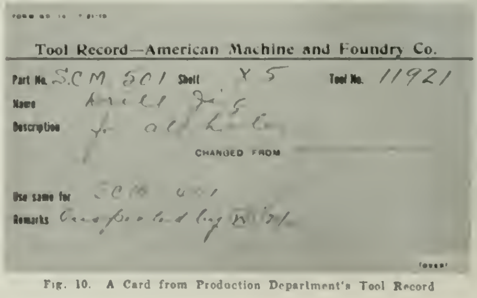
CASTINGS REC'D

FOR DEPT 1 DATE

J O	QUAN	SYMBOL	PAT NUMBER	MATERIAL	REMARKS
	15	SCM			

Fig. 9. Form used in notifying Shops that Material is on Hand ready for Use

When each department finishes work on a given order, a tag of the form shown in Fig. 14 is filled out and attached to the work, which is then forwarded to the inspection department. It will be seen that the upper part of this form provides spaces for the name of the operation, the order number, the symbol and piece numbers of the part, the number of pieces required and the date. It may happen that the work is in a hurry, in which case the department doing certain work will not wait until the order has been completed before forwarding it to the inspection department, but will forward a portion of the work with a tag of the form shown in Fig. 14. The inspector counts the work and records the number of pieces received in the space at the bottom of the form, putting his initials opposite this number in the space provided



Tool Record—American Machine and Foundry Co.

Part No. SCM 501 Shell Y5 Tool No. 11921

Name [illegible]

Description [illegible]

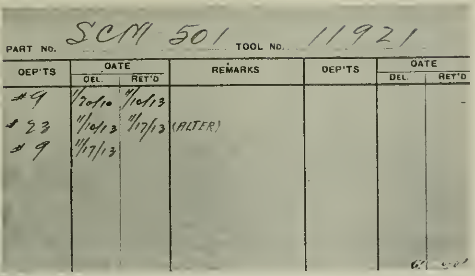
CHANGED FROM

Use same for SCM 401

Remarks [illegible]

(over)

Fig. 10. A Card from Production Department's Tool Record

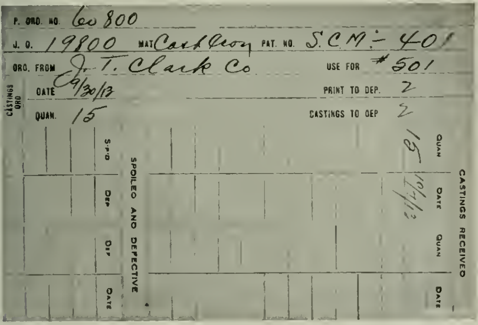


PART NO. SCM-501 TOOL NO. 11921

DEP'TS	DATE DEL.	DATE RET'D	REMARKS	DEP'TS	DATE DEL.	DATE RET'D
#9	1/20/10	11/10/13				
#23	11/10/13	11/17/13	(ALTER)			
#9	11/17/13					

Fig. 11. How Record of Tools sent out to Shops and those that have been returned is kept

for that purpose. It will be seen that this tag is perforated across the end. This makes it easy for the inspector to tear off the card and return it to the department handling the first operation. When the next lot of pieces is forwarded to the inspection department, the card is sent with them and the number of pieces recorded in the same way, this being continued until the complete number of parts has been machined. Each shop foreman has a box on his desk in which these cards are filed when returned by the inspection department. After the inspection department has looked over the work, a new tag of the same form is made out and attached to those pieces which have been found satisfactory and they are then sent on to the next department. This enables work that is required at once to be handled without any unnecessary delay. Tags of the form shown in Fig. 14 are printed on either pink, yellow or blue cardboard according to whether the work is required to fill a standard order, a repair order or an experimental order, as previously mentioned. The colors of these cards tell the shop foreman at a glance to which class the work belongs and advise him as to the method of procedure to follow in handling it. The standard orders are the regular manufacturing operations for which jigs and fixtures are provided. After the jig has been set up on the machine for handling a given class of work, the first piece is made and sent to the inspection department to determine its accuracy. If it is found satisfactory, subsequent pieces are merely given a cursory inspection, the jig being relied upon to maintain the necessary dimensions. In the case of repair work, jigs and fixtures are also used, but as such parts are to be shipped out and absolute reliance must be placed on their interchangeability, each part is given a thorough inspection before being shipped. Parts for the experimental orders are made without the assistance of jigs or fixtures of any kind. This work is usually assigned to the most skilled mechanics, but even under such conditions it is found advisable to have each part subjected to a most rigid inspection before it is sent on to the assembling department.

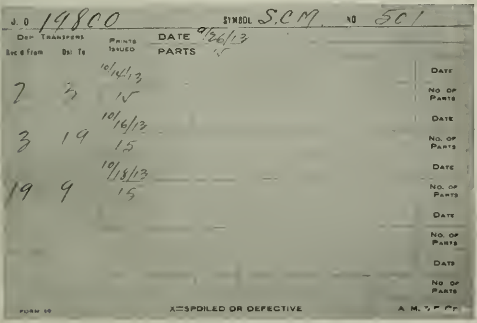


P. ORD. NO. 60800
J. O. 19800 MAT Cast Iron PAT. NO. S.C.M.-401
ORD. FROM J. T. Clark Co USE FOR #501
CASTINGS ORD DATE 9/30/13 PRINT TO DEP. 2
QUAN. 15 CASTINGS TO DEP 2

SPOILED AND DEFECTIVE
SP'D
DEP
DEP
DATE

CASTINGS RECEIVED
QUAN 15
DATE 10/1/13
QUAN
DATE

Fig. 12. Form used for recording Order and Receipt of Castings



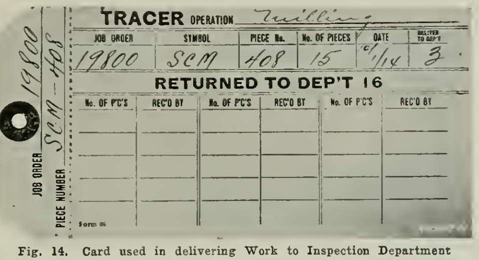
J. O 19800 SYMBOL S.C.M. NO 501
DATE 9/26/13
PARTS 15

DEP TRANSFERS Rec'd From	DEP TRANSFERS Del To	PRINTS ISSUED
7	2	10/14/13 15
3	19	10/16/13 15
19	9	10/18/13 15

DATE
NO OF PARTS
DATE
NO. OF PARTS
DATE
NO. OF PARTS
DATE
NO. OF PARTS
DATE
NO OF PARTS

FORM 10 X=SPOILED OR DEFECTIVE A. M. [illegible]

Fig. 13. Transfer Card showing Progress made Each Day in machining Castings



JOB ORDER 19800
PIECE NUMBER SCM-408

TRACER OPERATION Milling

JOB ORDER	SYMBOL	PIECE No.	No. OF PIECES	DATE	DELIVER TO DEP'T
19800	SCM	408	15	10/1/14	3

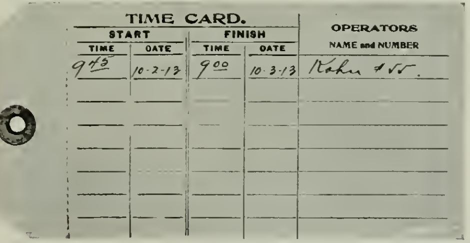
RETURNED TO DEP'T 16

No. OF PC'S	REC'D BY	No. OF PC'S	REC'D BY	No. OF PC'S	REC'D BY

Form 86

Fig. 14. Card used in delivering Work to Inspection Department

A time card of the form shown in Fig. 15 is printed on the back of each tracer card. Referring to this illustration, it will be seen that space is provided for the time and date upon which each job was started and finished and for the name and number of the operator. This card is for the guidance of the foreman in enabling him to keep track of his men. The time keeping department keeps an independent record of each job on cards of the form shown in Fig. 16. It will be seen that spaces are provided for the name and number of the operator, for the date and the job number and the time at which he started and stopped work on a given job. The different classes of operations are tabulated on this card and in using it the time clerk draws a line through the figures indicating the time of starting and stopping work and the operation performed. This card is then sent to the foreman and turned over by him to the cost keeping department. In handling standard orders, little trouble is experienced in maintaining a satisfactory rate of production, but the record of production time on repair and experimental orders is of great assistance in making sure that the work is turned out in reasonable time. The time required for producing any given job is compared with that taken for performing work of a similar nature which was done in the factory at other times, and in case an excessive amount of time is being taken in any case the foreman of the department in which such an occurrence takes place is given an opportunity to explain the cause.



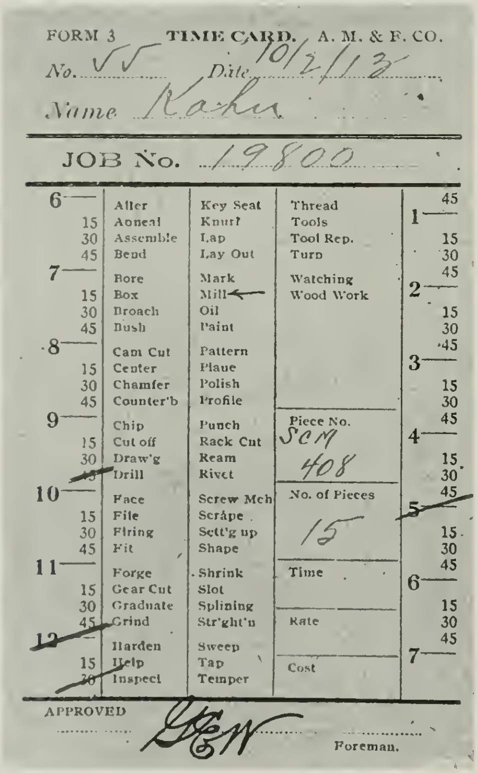
TIME CARD.

START TIME	START DATE	FINISH TIME	FINISH DATE	OPERATORS NAME and NUMBER
9:45	10-2-13	9:00	10-3-13	Kohn #55.

Fig. 15. Time Card used by Each Foreman in recording Work done by his Men

The method of issuing a single set of blueprints which follows the work from department to department is adopted where a relatively small number of parts is to be made. In many cases, however, a single order may be received for as many as 200 machines, and this will keep the factory busy for a considerable length of time. It would obviously be impractical to hold all of an order in a given department until it was completed. To obviate the necessity of such a course, the production department supplies each department in the factory that is to work on the order with a complete set of blueprints, and as fast as the work is completed it is sent on from department to department, the method of recording the work on the transfer cards (Figs. 14 and 15) being that previously described for the case where less than the entire number of pieces called for on the order was forwarded to the inspection department. In this way the work can be handled in an expeditious manner. If a certain quantity of parts is required ahead of the full amount, an excess amount of parts is started to provide for the possibility of damage or defective parts being found, and this work is pushed along as rapidly as possible.

In every factory it occasionally happens that work is spoiled in machining or that castings or other materials are found to be defective. When such a condition arises in the work handled by the American Machine & Foundry Co., the job is held up by the inspection department and the production department is notified that a certain number of pieces has been found defective. Certain parts are carried in stock to provide for such contingencies, but if stock parts are not available for replacement purposes the method of procedure depends upon whether a single set of blueprints which follows the work from department to department is provided, or whether each department works from a separate set. When a single set of prints is used, the inspection department fills in the form stamped on the back of the blueprint "Make ——— replacement parts on J. O. ———" and sends the print to the production department. If the parts are in stock, the required number will be withdrawn and the number of parts called for on the print reduced to correspond. If the parts are not in stock, the blueprint will be returned to the assistant superintendent who will send it to the department that performs the first operation. The inspection department holds up the remainder of the order, until the replacement parts have reached the same stage as the rest of the work. If a separate set of blueprints is issued to each department and the replacement cannot be made from stock, a special blueprint will be issued to follow the work from department to department. When the replacement order has been brought to the same condition as the remainder of the regular order, the inspection department will combine the two and destroy the replacement blueprint.



FORM 3 TIME CARD. A. M. & F. CO.
No. 55 Date 10/2/13
Name Kahn

JOB No. 19800

6	Alter	Key Seat	Thread	45
15	Anneal	Knurl	Tools	1
30	Assemble	Lap	Tool Rep.	15
45	Bend	Lay Out	Turn	30
7	Bore	Mark	Watching	45
15	Box	Mill ←	Wood Work	2
30	Broach	Oil		15
45	Bush	Paint		30
8	Cam Cut	Pattern		45
15	Center	Plane		3
30	Chamfer	Polish		15
45	Counter'b	Profile		30
9	Chip	Punch	Piece No.	45
15	Cut off	Rack Cut	SCM	4
30	Draw'g	Ream	408	15
~~45~~	Drill	Rivet		30
10	Face	Screw Mch	No. of Pieces	45
15	File	Scrape		~~5~~
30	Firing	Sett'g up	15	15
45	Fit	Shape		30
11	Forge	Shrink	Time	45
15	Gear Cut	Slot		6
30	Graduate	Splining		15
45	Grind	Str'ght'n	Rate	30
~~12~~	Harden	Sweep		45
15	Help	Tap	Cost	7
~~30~~	Inspect	Temper		

APPROVED GEW Foreman.

Fig. 16. Form of Card used by Time Keepers

There are few factories of any prominence that are not capable of turning out work of the necessary accuracy and finish to meet the requirements of their customers; but there are a great many shops that are hindered in the production of their work through lack of system or through the use of inefficient systems which fail to accomplish the results for which they were installed. This is notably the case in those factories which have employed inefficient production specialists who have installed "cure-all" methods that are unsuited for the work in hand. The system of the American Machine & Foundry Co., described in the preceding pages, is one which combines the valuable characteristics of simplicity and efficiency. It was worked out to meet the requirements of a plant dealing with a great variety of special work in addition to standard manufacturing work. Those who have read the article and grasped the working details of the system will readily appreciate the fact that the features which adapt it to the requirements of handling special work could be applied in factories whose product is of a similar character. It will also be apparent that the system could be used with very slight modifications in many factories handling standard products, and that its simplicity and efficiency should warrant its receiving careful consideration by the manufacturer who contemplates systematizing his work or installing a new system. This system seems to be one that is capable of reducing production costs and increasing efficiency and dividends.

* * *

AN IMPROVED MANGANESE STEEL

An improvement has recently been made in the production of manganese steel, by means of which a steel is obtained which is said to possess the characteristic hardness of the regular manganese steel, but which contains a lower amount of manganese. This renders its production cheaper and affords practical advantages in certain other respects. Commercial manganese steel contains from 11 to 14 per cent of manganese, and hitherto any attempts to produce a steel lower in manganese than 10 to 11 per cent has tended to make a metal nearly as brittle as glass and unfit for commercial use. The new product is based on the discovery that a certain critical relation exists between the percentage of manganese and the percentage of carbon employed with it in the alloy steel, and that by proportioning the carbon ingredients in accordance with this relation, a steel may be obtained containing from 6 to 9 per cent of manganese, or as low as 5 per cent, and possessing to a very marked degree the characteristic combination of ductility with hardness and the other important properties. It is believed that there is a practical limit, around 5 per cent, for the diminution of the manganese. In its preferred form the product, having in its composition an amount of manganese less than 9 per cent, and more than 5 per cent, contains carbon, other than graphite, between or not materially exceeding the following narrower limits, *viz.*, $1.075 - 0.04$ of the percentage of manganese as one limit, and $1.075 + 0.033$ of the percentage of manganese as the other limit, the percentages being taken with reference to the whole. For example, for an 8 per cent manganese steel the preferable limits for the carbon are $(1.075 - 0.04 \times 8) = 0.755$ per cent, and $(1.075 + 0.033 \times 8) = 1.342$ per cent, the amount of carbon present being controlled within these limits according to the degree of ductility required in the product. The ingredients of the product are preferably brought together in a molten state, as is usually the custom with manganese steel alloys. After casting, the metal is properly water-toughened. The new alloy is a poor conductor of heat and practically non-magnetic. This alloy steel is patented by William Campbell, John H. Hall, and Henry M. Howe, and the patent is assigned to the Taylor-Wharton Iron & Steel Co. of High Bridge, N. J.

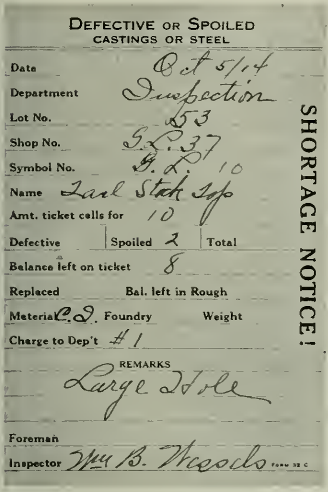
INSPECTION SYSTEM FOR MACHINE SHOPS

ORGANIZATION, LIMITS, NUMBER OF PARTS TO BE INSPECTED, DETECTING DEFECTS OF WORKMANSHIP

BY WILLIAM B. WESSELS[*]

THE necessity for a thorough system of inspection and the advantages gained thereby are now recognized by all modern manufacturing concerns, so that whereas ten or fifteen years ago inspection was relegated to an inferior position among shop duties, it now occupies a place in the front rank where it will certainly remain for all time. In support of these facts, for the benefit of anyone disposed to question them, an illustration or two may easily be cited. The business of a consulting engineer is assuming larger proportions every year, due to the tremendous strides being made in manufacturing industries. If one stops to analyze the functions of a consulting engineer, it will be found that inspection duties form a considerable part of them.

As a further illustration of the growing importance of inspection, it may be mentioned that testing and inspection bureaus are being established, which make a business of inspecting and testing factory and mill products at regular intervals. Such products as wire, cable, flexible tubing, hose, bar steel, etc., produced in factories subscribing for the bureau's service, are now marked with a label or other means, showing that they have been inspected and passed by the testing bureau. The general purpose of such an inspection is not only to give customers the fullest possible guarantee of reliability, and to act as a stimulus for the maintenance in the factory of high standards in design and materials; but also to afford manufacturers means whereby their products will be easily recognized in the field in distinction to inferior and unapproved goods. Furthermore, such an inspection will be an aid to manufacturers in keeping up the quality of work and supervision to a point which will best serve the interests of all concerned. It is seen, therefore, how largely the work of inspection is entering into manufacturing industries. One may be well assured that in these days of keen competition and close scrutiny of expenses of all kinds, an inspection force must be considered a good investment by every firm establishing or employing one, or it would not be tolerated.



DEFECTIVE OR SPOILED
CASTINGS OR STEEL

Date Oct 5/14
Department Inspection
Lot No. 553
Shop No. G.L.37
Symbol No. G.L. 10
Name Tail Stck Top
Amt. ticket cells for 10
Defective | Spoiled 2 | Total
Balance left on ticket 8
Repleced Bal. left in Rough
Meterial C.I. Foundry Weight
Charge to Dep't #1

REMARKS
Large Hole

Foreman
Inspector Wm B. Wessels

SHORTAGE NOTICE!

Fig. 1. Form used by Inspection Department in calling Attention to Shortage in Quantity

Organization of an Inspection Department

The organization of an ideal inspection system would mean the employment of enough inspectors so that each piece could be inspected after each operation. In this way, the inspector would find a defective or spoiled piece before any more time was spent on it. In some plants that are not systematized, as regards their methods of inspection, I have seen jobs that were spoiled on the first operation, complete before the defect was found out, thereby losing a lot of time and money. Another case where an inspector shows himself to be a necessity, is when a complete lot of work comes to him and he not only inspects it, but also keeps a record of the number of pieces received, so that in case of a shortage, the previous operator or department must report whether it was spoiled or defective. If the last operator or department cannot account for the missing piece or pieces, the inspector makes out a shortage slip of the form shown in Fig. 1 against that department, which will be turned in to the cost department where the loss will be figured, and at the end of the month an itemized account is sent to each department showing the heads of departments how much work has been spoiled. Such a record is also kept in the office and at the end of the year this will be found helpful in the company's stock taking. In case a piece or more is spoiled, the tag shown in Fig. 2 or something on this order, may be attached to the work, which will prevent any further confusion.

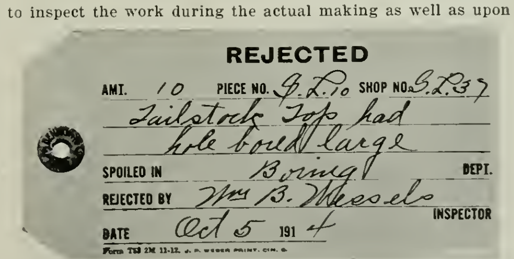
Use of Limiting Instead of Exact Dimensions

Further along in this article, in connection with a discussion of the inspection of work in the shop and the beneficial results to be derived from working to limiting instead of to exact dimensions, it is pointed out that it would be equally desirable if some method could be devised whereby inspectors of materials could be assisted in handling their work by furnishing them standards such as samples, curves or other data showing the limits between which materials could be passed, thus reducing to a minimum the possibility of errors in judgment. The idea intended to be conveyed is exemplified in part by maximum and minimum limit gages. Where such gages can be used, the product when inspected for correctness of size, is supposed to be not greater than the larger nor less than the smaller of the two gages. This is at times likely to cause confusion on the part of some manufacturers, as to what is necessary, or it may cause disappointment on the part of the customers as to what they receive.

Careful records should be kept of materials rejected or found defective in any respect, and steps should be taken to see that such materials are promptly disposed of in order to prevent any possibility of their becoming mixed with accepted materials. At the same time, those who are responsible for the defective parts are communicated with in the most expeditious way so that the defects may be made good with the least possible delay. Fig. 2 shows a rejected or defective material ticket used in the plant of a certain lathe manufacturer, and a similar form would meet the requirements of many other shops.

Not Necessary to Inspect Every Piece

In factories where the inspection department is well organized, an endeavor is constantly made in each department to inspect the work during the actual making as well as upon the completion of it. When it is remembered that in the stockroom ledger of many factories there are listed thousands of different items, one will appreciate the enormous volume of work that is constantly going through the factory and consequently through the inspection department. Of course, it would be a physical impossibility without increasing the force to a disproportionate size, to inspect every individual piece. It would also be equally unnecessary to do so, since many of the parts are made by automatic or semi-automatic machinery, and on all such work it is sufficient to inspect on a percentage basis, a case in point being screw machine product and other



REJECTED

AMT. 10 PIECE NO. G.L.10 SHOP NO. G.L.37
Tailstock Top had
hole bored large
SPOILED IN Boring DEPT.
REJECTED BY Wm B. Wessels INSPECTOR
DATE Oct 5 1914
Form T53 2M 11-12. J. R. WEBER PRINT. CIN. O.

Fig. 2. Form used by Inspection Department in rejecting Defective or Spoiled Work

repetition work. After the tools are once properly set for work of this kind, it is only necessary to prevent them wearing or getting out of alignment. When this contingency has been guarded against, an inspection of a percentage of the finished parts is quite as efficient as an inspection of every piece. On the other hand, parts which are not made by automatic machines, or which are not manufactured in sufficient quantities to warrant the making of dies and limit gages, templets, etc., require detailed inspection.

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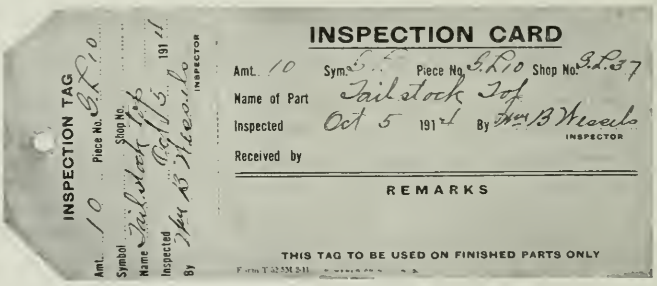
[*] Address: 1828 Holman St., Covington, Ky.

Next to inspecting the work before it leaves the machine or bench, *i.e.*, while it is still uncompleted and in the hands of the workman, the second best method is to have the material after each operation has been performed on it delivered with an identification card to a separate inspection room where it can be thoroughly inspected and passed or rejected. If satisfactory, it is retained and in due course re-issued to another workman for the performance of the succeeding operation. Where the work is small, this method will give excellent results. But in the majority of cases a procedure of this kind is not permissible on account of the large size or awkward shape of pieces, which would require too much labor to handle them. It then becomes necessary for the inspector to go to the work, inspect it and put his special stamp on it, or an inspection tag of the form shown in Fig. 3 may be advantageously employed. It will be found advisable when the size of piece permits of so doing, to stamp it while in the rough state with a serial number, and to check each serial number with the check number of various workmen who perform the work on it. In this way defective work can always be traced back to the right person, no matter what the lapse of time between the performance of the work and its inspection.



INSPECTION TAG

Amt. 10 Piece No. S.L.10

Symbol ..... Shop No. .....

Name Tailstock Top

Inspected Oct 5 1914

By Wm B Wessels INSPECTOR

INSPECTION CARD

Amt. 10 Sym. S.S. Piece No. S.L.10 Shop No. S.L.37

Name of Part Tailstock Top

Inspected Oct 5 1914 By Wm B Wessels INSPECTOR

Received by

REMARKS

THIS TAG TO BE USED ON FINISHED PARTS ONLY

Form T 32 5M 3-11

Fig. 3. Inspection Card attached to Work after its Perfection has been ascertained

In some classes of apparatus, the nature of work is such that each operation serves as a check on the preceding operation. Where such is the case, the workmen themselves act as inspectors. Carrying this idea still further, some concerns hold each workman responsible for any work that may be performed by him on a piece on which any of the preceding operations performed by other workmen have been incorrectly done. All defects or deviations from the drawings and specifications, noted by the inspectors during the inspection of materials or the building of machinery, are given most careful consideration to determine whether the piece should be scrapped outright, whether it may be rectified, or if the part happens to be an unimportant one, whether it may be passed as it stands. Of course, a full knowledge of the situation is required before an intelligent decision can be arrived at. If a decision cannot be given by the inspector himself, the matter is at once referred to the head of the department involved. In the meantime, if it seems advisable, all work which is likely to be affected in any way is stopped, pending a definite conclusion.

Complaints received from the outside that are either from the erecting department or district offices should, if applying to the works, be referred to the inspection department to be thoroughly investigated. A written report should then be made in each case to the manager of the works and to the erecting department, and also to the office for the purpose of having it forwarded to the proper district office. These complaints should be classified on a monthly basis and treated similarly to expenses due to pieces spoiled in the works. When complaints received from outside affect the design only, they should be referred to the engineering department where an analogous course of procedure would be followed. A record of all complaints ought to be maintained by the management, to whom are sent by the office, the erecting and engineering departments, and by the manager of works, copies of such correspondence as may be required from time to time in connection with further inquiry which it may seem desirable to the management to make.

Inspecting for Defects in Workmanship

Defects due to workmanship are undoubtedly more difficult to deal with than those due either to design or to material, though it is not the intention to convey the idea that any of them are easy. Reference is made here more particularly to items of a minor nature, such as form the bulk of defects. When a design has been supposedly corrected, it is of course possible that instead of eliminating trouble one may be simply getting into trouble of a different kind. Assuming the solution to be at hand, it becomes a question of changing records and drawings, when the matter is then closed, once for all. In case of a defect due to workmanship, however, while letters, or any other information, are sent to the assembling departments giving full instructions how to proceed in the future, it is necessary to follow up such instructions continuously in order to see that they are properly carried out, not only for a time, but for all time.

In choosing inspectors, the endeavor should be made to obtain men who have had the requisite experience in the works. In addition, such men should be selected as are likely to appreciate the responsibility of their position, and who are endowed with an abundance of good judgment, not only for passing upon materials submitted for inspection but also in dealing with the men about them. As regards their dealings with the men, inspectors should be absolutely fair and impartial. No discrimination should be made between one workman and another. A feeling of cooperation must also be fostered between the inspectors and the foremen if the work of inspection is to be carried out effectively, although inspectors should not be controlled by the foremen of any department, except a chief inspector.

In some instances I have seen foremen given charge of inspectors. This should not be, as a foreman is likely to order his inspector to pass material to maintain the required rate of production, and the inspector must obey for fear of losing his position. I have experienced this myself years ago; and I know that better results will be obtained if an inspector is under the jurisdiction of none but a chief inspector. As to machinery, this must be inspected with regard to its fitness for the use intended, and here is where discrimination may be shown to good advantage. Drawings usually call for absolute measurements; that is, they give single measurements to work to, and do not, as a general rule, specify what will be accepted and what will not in the matter of variation in the absolute size. It is sincerely hoped that whatever objections exist at present to the specifying of limits of one or two dimensions on drawings may easily be overcome, at least to the extent of introducing such a system on drawings for standard details.

As it is neither possible nor necessary in the vast majority of commercial operations, to reach an absolute degree of refinement, the question is one of relative accuracy. In other words, the error should be confined between the limits of variation either way from the exact dimensions, if the work is to be thoroughly satisfactory. No proper answer can be given in regard to suitable limits until the nature of the work is known. For instance, consider two samples of opposite extremes: one allows a maximum variation of the given dimensions; in the other, no variation must enter. Between these, there is an almost infinite number and variety of graduations. It is the business of the inspectors to differentiate between them—by no means a simple task—and upon their respective abilities to do so depends their success in the inspection department. Their success in this department would naturally serve as a guarantee of their eligibility for further advancement. A certain company in selecting foremen gives preference to inspectors and rate setters, or "feed and speed men," as the latter are sometimes called. As may be surmised, men with proper qualifications for inspectors are exceedingly difficult to obtain from the ranks of skilled artisans, for while practically every inspector must be a journeyman to some trade, not every journeyman makes a good inspector.

There is no better field for cooperation, nor one in which either the results of cooperation or the harmful effects resulting from lack of it, may be more easily seen than the work of inspection. The efficiency of inspection depends largely upon the aid received from the engineering, testing and other departments, members of which are more or less in touch with manufacturing processes and are thus enabled to make many helpful suggestions regarding the work. Of equal value are the letters received from the erecting departments of various district offices, even though these be in some instances complaints regarding defects of machinery. Inspectors are constantly being impressed with the fact that no one can estimate the possible harmful effect which any trouble, even when trivial, may create in the minds of customers. Every letter of complaint from customers should be accepted at its full face value and thoroughly investigated, first with a view to ascertaining the cause of the trouble, and second with a view to preventing a recurrence of it.

It will be found decidedly interesting when complaints are received involving defective workmanship to occasionally send the inspector and foreman of the department in which the apparatus was built to see for themselves the exact cause of the trouble. In this way, their viewpoint will be broadened and they will appreciate even more fully than they otherwise would the requirements of the machinery built in the works. No matter what precautions may be taken to have nothing but perfect machinery shipped from the works, there will be certain points, particularly in connection with new lines of machinery or in applications of standard apparatus, than can only be learned from actual experience. Hence, the works are dependent to quite an extent upon district offices and erecting departments in order to keep them thoroughly posted on all matters of this kind.

* * *

TECHNICAL ENGLISH AS WRITTEN BY THE STENOGRAPHER

BY F. B HAYS[*]

The following letter is a sample of the kind turned out by the average stenographer when trying to write technical English. Persons who have had much experience in dictating letters and other subjects of a technical nature will readily recognize the type. Of course this letter is not a facsimile of one actually written, but is a compilation of the mistakes frequently made by stenographers who have not had much experience in technical work.

Cosmos & Co., Dec. 14, 1914.
New York City
Gentlemen:

We beg to advise that our model B type R machine is best adopted to the work you refer to. This machine has a last iron base, with a phosphate bronze frame. Its total weight is only eighty pounds.

This machine was designed by our corpse of engineers with the idea of combining strength with lightness. Its bearings are of magnolius metal, its shafts of Rome-nickel steel, and its pins are of bold rolled steel Cy and Ide treated. Its springs have the greatest possible restlessency and are made by a special process on a lawn swing turret lathe. Its housing is formed in two pieces by a compound die on a lunch press.

It operates on a current of 110 colts and 8 lampears. It can be used with any steam engine having an incubated horsepower of six or greater at an hour P.M. of 200.

Trusting this information will answer your requirements, we are,

Yours very truly,
MECHANICAL SUPPLY CO.

P.S. You did not state whether your engine is condescending or noncondescending, so we have assumed it to be the latter.

DON'TS FOR DROP-FORGE DIE HARDENERS AND USERS[*][†]

Don't put too much oil on the die during forging as it may check or burst it.

Don't keep a die in a cold place after hardening, particularly if it has not been drawn properly.

Don't put a cold die block into a hardening or annealing furnace that is hot. Heat both up together.

Don't have any dark spots on the blocks when taken from the furnace. They should be the same color all over.

Don't use cyanide on the face in hardening die blocks, as it will cause the sharp corners of the block to break off.

Don't have the furnace too hot when heating the die blocks for hardening, as it is not the furnace that you want to harden, but the blocks.

Don't try to make the die do too much. Do as much in the breaking down as possible and allow the finishing dies to do as little as possible.

Don't draw a die block too fast after hardening. It is better to leave it on the hot plate or in the furnace one-half hour too long than not long enough.

Don't keep a die in the cooling water too long. Take it out as soon as the fingers can be held on the deepest part of the impression without burning them.

Don't put too much water on the shank of the die blocks. Only sufficient water should be put on the shanks during the cooling of the face to prevent distortion.

Don't break the corners on a die block by having them too hot. To aid in preventing breakage of corners of a die block during hardening soap or oil the sharp corners before putting it in the water.

Don't allow the steel in forging to get too cold as it is very likely to crack the die, particularly where the impressions are deep and tapered. Excess material will also cause dies with deep impressions to crack.

Don't start up the hammers in cold weather without first preheating the dies; the dies may break if they are not heated before using. This accounts for the greater number of dies broken in cold weather than in warm weather.

Don't delay drawing the temper. As soon as the block has cooled so that the deepest impression will not burn the fingers, it should be immediately placed in a drawing furnace or drawn on a hot plate, shank down. This drawing should take place immediately after the block is taken out of the water.

Don't blame all the breakage of die blocks on the steel or the die block manufacturer. If a die block had a hole about one inch diameter drilled through the center of it longitudinally, it would prevent the block from breaking, provided the block should have a pipe. Drilling, of course, is only a precaution against piping.

Don't use still water for hardening a die block. The blocks should be immersed to a depth of about three inches in running water. This running water should have sufficient force to penetrate the steam film that forms when a piece of steel is cooling. By having a good flow of water and good force, it will prevent soft spots in the working face of the block.

Don't allow the shoes in the hammers to get out of shape. One-sixty-fourth inch warpage in the shoe will very frequently break a die. Shoes are frequently distorted, due to the fact that short dies are used for a certain length of time and then long dies are used on the same shoes, without dressing them. This will distort the shoes and break the die blocks.

Don't heat a block fast. A rough and ready rule for the length of time a die block should be heated is one hour for each inch of thickness, plus one hour. In other words, a block eight inches thick should be heated about nine hours. It is better for the blocks to stay in the furnace an hour too long and thereby insure that they are heated throughout, than not to have them in the furnace long enough.

* * *

Bell metal is a bronze that contains 80 per cent copper and 20 per cent zinc.

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[*] Address: 107 W. Walnut St., Indianapolis, Ind.

[*] From article by W. L. Goodrich in "The American Drop Forger."

[†] For "Don'ts" previously published, see "Don'ts for Ball Bearing Users," July, 1914.

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A "MECHANICAL" WAR

The European war will be notable in history for the enormous numbers of men engaged and for the general use of machinery. The internal combustion engine has played an important part as the motor for aeroplanes, dirigible balloons, submarines, automobiles and trucks. The motor trucks used both to carry loads and to act as tractors of trains comprising five or six cars have made possible the rapid movement of great numbers of men and vast quantities of munitions of war and other supplies, compared with what was possible when the movements of armies were almost entirely on foot and supplies were transported in wagons drawn by horses. The armored car equipped with rapid fire guns is a formidable appliance that has accomplished enormous destruction on both sides, and it was the motor truck that hauled the great siege guns which hammered down the forts at Liége and Antwerp.

Some motor car enthusiasts have suggested the name "automobile" war for this great conflict; but a more appropriate name would be "mechanical" war. It is a war in which waving banners, playing bands and military pomp are subordinated to essentially practical methods. Complicated field guns, hidden from sight and operated by engineers and mechanics, send forth their missiles of destruction without the operators seeing their enemies. Far behind the field guns, the motor trucks, the aeroplanes, the battleships and all the other mechanical paraphernalia of modern war are the metal-working machines, the basic tools of industry as well as of destruction, without which modern warfare would be impossible. The pity is that these machines should be diverted from the arts of peace to those of war.

* * *

ADJUSTABLE BORING TOOLS

A type of machine tool accessory that has come into common use during the past few years is the adjustable boring tool. It is being made by a number of concerns, and all employ the same general principle of providing means for shifting a boring tool with reference to the center of rotation.

This tool seems to have met a real need. It may be used in the lathe for accurately boring jigs, fixtures and other parts strapped to the carriage, providing means by which holes may be bored to exact diameters. But the widest application is to the drilling machine, which with the help of the adjustable boring tool may be converted into a fairly satisfactory boring machine. This new accessory not only provides cheap and simple means for boring accurate holes with a cheap machine tool, but greatly increases the range of available boring tools, and may be made to take the place of a large stock of reamers at a fraction of their cost. While perhaps it cannot be made to cut as rapidly as solid or adjustable reamers, the feature of adjustability and wide range of application more than compensates for the loss of efficiency, especially in repair shops where the cost of a large stock of reamers is prohibitive.

This is an example of a machine tool accessory designed strictly for tool-room use, which has been developed to a general purpose tool of capacity and efficiency probably far beyond the anticipations of anyone responsible for its early forms.

* * *

BUILDING UP AND MAINTAINING A MANUFACTURING BUSINESS

It is said to be harder to keep a fortune than to make one, and for the same reasons it may be more difficult to maintain a business than to build it up. It does seem to be a law of nature that nothing can stand still—it must either go forward or backward. When a business is being built up the movement is forward—but when development ceases it goes backward actually or relatively. Competitors are progressing, and the concern that no longer is going ahead is left behind.

A machine tool building concern of over sixty years standing which recently closed down affords an excellent example of this condition. Once well known and doing a good business, some years ago signs of decay became noticeable, although not recognized in time by the management, and now the end has come. Started by thoroughly practical men and for many years managed by a board of efficient directors, the business was so prosperous that it paid dividends as high as 50 to 60 per cent. But in the course of time the founders and the original board of directors passed away, the management was left in the hands of relatives and descendants, who, less competent than their predecessors, enjoyed the proceeds of the business already established, and neglected to introduce new blood and younger men with modern ideas.

The directorate, composed of individuals who had obtained their place by inheritance, could not understand why large sums should be expended for advertising, sales promotion and new designs. Improved equipment and other features that should have been introduced to promote efficiency were regarded as unnecessary expenses. The result was that the product remained practically at a standstill, without improvement, while competing machine tool manufacturers forged ahead. The sales dwindled because of the lack of sales promotion, and in the last ten years the concern had passed all its dividends. Finally the dissatisfied stockholders closed down the business so that they could put their money into other and more profitable lines, and a well-known name, representing years of accumulated good-will, at one time a business asset of no small value, was lost.

* * *

INFLUENCE OF NOISE ON WORKMEN

Most manufacturing operations are attended by noises of varying degree. In the present state of mechanical design and construction, noise is unavoidable, but we predict that as efficiency methods are developed, more and more attention will be paid to the suppression of unnecessary noises and the softening of unavoidable noises by guards, shields, massive design, heavy foundations for machines and other means. It is a demonstrated physiological fact that loud, long-continued noises have a serious effect on the nervous system and produce extreme fatigue. Of course all are familiar with the fact that if noise is very severe, it deadens the hearing, often producing permanent deafness.

Many accidents are caused by failure to understand orders and directions in a noisy plant, especially in the case of green men unaccustomed to the din produced by pneumatic hammers and other tools working on steel. Probably it is too much to hope that "sound destroyers" will eventually be developed, although there is some scientific basis for the belief that a result of this kind may be accomplished where the sounds produced in a street or in a room are to be lessened in an adjoining room. In the case of oil forges used for rivet heating, the noise produced by the rapid succession of slight explosions set the air in a quiver and overpower the auditory sense. The design of these burners might be changed so as to change the combustion effect and eliminate the noise by changing the rate of the explosions. If the explosion rate were rapid enough, the sound would no longer be audible because it would be above the pitch of the human ear.

Whatever may or may not be theoretically or practically possible, the subject is one that should be seriously considered by engineers who aim to produce working conditions that will lead to higher efficiency.

* * *

INDUSTRIAL CONDITIONS IN GERMANY

The effect of the war on the machine tool industry in Germany closely resembled that in the United States, except in cities like Essen and Düsseldorf and other metal manufacturing centers. Business in the machinery industry had been dull for over a year; but on the declaration of war orders ceased. Then beginning with the month of September sales gradually increased until some of the larger German machine tool dealers showed a total of sales for December that exceeded any previous month for more than a year. These sales appear to have been largely to concerns manufacturing war material—not necessarily arms or munitions of war, but motor trucks, electrical material of various kinds, textile material, clothing, shoes, cooking utensils and other equipment for the use of the armies. Some of these machine tool orders, however, came from street railways, breweries and other industries that are apparently in no way connected with the war. The same kinds of tools were in demand as those sold in the United States. That is, turret lathes, automatic screw machines, engine lathes from fourteen up to twenty-four inches swing, small milling machines, grinding machines and small drilling machines for holes up to one inch, sold rapidly; but there were few orders for heavy drilling machines, radials, planing and shaping machines, etc. In Essen and Düsseldorf and the other metal manufacturing sections the mills and factories are running day and night and Sundays. The men have not been called out from such enterprises, and they present an appearance of extraordinary activity.

It is rather peculiar to see the effect of the war orders on the sales of machine tool dealers in Germany and other European countries. All the American tools in demand were completely sold out three months ago, and in Germany they began in November and December to deliver tools made in that country, which had apparently been ordered three or four months before. How the machine tool industry will be affected by the impetus thus given to manufacturers in Germany is a question worth considering. Many concerns that have not previously made machine tools and the various metal appliances and material in demand during the war, have gone into their manufacture and will naturally continue in the same lines after the war closes. The German practice of manufacturing tools in small lots is likely to increase the competition among their own manufacturers rather than with ours.

It is a long look ahead to forecast the future of German trade when peace comes; but our belief is that Germany will resume her friendly relations with Russia with less difficulty than is now supposed; first, because there are many Germans in Russia connected with large industrial enterprises who have married in the country and are so related to Russian families as to create a friendly atmosphere; second, because of the proximity of Germany and her facilities for quick deliveries into Russia—during the Japanese war the Germans enjoyed better facilities for shipping their material through Russia than the Russians themselves did; third, because the Germans manufacture a vast amount of material which is particularly adapted by price and quality to the requirements of the Russian market. All these conditions it will be difficult for other nations to overcome.

ON PRODUCING MECHANICAL MOVING PICTURES

With the development of the moving picture industry, there has come into existence a phase of picture making of great interest to the mechanical public. In the effort to produce amusing pictures the services of cartoonists have been enlisted and the results have been astonishing as well as ludicrous. Men, women, animals and inanimate objects go through the most amusing and astounding evolutions, defying gravity, traveling at lightning speed and upsetting natural laws generally.

In order to depict a moving object on the screen with a fair semblance of naturalness it is necessary to make a large number of drawings. Some of the reels for which pictures were made by cartoonists have required 3000 or 4000 separate drawings. Obviously, the labor involved is great, and short-cuts for reducing the labor of drawing are interesting. They are especially interesting to the mechanical world for the reason that the moving picture machine is being used more and more for selling machinery, illustrating its operation and products. As has been pointed out in these columns before, it is possible to illustrate inventions that have never been built and to show the functions of hidden parts of machines and their general operation at a rate which permits critical analysis by the observers. Such pictures, of course, would require to be made from drawings and for this reason we have extracted the following paragraphs from a recent patent granted to J. R. Bray on a "Process of and Articles for Producing Moving Pictures."

The invention provides means of producing on a commercially practical scale, moving pictures which may be designated as inanimate cartoons to distinguish them from ordinary moving pictures. In the usual method, the object photographed is in motion and the exposures are made on the film or other sensitized surface with such rapidity that each successive picture shows the object in a slightly advanced position from that which is occupied in the preceding picture. In this process, an object in motion is not photographed but a series of pictures or drawings are photographed in succession to illustrate the successive positions which the object would take if it were in motion. By rapidly projecting on a screen the photographs of these drawings, the persons, animals or other objects appear to move the same as they do in ordinary moving pictures. These animated cartoons differ from the ordinary moving pictures in that as the drawings may be made from imagination rather than from life, the persons, animals, inanimate objects or the like may be represented as performing acts and assuming positions and expressions which would be impossible in reality and which may be made extremely amusing and entertaining.

The main portion of the invention resides in the steps invented to facilitate the rapid and inexpensive production of a large number of pictures of a series, all the pictures for one scene showing the same setting or background in whole or in part and successive pictures showing the same movable object in slightly different positions. The differences in the successive positions must be comparatively slight and of the proper character so that when the photographs are taken in succession with a moving picture camera, and the resulting film is used in a projector, the object appearing in the picture on the screen will seem to move about from place to place and assume various expressions and positions in a natural and characteristic manner. This requires the making of hundreds or thousands of pictures to be photographed. The reducing to a minimum of the labor and cost involved in the making of these drawings is an important result secured by the invention.

After deciding on the desired scene, room, grouping of stationary objects or other setting which the artist desires to have as a background for the picture, he makes a drawing of said background on any suitable sheet material. He then reproduces by some printing process a large number of copies on a thin translucent material, preferably tracing paper. On the original sheet with the drawings, a guide line or certain guide marks are reproduced on all the copies but outside of the limits of the picture proper. After obtaining by a printing process the desired number of copies on tracing paper of the background, which is to constitute a portion of the complete picture, the artist draws on each printed copy the objects which it is desired to represent as moving. On one sheet the object would be represented in one position, on the next sheet it would be represented in a slightly different position, while on a third it would be in a still different position and so on.

Ordinarily, the background would be printed in black and the moving objects would be drawn also with black ink or paint. If desired, the movable objects may be drawn in solid black, in which case they may be drawn in on the tracing paper directly over parts of the background if the latter be in outline, and no erasure of the background will be necessary. If portions of the background be in solid black and the movable portion be also in solid black, the position of the object in front of the solid black portion of the background may be clearly indicated by erasing or otherwise removing the ink along lines to bring out the outline of the moving object.

The use of tracing paper or other transparent sheet material is of first importance. After one drawing with its printed background and printed guide line has been made and the object has been drawn thereon in the initial position, a second sheet with its printed background and guide line may be superimposed upon the first and, due to the transparency of the material, the guide lines may be brought into registry. The artist then proceeds to draw the object in the second position on a second sheet. As he can see the object in its initial position on the second sheet, he can very easily and accurately secure the proper proportions and appearance of the object on the second sheet and can also secure the exact desired difference in position. In some cases it may be desired to represent only a portion of the object as moving, in which case the object is accurately traced, except the part in motion, which is then drawn in a new position. The use of transparent material thus facilitates the securing of perfect registry but also insures the maintenance of the proper proportions, the change of the desired extent between successive pictures and the imparting of realistic and natural movements.

The inventor states that he has found most inks unsuitable for use on tracing paper where it is desired to show an object in solid black or in wash drawings. The ordinary liquid carriers for the pigments of inks will when the ink dries leave the paper stretched or wrinkled, and the wrinkles or irregularities will show on the screen after the drawings have been photographed. He states that washed shading may be made on the thinnest tracing paper by the use of an ink having turpentine as the carrier of the pigment.

After the series of pictures have been completed, they are photographed successively by means of an ordinary moving picture camera modified by the introduction of a speed reducing gearing which provides for a comparatively large crank movement, say one turn, for each exposure. The pictures are placed one at a time on a suitable support, properly positioned in respect to the camera. The guide marks and guide lines play an important part in connection with photographing the operation as also does the fact that the pictures are drawn on transparent material. The support is provided with guide lines or marks corresponding to those of the picture and as each sheet is placed on the support, the lines or marks on the latter are visible through the paper so that the sheet may be easily adjusted until its guide lines or marks are in perfect registry with those on the support. This insures the steadiness of the picture when projected on the screen

An important feature of the invention is the method employed for controlling the speed of action in the picture. With the ordinary moving pictures the speed of action is controlled primarily by the rapidity of movement of the object photographed, although the rapidity at which the exposures are made in the camera and the rapidity with which successive pictures are thrown on the screen may be varied. In this process, the rapidity of action in the picture projected is primarily controlled by varying the number of exposures for different pictures. For instance, if the scene requires an object to move first rapidly and then slowly and then stop for an instant, the pictures representing the object during the first portion of its course might be given only a single exposure or only a very few exposures. To represent the object as moving more slowly, each picture would be given a larger number of exposures, and to represent the object as coming to a dead stop a still larger number of exposures would be given, dependent upon the time which it is desired to represent the object as remaining at rest. If the pictures are projected on the screen at the rate of sixteen a second, which is the common rate, and it is desired to represent an object as remaining at rest for two seconds, the picture showing the object in that position will be given thirty-two exposures.

From the foregoing, it is apparent that the process is applicable to the representation of machinery in motion and that its employment would materially reduce the labor of making drawings. In fact, it would be possible in the case of rotating parts, to show gears, pulleys and other members rotating by the simple expedient of mounting the parts so as to be turned on their axes for successive views.

* * *

WESTINGHOUSE EMPLOYES WELFARE PLAN

The Westinghouse Electric & Mfg. Co. has issued a preliminary statement of its sickness and accident relief, accident compensation and service pensions, on which its officers have been working for over a year. The plan includes three distinct and separate features as follows:

1. Extension of the present relief department.
2. An accident compensation plan.
3. Service pension.

The privileges of the relief department are open to every department, male or female, regardless of age, position or location, upon payment of small monthly dues. The company pays the entire expense connected with the operation and maintenance of this department, the dues being reserved wholly for the payment of benefits proportional to wages, for sickness and accident arising from causes other than employment. In the event of death, the amount paid from the dues will be duplicated by the company which will also meet any deficit that may arise. Benefits will be continued as long as disability lasts, or until the age of seventy years is reached, when pensions will then be granted.

The accident compensation fund is maintained by the company for the benefit of all employes, male or female, whether they belong to the relief department or not. This plan covers the payment for disability due to accident or for death resulting from accident while at work as an employe, and makes provision for both total and partial disability. In case of total disability, the company will pay as long as disability lasts, even for life, two-thirds of the average wages received, and for partial disability two-thirds of the reduction in the earning capacity of the employe, even though the employe should eventually leave the service of the company. In case of death, the company will immediately pay the dependents or next in kin $150. Medical, surgical and hospital expenses under the direction of the company's medical officers will be paid during disability from such accident.

Employes of the company shall be retired at the age of seventy years and those who at the time of such retirement are members of the relief department and have completed at least twenty years of continuous service are granted a pension amounting to one per cent of the average monthly wages during the last ten years of employment for each year of continuous service with a minimum of $20 per month and a maximum of $100 per month. In those states already having workmen's compensation laws, as in the case of New Jersey and Ohio, where the company also maintains plants, such laws may be substituted in whole or in part. Where the provisions of the Westinghouse plant are more liberal, these will generally prevail.

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The price of printed patent specifications in Great Britain relating to British patents has been reduced from 8d. (16 cents) to 6d. (12 cents) a copy, including domestic postage. This reduction came into force on January 1, 1915, and applies to all specifications.

DRAWING METAL TUBES OF SPECIAL SECTION[*]

METHODS OF PRODUCING ACCURATELY SIZED AND SHAPED TUBES OF BRASS AND COPPER

BY CHESTER L. LUCAS[†]

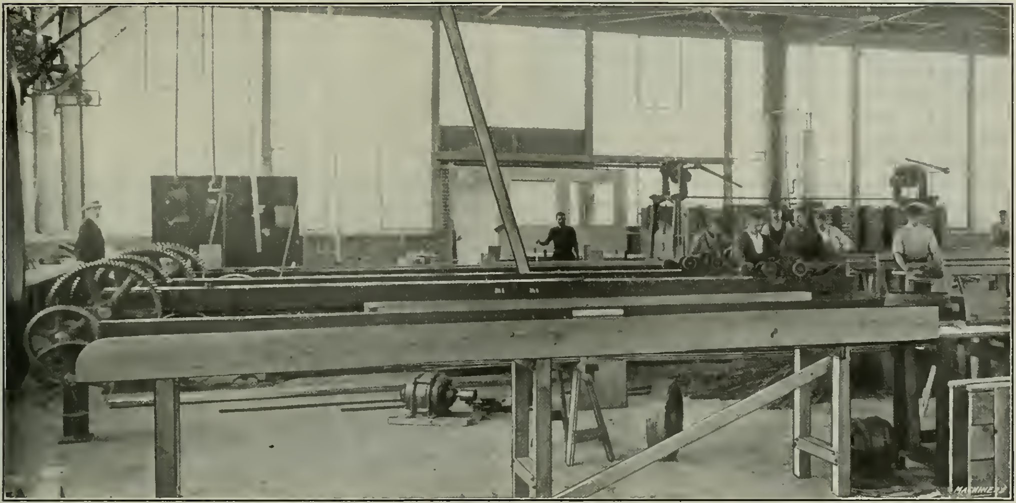

Fig. 1. Some of the National Co.'s Draw-benches

THE drawing of brass and copper tubing to special sizes and sections is a process little known outside of the Naugatuck Valley of the "Nutmeg State." In this part of Connecticut, brass working is the leading industry; so much so, in fact, that Waterbury, in the heart of this section, has been appropriately named the "Brass City." Through the courtesy of the officials of the National Co., one of the youngest and most progressive of the tube-drawing concerns, we are able to give an outline of the operations connected with the work.

The entire process of tube-making from the ingot to the finished shape is rarely conducted under the same roof. The work is divided into the production of semi-finished heavy-walled tubes in one plant and the redrawing of the tubes in another. It is the latter end of the work that the National Co. specializes on, and as its product of special sizes and shapes is nearly all under one inch in diameter, the rough tubes that it receives from the heavy mill are ordered 1⅛ inch outside diameter and 0.85 inch inside diameter. It should be remembered that all tubes, no matter what the finished shape is to be, are redrawn from these roughly finished round tubes.

Broadly speaking, brass and copper tubes are started by one of three commonly used processes. These are the casting process in which a tubular cast ingot measuring about three and one-half feet long with walls one inch thick and a two-inch hole is the basis. Another is the brazed seam process in which the start is made by bending up a heavy brass plate to a tubular form and welding or brazing the joint. The third process is the Mannesmann process in which a heated billet of metal about three feet long and four inches in diameter is rotated rapidly between two slightly conical rolls, resulting in an internal rupture of the billet. By internal rupture is meant the opening up of a central seam which is caused by the "shrugging" of the metal at the center from the rolling pressure on the outside of the bar. A pointed arbor is forced through this spongy center and the result is a roughly formed tube. From this point, in all three processes, the tubes are drawn by the same method to the sizes and shapes specified by the redrawing mills.

Fig. 1 shows a part of the tube-drawing department of the National Co.'s new plant. The draw-benches, by means of which the tubes are drawn, are of the Waterbury-Farrel Foundry & Machine Co. make, and one of these appears separately in Fig. 3. These machines are of different sizes for working on heavy or light stock, varying in pulling power from 1000 pounds to 20,000 pounds, but each machine handles tubes up to twenty feet in length. The mechanism of the draw-bench is very simple and powerful. As shown in Fig. 3 and in detail in Fig. 2, it consists of a "bench" about twenty-five feet long within which is an endless sprocket chain of

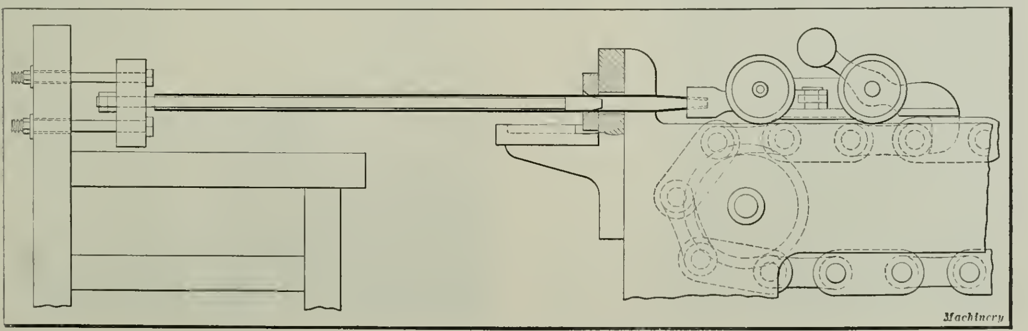

Fig. 2. Diagram illustrating the Tube-drawing Operation

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[*] For information on this and similar subjects previously published in MACHINERY see "The Making of Seamless Gold Wire," March, 1911; and "The Manufacture of Tubing by Autogenous Welding," January, 1912.

[†] Associate Editor of MACHINERY.

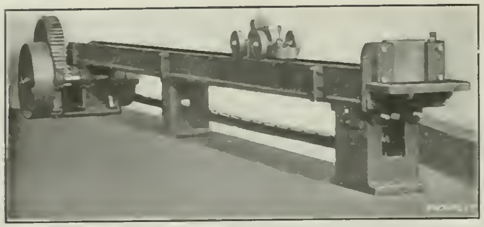

Fig. 3. Waterbury-Farrel Foundry & Machine Co. Draw-bench

very heavy pattern that passes over a sprocket at the driving end and an idler at the head of the machine. The drive is through compound gearing to the sprocket at the end of the draw-bench, and the sprocket chain runs continuously. The speed at which the chain travels is about sixty feet a minute for the smaller sized machines but slower in the larger machines.

At the forward end of the machine, the frame runs into a very heavy head, against which the dies are held when drawing the tubes. Supported centrally in the head is a steel plate with a clearance hole large enough for the tubes to pass through. Directly against this clearance plate, the dies are held loosely while the tubes are pulled through them. This drawing operation is accomplished by a carriage, drawn away from the head of the machine by means of a hook that may be caught between the chain links. On the forward end of this carriage is a pair of gripping jaws that catches the end of the tube when it is started through the die and pulls it through the die. At the end of the stroke, the hook is lifted out of the chain and the carriage returned by hand.

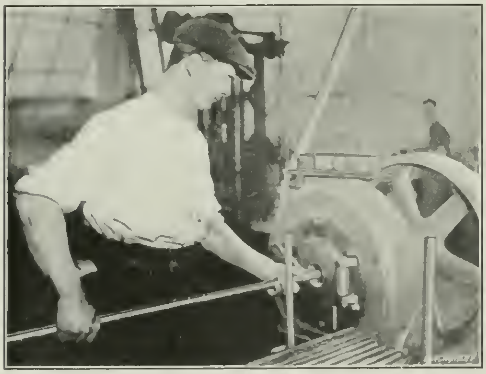

Fig. 4. Swaging the Ends of the Tubes preparatory to drawing

It is quite necessary to control the inside diameter of the tube that is being drawn, as well as the outside, otherwise the reduction would all take place from the outside and leave the walls of the tube very thick. In order to properly gage the inside of the tube while it is being drawn through the die, the inside is kept from closing in by the insertion of a steel mandrel or "triblet," as it is called. This triblet is a rod which is slightly smaller in diameter than the tube over which it is drawn, and of course it must be of a length longer than any tube that will be drawn over it. To the end of the triblet is welded a hardened steel tip, the shape and size of which gage the inside of the tube. At its opposite end it is secured to the center of a bar that has a sliding action of five or six inches over two bolts in the standard of the wooden bench at the rear The purpose of this movement will be explained later.

The Drawing Operation

As before stated, the tubes as received from the heavy drawing mill are approximately 1¼ inch diameter, with walls 0.85 inch thick. It is obvious that no reduction can take place until the ends of these tubes have been reduced to a size that will pass through the drawing die so that they may be gripped by the tongs and pulled through the die. This is done by means of a Waterbury-Farrel Foundry & Machine Co. swaging machine, as illustrated in Fig. 4. At this stage the tubes are approximately six feet long. The ends are swaged down in this machine by a pair of dies that revolve around the tube and strike together at a very rapid rate. The tubes are reduced for a distance of about four inches, which allows them to project through the die far enough to be gripped.

We now come to the drawing operation itself, which is performed as illustrated in Figs. 5 and 6. For rapid production, two men are required to operate a draw-bench, one of whom attends to the placing and removing of the tubes on the triblet, while the second man handles the gripping jaws and looks out for the return of the carriage. Fig. 5 shows one of the operators putting the tube on over the triblet. For this purpose he allows the swaged end of the tube to rest on a standard that projects from one side of the machine. After the tube has been placed over the triblet, the tube and triblet are pushed back for the five inches movement that has been before spoken of. The reduced end of the tube is now passed through the die, and the second operator grips it with the carriage tongs, which close on the work as soon as the pulling action commences. Next he allows the hook that may be seen in this illustration to drop into one of the links of the chain, and the tube is pulled through the die, carrying the triblet forward for the full distance of its play, after which it remains stationary while the tube draws by it. This advance of the triblet brings the full-sized section of the tip central in the die, and thus the die and the triblet provide an outer and inner gage through which the metal is drawn. As the tube passes through the die, the operator flushes it with drawing lubricant. Fig. 6 shows the tube in process of drawing. As the drawing operation reduces the diameter of the tube and the thickness of the walls, the surplus metal lengthens the tube, so that a tube six feet long at the beginning is often twelve feet long after the first or second drawing operation. When it approaches the limit of the drawing length, it is cut into halves with a circular saw.

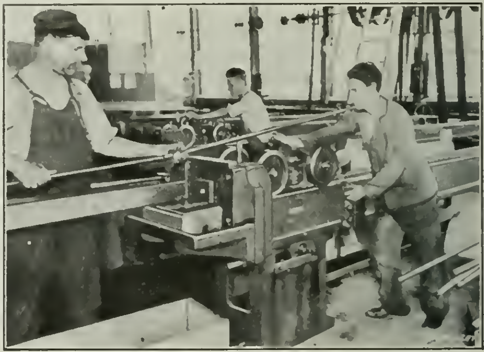

Fig. 5. Passing the Tube over the Triblet before drawing

Fig. 6. The Drawing Operation

One of the points that makes for rapid production in tube drawing is the knowledge of the amount of metal that can be "moved" at each drawing operation. In general, this averages two to four gage numbers. Between the drawing operations, the tube must be annealed, and this is done in a large furnace, shown in Fig. 7. The tubes are piled on a carrier that is rolled into and out of the furnace. A low red heat brings them to the annealing point, after which they must be pickled and washed before redrawing.

Up to the present, nothing has been said about the dies for drawing or the special shapes to which the tubing is drawn. All are started from the round, and even finished round tubes go through this process to bring them to the exact gage diameter, thickness of walls, etc. In regard to the dies for the special shapes, there is very little to be said except that they are made from tool steel about one inch thick and from four to six inches diameter according to the size opening. In each case they are made from one piece of steel. The entering side of the die is chamfered so that the metal will draw in easily, and of course polishing of the drawing surfaces of the die is very essential. These dies are hardened and drawn and after they have worn out to a size too large for that required, they are shrunk in and polished out to the original size. The triblet tips are made to conform to the dies with which they are used, allowing, of course, for the thickness of the walls.

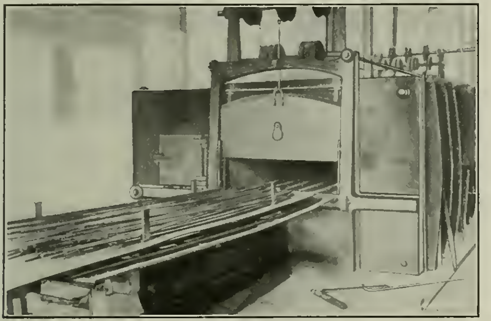
Fig. 7. An Annealing Furnace for Tubes

The more unusual the shape of the section of the tubing to be drawn, the larger the number of operations that will be required. Thus in drawing a square tube it would take several operations to bring it to the sharp cornered square shape that would be required. An experienced tube-drawer knows just how much he can reduce the metal at each draw, and consequently keeps the number of operations as low as possible.

The possibilities of tube-drawing are practically unlimited. In addition to brass and copper tubing, silver tubes, or in fact tubes of any of the non-ferrous metals, may be readily drawn, and at the National Co.'s factory the limits are held very close. Tubing is drawn here to any outside dimension in thousandths inch, with similar limits for the thickness of walls and the diameter of the hole.

* * *

In a paper prepared by Rome G. Brown for the International Water Power Congress that was to be held at Lyons, France, last September, some interesting figures are given on the potential water power of the United States. The potential water power of the United States is conservatively estimated at 150,000,000 kilowatts, and of this at least 15,000,000 kilowatts is yet unutilized which would be in process of utilization if conditions were such as to attract private capital. The amount of water power already commercially utilized in the United States is approximately 5,000,000 kilowatts while the amount of steam power in use is about 15,000,000 kilowatts. To those who anticipate the time when the coal resources of the country will be exhausted, it will be a comforting thought to learn that the potential water power is theoretically equal to the consumption of 40,000,000 pounds of coal hourly or 480,000 short tons daily. In other words, if all the water power of the United States was utilized and turned into heat, it would annually equal that generated by nearly 180,000,000 tons of coal.

S. A. E. STANDARD THREADS

At the meeting of the standards committee of the Society of Automobile Engineers, held last November, reports were submitted by a number of sub-committees. One of these reports related to the extension of the S. A. E. standard threads for screws beyond 1½ inch diameter. For diameters larger than 1½ inch, it was recommended that two standards be adopted, one of coarse and one of fine threads; the form of thread, of course, would remain the United States standard form, and the number of threads per inch to be used would be as follows:

For coarse threads, beginning at 1⅝ inch, and advancing by ⅛ inch increments to 2⅞ inches, inclusive, 12 threads per inch.

Beginning with 3 inches, and advancing by ⅛ inch increments up to 5⅞ inches, inclusive, 10 threads per inch.

Beginning with 6 inches, and advancing by ⅛ inch increments upward, 8 threads per inch.

The fine threads were to be as follows:

Beginning with 1⅝ inch, and advancing by ⅛ inch increments up to 2⅞ inches inclusive, 18 threads per inch.

Beginning with 3 inches, and advancing by ⅛ inch increments upward, 16 threads per inch.

These recommendations were presented after a careful survey of data submitted by twenty-two motor-car manufacturers, together with returns received from manufacturers of automobile parts and tap manufacturers. Present practice reveals no harmony in the use of screw threads for large diameters. The sizes recommended are representative of the practice so far as indicated and discussion is invited with relation to the standard proposed. The reason why two series of pitches are adopted is because one would be generally required for cast metals while the other would be used in steel. This report on screw threads is not final, but intended as a progress report only.

* * *

China recently enacted a weights and measures law in which the meter and kilogram are prescribed as the sole standards, although the old system of measures is still recognized. The units of the old system are defined in metric terms, the length unit being exactly 32 centimeters. The metric units are given the same names in the Chinese language as the nearest old units, but to each is given the prefix "sin," which means "new." Thus the meter will be known as "sin-tchi," and the kilogram as "sin-king." The metric system was not made compulsory at the outset, the date of compulsory application of the act being fixed later.

* * *

CHIP FROM CUTTING-OFF MACHINE

The accompanying illustration shows a curious chip obtained from an ordinary cutting-off machine, the material cut being ordinary mild machine steel. The cutting-off tool was ground with a 10-degree clearance angle in front but was flat on top. The chip is 3/16 inch wide, about 0.007 inch thick and has a total length of about 35 feet. There are about 120 convolutions or layers from the center to the periphery. The chip came from the machine neatly rolled up, as shown in the accompanying illustration.

Steel Chip 35 Feet Long rolled like a Clock-spring by Cut-off Tool

PROPOSED GRINDERS' SAFETY CODE

FOR THE USE AND CARE OF ABRASIVE WHEELS AND THE PARTS OF GRINDING MACHINES RELATED THERETO

RECOGNIZING the lack of appreciation among many users of abrasive wheels, insurance engineers, officials of state labor departments and factory inspectors, of the important factors bearing on safety in connection with abrasive wheels, and recognizing that this lack of appreciation is responsible for many easily preventable accidents, the abrasive wheel manufacturers appointed a committee to draft a code for safe practices in relation to abrasive wheels. This code is to be used as the foundation of a campaign for uniform state laws and uniform insurance rules in an endeavor to overcome present and prevent future unsafe practices and also to eliminate much of the confusion existing at present, brought about from the lack of uniformity in state and insurance requirements. This lack of uniformity has resulted in a condition which seriously affects every user of abrasive wheels, every manufacturer of abrasive wheels, and every manufacturer of grinding machinery.

The report of a special committee appointed by the National Machine Tool Builders' Association to consider safety in connection with abrasive wheels and grinding machines, and a tentative report of a special committee appointed by the state of Pennsylvania to draft laws pertaining to grinding and polishing, were used as a basis of consideration for the code which follows and which has been approved by the following abrasive wheel manufacturers:

Abrasive Material Co., Philadelphia, Pa.
American Emery Wheel Works, Providence, R. I.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Carborundum Co., Niagara Falls, N. Y.
Canadian-Hart Grinding Wheel Co., Hamilton, Ont., Canada.
Commercial Corundum & Emery Wheel Co., Chicago, Ill.
Cortland Corundum Wheel Co., Cortland, N. Y.
Dayton Grinding Wheel Co., Dayton, Ohio.
Detroit Grinding Wheel Co., Detroit, Mich.
Dominion Abrasive Wheel Co., Toronto, Canada.
Hampden Corundum Wheel Co., Springfield, Mass.
Manhattan Rubber Manufacturing Co., New York City.
National Corundum Wheel Co., Buffalo, N. Y.
New York Belting & Packing Co., New York City.
Norton Co., Worcester, Mass.
Pittsburg Emery Wheel Co., Rochester, Pa.
Safety Emery Wheel Co., Springfield, Ohio.
Springfield Mfg. Co., Bridgeport, Conn.
Star Corundum Wheel Co., Detroit, Mich.
Sterling Grinding Wheel Co., Tiffin, Ohio.
Superior Corundum Wheel Co., Waltham, Mass.
Vitrified Wheel Co., Westfield, Mass.
Waltham Emery Wheel Co., Waltham, Mass.

Abrasive wheel manufacturers recommend three general types of safety devices to be used for grinding wheels, namely, protection flanges, protection hoods and protection chucks.

Protection Flanges

1. The abrasive wheel manufacturers recommend protection flanges of the double or single concave type, used in conjunction with wheels having double or single convex tapered sides or side.

2. Flanges of the sizes shown opposite wheel diameters in column C, Table I shall be used. As wheels wear, size of flanges as indicated in column C shall be maintained.

3. New installations of protection flanges for double tapered wheels shall have a taper of not less than three-fourths inch to the foot for each flange, and the center of flange shall conform with the dimensions shown in column B. Such flanges shall be of a thickness not less than is shown in column D.

4. New installations of protection flanges for single tapered wheels shall have a taper of not less than three-fourths inch to the foot and the center of flange shall conform with dimensions shown in column B. Thickness of such flanges shall be as shown in column F.

5. Each flange, whether straight or tapered, shall be relieved or recessed at the center at least one-sixteenth inch on the side next to the wheel for a distance as specified in column E.

6. All tapered flanges over ten inches diameter shall be of steel or other material of equal strength. Tapered flanges ten inches and smaller in diameter may be made of cast iron.

7. All flanges shall be accurately turned, correct to dimensions and in balance, except flanges which are purposely made out of balance. Two such flanges are known as balancing flanges and are sometimes used to counteract out of balance condition in an abrasive wheel.

8. Both flanges in contact with the wheels shall be of the same diameter.

TABLE I. DIMENSIONS OF TAPERED FLANGES AND TAPERED WHEELS WHERE HOODS ARE NOT USED IN CONJUNCTION THEREWITH

A = maximum flat spot at center of flange, in inches;
B = flat spot at center of wheel, in inches;
C = minimum diameter of flange, in inches;
D = minimum thickness of flange at bore, in inches;
E = minimum diameter of recess in taper flanges, in inches;
F = minimum thickness of each flange for single taper at bore, in inches.

Diam. Wheel	A	B	C	D	E	F
6	0	1	3	3/8	2	3/8
8	0	1	5	3/8	3½	3/8
10	0	2	6	½	4	½
12	4	4½	6	5/8	4	5/8
14	4	4½	8	5/8	5½	¾
16	4	6	10	5/8	7	7/8
18	4	6	12	¾	8	1
20	4	6	14	¾	9	1
22	4	6	16	¾	10½	1 1/8
24	4	6	18	¾	12	1 1/8
26	4	6	20	¾	13½	1 1/8
28	4	6	22	7/8	14½	1¼
30	4	6	24	7/8	16	1¼

9. Where hoods are used in conjunction with tapered wheels and tapered flanges, the specifications given in Table III may be followed.

Protection Hoods

10. Protection hoods shall always be used where practicable with wheels not provided with protection flanges. Hoods shall be designed and constructed of a material sufficiently strong to retain all pieces of a broken grinding wheel.

11. Hoods shall conform as nearly as possible to the periphery of the wheel, and shall be so designed as to leave exposed the least portion of the wheel compatible with the work, and shall be of the adjustable type or provided with a sliding tongue or similar device, or a method of contracting the rim, for the purpose of closing the opening in the hood as the wheel is reduced in diameter, to afford maximum protection at all times.

12. Protection hoods must be securely fastened to the grinding machine or floor.

13. Protruding ends of the wheel arbors and their nuts shall be guarded.

Cups, Cylinders and Sectional Ring Wheels

14. Cups, cylinders and sectional ring wheels shall be either protected with hoods or enclosed in protection chucks or surrounded with protection bands. Not more than one-fourth the height of such grinding wheels shall protrude beyond the provided protection.

General Safety Requirements

TABLE II. MINIMUM SIZES OF MACHINE SPINDLES IN INCHES FOR VARIOUS DIAMETERS AND THICKNESSES OF GRINDING WHEELS

Diam in Inches	Thickness of Wheel in Inches																		
	¼	3/8	½	5/8	¾	1	1¼	1½	1¾	2	2¼	2½	2¾	3	3¼	3½	4	4½	5
6	½	½	½	½	½	½	5/8	5/8	¾	¾	¾	¾	¾	¾	¾	¾	1	1	1
7	½	½	½	½	5/8	5/8	5/8	¾	¾	¾	¾	¾	¾	1	1	1	1	1	1
8	5/8	5/8	5/8	5/8	5/8	5/8	¾	¾	¾	1	1	1	1	1	1	1	1¼	1¼	1¼
9	5/8	5/8	5/8	5/8	¾	¾	¾	¾	1	1	1	1	1	1¼	1¼	1¼	1¼	1¼	1¼
10	¾	¾	¾	¾	¾	¾	¾	¾	1	1	1	1¼	1¼	1¼	1¼	1¼	1¼	1½	1½
12	¾	¾	¾	¾	¾	1	1	1	1	1	1	1¼	1¼	1¼	1¼	1¼	1½	1½	1½
14	7/8	7/8	7/8	7/8	1	1	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1½	1½	1½	1½	1½	1½
16					1¼	1¼	1¼	1¼	1¼	1¼	1½	1½	1½	1½	1½	1¾	1¾	1¾	1¾
18	..				1¼	1¼	1¼	1½	1½	1½	1½	1½	1½	1½	1¾	1¾	1¾	1 7/8	1 7/8
20	..	..				1½	1½	1½	1½	1½	1½	1½	1¾	1¾	1¾	1 7/8	1 7/8	1 7/8	1 7/8
24						1½	1½	1½	1¾	1¾	1¾	1¾	1¾	1¾	2	2	2	2	2
26							1½	1½	1¾	1¾	1¾	1¾	2	2	2	2	2¼	2¼	2¼
30								1¾	1¾	2	2	2	2	2	2¼	2¼	2½	2½	2½
36									2	2¼	2¼	2¼	2½	2½	2½	2¾	2¾	3	3

Machinery

15. Competent men shall be assigned to the mounting, care and inspection of grinding wheels and machines.

16. Before mounting, all wheels shall be closely inspected to make sure that they have not been injured in transit, storage or otherwise. For added precaution wheels other than of the elastic and vulcanic type should be tapped lightly with a hammer. If they do not ring with a clear tone they should not be used. Damp wheels when tapped with a hammer may not give a clear tone. Wheels must be dry and free from sawdust when applying this test.

17. Grinding wheels shall fit freely on the spindles. They shall not be forced on nor shall they be too loose.

18. Wheel arbor holes shall be made 0.005 inch larger than the machine arbor.

19. The soft metal bushing shall not extend beyond the sides of the wheel at the center.

20. Ends of spindles shall be threaded left and right so that the nuts on both ends will tend to tighten as the spindles revolve. Care should be taken in setting up machines that the spindles are arranged to revolve in the proper direction, else the nuts on the ends will loosen. (See paragraph 28.)

21. Wheel spindles shall be of sufficient length to permit of the nut being drawn up at least flush with the end of the spindle, thus providing a bearing for the entire length of nut.

22. The surfaces of wheels in contact with straight or tapered flanges, the surfaces of the flanges in contact with the wheels, and the wheel washers between the flanges and wheels shall be clean, smooth and free from foreign material.

23. Size of straight flanges for straight wheels shall not be less than shown by column B, Table III.

24. All straight flanges shall be relieved or recessed at the center at least one-sixteenth inch on the inside surface of flange, for a diameter as specified in column C.

TABLE III. DIMENSIONS OF STRAIGHT FLANGES AND STRAIGHT WHEELS USED WITH PROTECTION HOODS, IN INCHES

A Diameter of Wheel	B Min. Outside Diam. Flange	C Min. Diam. Recess	D Min. Thickness Flange at Bore
6	2	1	3/8
8	3	2	3/8
10	3 1/2	2 1/4	3/8
12	4	2 3/4	1/2
14	4 1/2	3	1/2
16	5 1/2	3 1/2	1/2
18	6	4	5/8
20	7	4 1/2	5/8
22	7 1/2	5	5/8
24	8	5 1/2	5/8
26	8 1/2	6	5/8
28	10	7	3/4
30	10	7	3/4

25. Wheels shall never be run without flanges.

26. Both flanges in contact with the wheels shall be of the same diameter whether straight or tapered.

27. Wheel washers of compressible material such as blotting paper, rubber or leather, not thicker than approximately 0.025 inch, shall be fitted between the wheel and its flanges. It is recommended that the wheel washers be slightly larger than the diameter of the flanges used.

28. When tightening clamping nuts, care shall be taken to tighten same only enough to hold the wheel firmly, otherwise the clamping strain is likely to crack the wheel.

29. Flanges, whether straight or tapered, must be frequently inspected to guard against the use of flanges which have become bent or sprung out of true, or out of balance. If a tapered wheel has broken, the tapered flanges must be carefully inspected for truth before using with a new wheel. Clamping nuts shall also be inspected.

30. The work rest must be kept adjusted close to the wheel to prevent the work from being caught. Work rests must be rigid and always securely clamped after each adjustment.

31. A speed of 5000 peripheral feet per minute is recommended as the standard operating speed for vitrified and silicate straight wheels, tapered wheels and shapes other than those known as cup and cylinder wheels, which are used on bench, floor, swing frame and other machines for rough grinding. Speeds exceeding 5000 feet may be used upon recommendation of the wheel manufacturer, but in no case shall a speed of 6500 peripheral feet per minute be exceeded.

32. A speed of 4500 peripheral feet per minute is recommended as standard operating speed for vitrified and silicate wheels of the cup and cylinder shape, used on bench, floor, swing frame and other machines for rough grinding. Speeds exceeding 4500 peripheral feet per minute may be used upon recommendation of the wheel manufacturer, but in no case shall 6000 peripheral feet per minute be exceeded.

33. For elastic, vulcanite and wheels of other organic bonds, the recommendations of individual wheel manufacturers shall be followed.

34. For precision grinding an operating speed of 6500 peripheral feet per minute may be recommended. Speeds higher than this can be used only upon recommendation of the wheel manufacturer.

35. The following table gives revolutions per minute for various sizes of wheels for the peripheral velocities at the head of each column.

TABLE IV. REVOLUTIONS PER MINUTE FOR VARIOUS SIZES OF GRINDING WHEELS TO GIVE PERIPHERAL SPEED IN FEET PER MINUTE AS INDICATED

Diam. Wheel in Inches	4000	4500	5000	5500	6000	6500
1	15279	17200	19099	21000	22918	24850
2	7639	8590	9549	10500	11459	12420
3	5093	5725	6366	7000	7639	8270
4	3820	4295	4775	5250	5730	6205
5	3056	3440	3820	4200	4584	4970
6	2546	2865	3183	3500	3820	4140
7	2183	2455	2728	3000	3274	3550
8	1910	2150	2387	2635	2865	3100
10	1528	1720	1910	2100	2292	2485
12	1273	1453	1592	1750	1910	2070
14	1091	1228	1364	1500	1637	1773
16	955	1075	1194	1314	1432	1552
18	849	957	1061	1167	1273	1380
20	764	860	955	1050	1146	1241
22	694	782	868	952	1042	1128
24	637	716	796	876	955	1035
26	586	661	733	809	879	955
28	546	614	683	749	819	887
30	509	573	637	700	764	827
32	477	537	596	657	716	776
34	449	506	561	618	674	730
36	424	477	531	553	637	689
38	402	453	503	534	603	653
40	382	430	478	525	573	621
42	364	409	455	500	546	591
44	347	391	434	477	521	564
46	332	374	415	456	498	539
48	318	358	397	438	477	517
50	306	344	383	420	459	497
52	294	331	369	404	441	487
54	283	318	354	389	425	459
56	273	307	341	366	410	443
58	264	296	330	354	396	428
60	255	277	319	350	383	414

36. Machine spindle shall be tested and determined correct for size of wheel to be operated before wheel is mounted, and shall never be changed as a wheel is reduced in diameter, except by men assigned for such duties.

37. If a wheel spindle is driven by a variable speed motor, speed control of the motor shall be enclosed in a locked case, or some device shall be used which will prevent motor from being run at too high speeds.

38. Grinding machines shall be sufficiently heavy and rigid to prevent vibration, and they should be securely mounted on substantial foundations.

39. No user of wheels shall use on any given machine a wheel of larger diameter or greater thickness than specified by the machine builder.

40. Wheels which wear out of round shall be trued by a man assigned to that duty. If wheels become out of balance through wear and cannot be balanced by truing or dressing, they should be removed from the machine.

41. A wheel used in wet grinding shall not be allowed to stand partly immersed in the water. Water-soaked portion may throw the wheel dangerously out of balance.

42. Wheel dressers should be equipped with rigid sheet metal or other guards over the tops of the cutters, to protect operator from flying pieces of broken cutters.

43. Goggles shall be provided for use of grinding wheel operators where there is danger of eye injury. They should be readily accessible, or better, should be the individual property of the operator. Where this is not done, men should be urged to wash their faces immediately before and after using the goggles.

44. The space about the machine shall be kept dry, clean and as free as possible from castings or other obstructions.

45. Grinding rooms shall not only be well ventilated and well lighted, but kept warm and dry. Machines shall be attached to a dust-exhausting system. Besides protection to the workmen, the dust exhausting system prevents wear and tear on machinery and belts.

46. Care shall be exercised in the storage of wheels. They shall be stored in dry places and should be well supported on edge in racks. Work shall not be forced against a cold wheel but applied gradually, giving the wheel an opportunity to warm and thereby eliminate possible breakage. This applies to starting work in the morning in grinding rooms which are not heated in winter and new wheels which have been stored in a cold place.

Precautionary Suggestions

47. It is recommended that where possible straight flanges of the dimensions shown in Table III be used in conjunction with protection flanges. This recommendation is made as an additional protection to give added strength to the safety flanges.

48. Cone pulleys determining the speed of a wheel should never be used unless belt locking devices are provided.

49. The maximum size of wheel which should be used with

given operating speeds should be indicated on each machine.

50. Grinding machines should be provided with a stop or some method of fixing the maximum size of wheel which may be used, at the speed at which the wheel spindle is running.

51. Boxes must be of proper length to provide an ample bearing surface, and prevent heating or rapid wear. It is important that the bearings be kept well lubricated and properly adjusted. Ring oiling devices are recommended, amply protected from dust and grit, and box caps should be adjusted for take-up.

52. For protection against flying chips, etc., plate glass in metal frames can be placed just above the grinding spaces of the wheels.

53. Where it is impracticable or undesirable to use a glass shield, a leather flap may be attached to the hood and adjusted so as to intercept sparks and dust.

The committee of the National Machine Tool Builders Association appointed to confer with the committee of abrasive wheel manufacturers has formally approved of the safety code given in the foregoing.

* * *

GRINDING STREET CAR WHEELS UNDER THE CAR

It is extremely annoying to ride in a street car having flat wheels. Not only is it annoying to ride in a flat wheel car, but it is exasperating to have such cars traverse the streets of a city or town. The constant pounding of flat spots on the rails becomes a greater nuisance every time it is felt and heard. But the maintenance of street car equipment as regards the elimination of flat spots on wheels is a difficult and expensive proposition. If the wheels are removed and ground in a machine the moment a flat spot is detected, it means tying up a car for the time required to remove the truck and put in another with perfect wheels, and often the car cannot be spared for the purpose. The longer the car runs, however, the worse the flat spot gets and finally it becomes so bad that it is impossible to grind it out without cutting away all the hard part of the tread—hence, the value of grinding machines that grind the wheels while under the car and which require a minimum time for the operation.

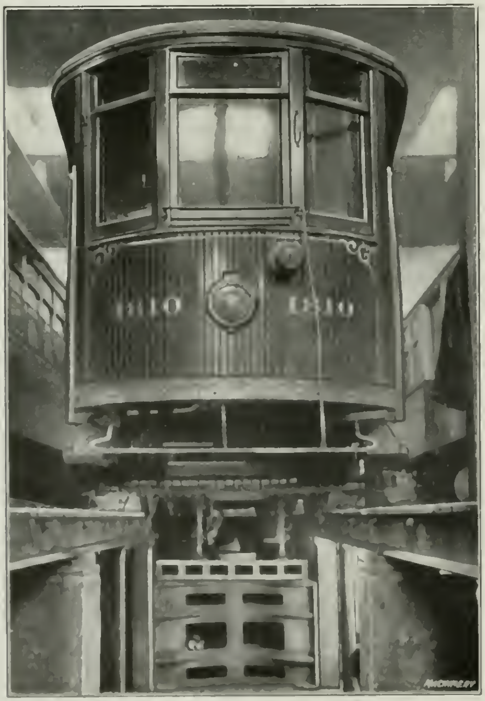

Fig. 1. Street Car in Position for having its Wheels ground

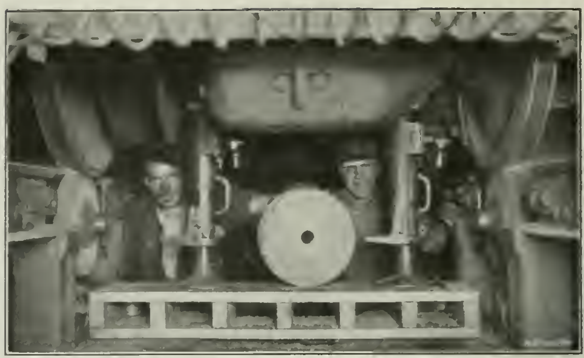

Fig. 2. Closer View of Grinding Operation (Note Streams of Sparks)

The American Emery Wheel Works of Providence, R. I., has tackled the problem of grinding car wheels in the Providence shops of the Rhode Island Traction Co. Grinding car wheels is a difficult service, as the grinding wheels receive very severe usage in this work. Every time a flat spot is encountered there is a tendency for the grinding wheel to glance away. Moreover, as these flat spots are sometimes on the low side of a worn wheel, it is necessary oftentimes to remove fully 1/4 inch by grinding. The steel tires used on car wheels are very tough and the treads of chilled wheels are very hard. Every time the motorman spins the wheels in sand on a slippery rail the surfaces become harder and more glassy.

Fig. 1 shows the way in which the car wheels are ground without removing them from the bearings in the trucks. The grinding mechanism is located in the car house pit, the grinding wheels being located in the line of track. After the car has been run to a position over the grinding machine, it is jacked up, bringing the wheels clear of the rails as shown in Fig. 2. A short length of rail directly under each car wheel is then removed from the track and the grinding wheels are raised to come in contact with the car wheels. Power for driving the car wheels is furnished through the motor of the car and they are turned at a speed of about 75 R. P. M. The American grinding wheels used are 14 inches diameter and 2 1/4 inches wide. The grinding speed is 1600 R. P. M.

This grinding job has been developed to the point where it now requires an average of about twenty minutes to grind a pair of car wheels. One pair of grinding wheels trues up from forty to forty-eight pairs of car wheels. This is considered a good record in view of the condition of the wheels and the amount that has to be ground away to obtain a true tread.

C. L. L.

* * *

STEAM TURBINES IN ROLLING MILLS

The steam turbine did not find favor for rolling mill drives until recently, because it necessarily had to operate at high speeds, and its torque characteristics were not considered by mill engineers as suitable for rolling mill purposes. A recent installation in the plant of the Carpenter Steel Co., Reading, Pa., indicates, however, that any difficulties which may have presented themselves in the utilization of turbines for rolling steel have been surmounted. According to the *Iron Trade Review*, the speed problem has been solved by the use of reducing gears similar to those employed on board ship. These gears have also, in connection with suitable flywheels, settled the torque question. The turbines used are of the De Laval type, built by the De Laval Steam Turbine Co., Trenton, N. J. The equipment to be driven includes a three-high roughing mill together with 10-inch and 8-inch finishing mills. The entire cost of installation, consisting of the turbine, reduction gear, condenser and accessories erected complete, is said to have been approximately $25,000. Owing to the economy secured through its use, it has been possible to reduce the capacity of the boilers in operation from 1000 boiler horsepower to about 600 boiler horsepower. This reduction of boilers in use means an approximate saving of about $15,000 a year to the steel company.

MODERN ESTIMATING METHODS

SOME OF THE FUNDAMENTAL PRINCIPLES OF COST ESTIMATING WITH SPECIFIC INFORMATION ON THE GENERAL PROCEDURE

BY ALBERT A DOWD[*]

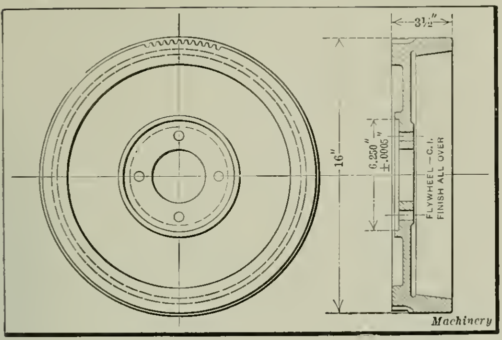

Fig. 1. Example of Work selected to illustrate Estimating Methods

THE growth of the automobile industry in this country, and the resulting desire of manufacturers to obtain the maximum production, in conjunction with the increasing use of high-speed steel, are largely responsible for many of the great developments in machine tool design. These factors make possible the use of cutting speeds and feeds little dreamed of a few years ago, and have brought into prominence specialists on production work. These men have made a study of shop methods and conditions and are experts in obtaining high-speed productions on the various classes of interchangeable work. Some factories employ what is termed a production engineer, whose duties are to so arrange the handling of the work in process throughout the whole factory, that the maximum production may be obtained. This man is also responsible for the regulation of cutting speeds and feeds on the various classes of work, and his experience and forethought have considerable weight with the tool designer in the design of special tools, fixtures, etc. Many machine tool builders provide an estimating department, devoted to the needs of their customers and, incidentally, this department is of great assistance in the marketing of their product. In some instances the estimating department is spasmodically "up to its eyes" in work, or at "low water mark," depending upon the machine tool situation throughout the country. There are some builders who do not have a regular estimating department, the work being done when needed, by the superintendent or a foreman well versed in the class of work upon which the estimate is desired. When a specialist is employed, a separate department devoted to this class of work is set apart, with the necessary designers, to make the department thoroughly efficient.

Abuse of Estimating Processes

There is perhaps no way in which estimating methods are more abused than in the indiscriminate application of unnecessary special tools in the manufacture of interchangeable work. For example, a customer desires an estimate on a machine capable of turning out a piece of work as per blueprint submitted. He wishes to know the cost of the machine with tool equipment for producing the work. The specialist examines the blueprint carefully, possibly spending ten or fifteen minutes in thoroughly grasping its details, and then makes a memorandum to the sales department as follows: "We can make the piece complete in about twenty minutes and it will require special tools costing, say, $350. The machine we recommend for the work is ——, and the cost $1300.

Now a method of this sort is guesswork estimating, pure and simple, and yet it may be very close to the mark on account of the specialist's long experience on this class of work, his knowledge of some previous piece which is machined in about the time stated, and the cost of the equipment, likewise based on a recollection of what was used in the previous instance. But no matter how long an experience and how thorough a knowledge the specialist may have, the fact remains that this is guesswork estimating just the same, and would not appeal to a prospective buyer, were he to know the methods by which the results in his estimate were determined.

An improvement on the method given is that of roughly figuring the machined surfaces of the piece at a conservative cutting speed and feed and making due allowance for setting up work and movements of tools. A few free-hand sketches of necessary tools give a basis on which their approximate cost may be figured; yet even with a method like this, what does the prospective customer get? At the very best all that he receives is an approximation of the time required, and a lump sum for the cost of certain tools not specifically mentioned, with which the work is to be accomplished. It will be seen that the customer's imagination is put to a severe strain in order to determine what he is going to get for his money. In addition to this, he is not advised of the machining operations on the work, nor does he know whether locating surfaces and sequence of operations will agree with other tools, jigs or fixtures which already may have been designed and built. He may, perhaps, sign a contract for the machine and tools, taking them on faith, but he is nevertheless somewhat uneasy over the situation until after the machine has been installed and is in operation. It is perfectly natural for a customer to wish to know what he is buying and he will be much better satisfied if he receives more definite information regarding his contemplated purchase. The foregoing points are taken from the customer's valuable point of view.

On the other hand, from the machine tool builder's standpoint, the matter at first looks as if the expense item would be much smaller if something on the order of the foregoing method were used, because the time required for an estimate of this sort is comparatively short. The sales department, however, will be strongly in favor of detailed estimates and will call attention to competition in this or that case where

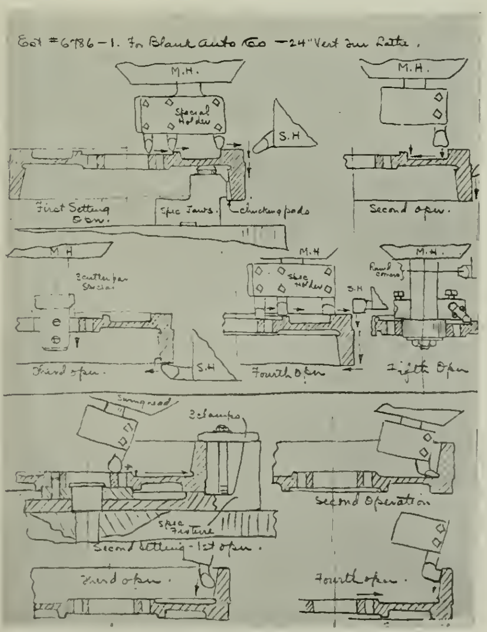

Fig. 2. Preliminary Free-hand Sketch of Tools and Operations

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[*] Address: 221 Grove St., Bridgeport, Conn.

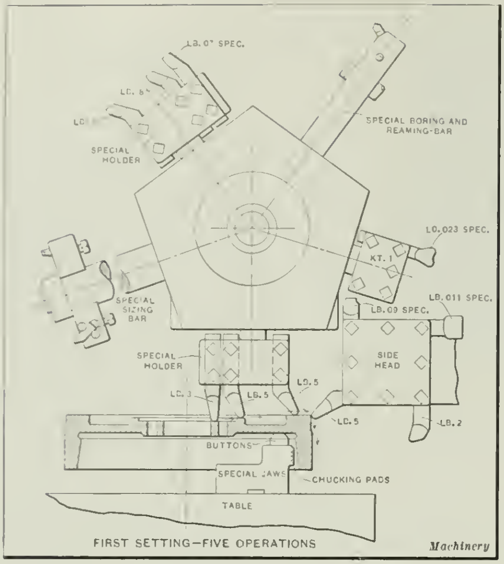


Fig. 3. Layout of Tools for First Series of Operations

layout of tools and diagrams showing operations was made by a rival concern who, incidentally, got the contract for the job.

The expense connected with an estimating department is, however, considerable and some builders of machinery manage very well without going to this expense by detailing a competent man to handle the work and borrowing a draftsman from the main drafting-room when necessary. This reduces the expense when business is dull, as men can be employed otherwise during the dull season. Although the expense of tool diagrams and layouts showing methods of machining is considerable, there is a strong point in favor of this method. If the contract is secured, the design of tools is greatly simplified, because many points have been thought out during the preliminary work.

Up-to-date Estimating Methods

Many of the methods of estimating, preparation of tooling diagrams, etc., given here are those in vogue at the Bullard Machine Tool Co. of Bridgeport, Conn. As this firm is engaged in the manufacture of vertical turret lathes and vertical boring mills, it is evident that the examples herewith given are applicable principally to these machines, although the system may readily be adapted to other machine tool estimates. One of the important fields of usefulness of any machine tool builder's estimating department is assisting a customer to get the worth of his money out of his machine by showing him improved methods of machining his work so that he can use the machine to the best advantage. It naturally follows that such a customer is well pleased with the attention shown him and speaks well of the machine to others so that the effects are far-reaching and frequently result in additional sales.

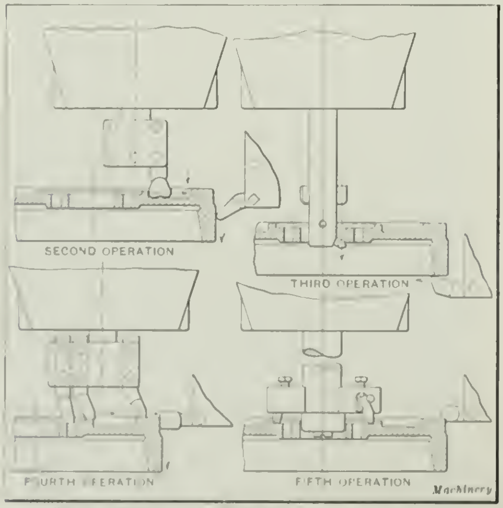


Fig. 4. Action of Tools for Second, Third, Fourth and Fifth Operations—First Setting

In order properly to describe these estimating methods, let us suppose that a customer sends in a blueprint of the flywheel shown in Fig. 1. The statement is made that 5000 wheels are required for a year's production. The cost of a machine with tool equipment for turning out the work in the least possible time is desired by the customer. The work is to be within certain limits of accuracy, these being given on the blueprint. The ultimate production is the only thing of moment to be considered in this instance and, therefore, the tool equipment should be such that it will do the work as rapidly as possible.

The first thing to be considered is the machine best adapted to do the work. As will be seen by reference to Fig. 1, the wheel is 16 inches in diameter. The 24-inch vertical turret lathe is selected for this work as it seems most suitable and has ample power combined with the necessary speeds. Having decided upon the proper machine, the methods of holding the work and machining it must be carefully considered so that the work may be handled in the shortest possible time.

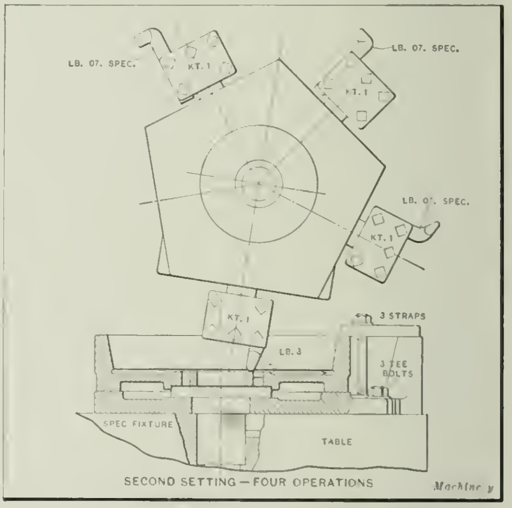


Fig. 5. Layout of Tools for Second Setting of Work

A free-hand layout is first made, such as shown in Fig. 2, in which the various settings and operations are roughly outlined with indications of special tools and holders required. Occasionally several layouts are made free-hand, indicating various methods of machining, and one is selected which seems most economical. This free-hand layout is given to a draftsman who uses it as a guide in making quarter scale tool diagrams and methods of setting up the work. These diagrams are made on tracing paper with a medium soft pencil so that blueprints can easily be made from them. By referring to Figs. 3, 4, 5, and 6, it will be seen that the tools are shown in their cutting position for each operation, thereby precluding the possibility of interference between the main and side-head tools. Fig. 3 shows the layout of tools necessary for the first setting, and the tools for the first operation are shown at work upon the piece.

Fig. 4 shows the action of the tools during the second, third, fourth, and fifth operations. The direction of the cuts is shown by the arrows. Fig. 5 shows the layout of the tools for the second setting and the general construction of the locating fixture, while Fig. 6 represents the second, third, and fourth operations with the tools in the working position. This last sheet should contain the title and the customer's name, together with the estimate number. It will readily be seen that by this method of representing the various operations on the work, a clear idea of the machining methods may be quickly grasped by a prospective customer.

Speeds and Feeds

The speeds and feeds to be used in machining any piece of work are largely a matter of experience and judgment, as there are a number of variable factors which have an influence on the matter.

1. Material to be cut, its quality (hard or soft), and the amount of stock which is to be removed.

2. Sectional strength of the casting or forging. This point is quite important, for the reason that high speeds and feeds cannot be used on very thin section without a strong probability of "chatter." In addition, a thin casting may, perhaps, be of such a structure that it cannot be held as rigidly as if it were of heavier section.

3. Method of holding. It is obvious that unless the piece can be securely gripped by the jaws, considerable care will be necessary in machining, and feeds and speeds must be lighter than if a good surface for holding were provided.

4. Power of the machine and quality of tools used. These points must both be considered but are not now of as great importance as they were a few years ago, for the reason that the machine of today is usually powerful enough to properly care for the demands made upon it. High-speed tools also are used nowadays almost exclusively for rapid production work.

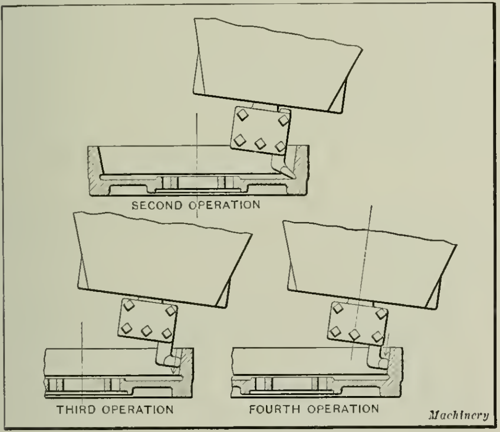
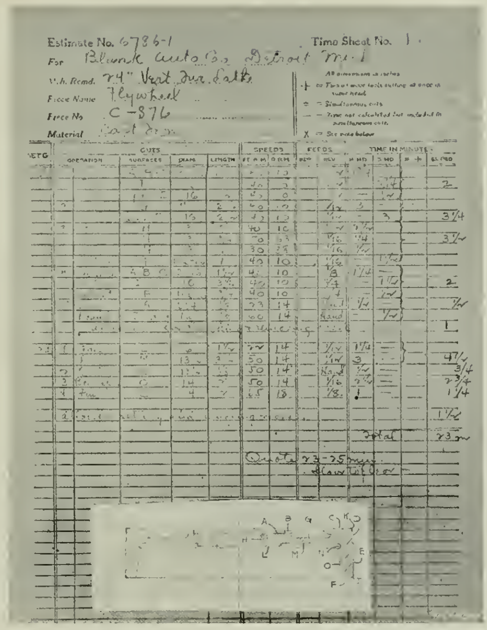


Fig. 6. Second, Third and Fourth Operations—Second Setting

6. Material to be cut dry, or with a cutting lubricant. Much higher speeds and greater feeds can be used when lubricant is employed so that this matter also is one of importance.

The following table of cutting speeds is one which has been used by the writer in estimating work for several years. It is, of course, subject to variations to suit abnormal conditions, but may be used as a basis from which to figure speeds for various materials. The table is based on the removal of a normal amount of stock and a moderate feed for roughing. Finishing speeds can be increased from 30 to 50 per cent over those given in the table, unless very coarse feeds are used, in which case an increase of about 25 per cent is all that should be used. Finishing speeds on mild steel, bronze, or malleable iron can be nearly double that used for roughing. Speeds given in the table are conservative but are based on material thoroughly cleaned, well pickled, and free from sand. The use of a suitable cutting lubricant is assumed for everything except cast iron which is usually cut dry. Speeds should not be over 75 per cent of those given if other materials are to be cut dry.



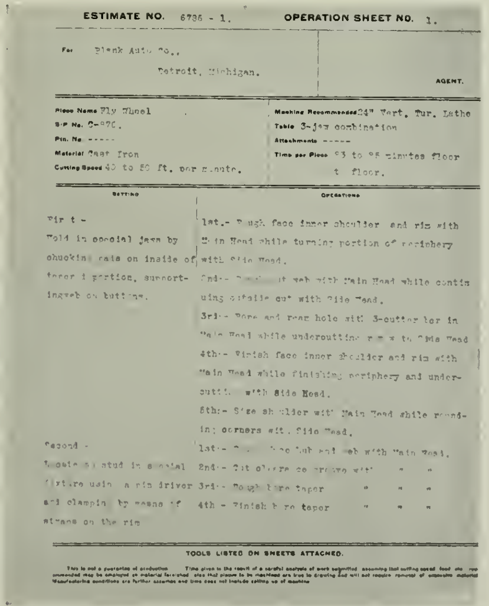
Estimate No. 6786-1
Time Sheet No. 1
For Blank Auto Co. Detroit Mich
M. h. Recmd. 24" Vert. Tur. Lathe
Piece Name Flywheel
Piece No. C-876

All dimensions in inches
X = See note below
CUTS
SPEEDS
FEEDS
TIME IN MINUTES

Fig. 7. Time Study Sheet with Data for Flywheel shown in Fig. 1

Material	Feet per Minute.
Cast iron	50
Cast steel	60
Malleable iron	70
Machine steel forgings (0.15 to 0.20 per cent carbon)	65
Machine steel (black stock)	70
Tool steel forgings	35 to 40
Steel alloys (containing nickel and chromium)	30 to 50
Yellow brass	200
Composition brass	120 to 150
Bronzes	30 to 80

There is considerable variation in the speeds tested for steel alloys and bronzes, owing to the different compositions.



ESTIMATE NO. 6786 - 1. OPERATION SHEET NO. 1.

For Blank Auto Co.,
Detroit, Michigan.

AGENT.

Piece Name Fly Wheel
S-F No. C-876.
Pat. No -----
Material Cast Iron
Cutting Speed 40 to 50 ft. per minute.

Machine Recommended 24" Vert. Tur. Lathe
Table 3-jaw combination
Attachments -----
Time per Piece 73 to 75 minutes floor to floor.

SETTING	OPERATIONS
First - Hold in special jaws by chucking rails on inside of [illegible] portion, supporting web on buttons.	1st.- Rough face inner shoulder and rim with Main Head while turning portion of periphery with Side Head. 2nd.- [illegible] web with Main Head while continuing outside cut with Side Head. 3rd.- Bore and ream hole with 3-cutter bar in Main Head while undercutting rim with Side Head. 4th.- Finish face inner shoulder and rim with Main Head while finishing periphery and undercutting with Side Head. 5th:- Size shoulder with Main Head while rounding corners with Side Head.
Second - Locate on stud in special fixture using a pin driver and clamping by means of straps on the rim	1st.- [illegible] face hub and web with Main Head. 2nd.- Cut oil groove with " " 3rd.- Rough bore taper " " " 4th - Finish bore taper " " "

TOOLS LISTED ON SHEETS ATTACHED.

Fig. 8. Operation Sheet which gives Methods of holding Work and Order of Operations

REVOLUTIONS PER MINUTE FOR VARIOUS CUTTING SPEEDS AND DIAMETERS

Diam.	Feet Per Minute							Diam.	Feet Per Minute						
	30	35	40	45	50	60	70		30	35	40	45	50	60	70
1	114.0	134.0	153.0	172.0	191.0	229.0	268.0	26	4.40	5.10	5.90	6.60	7.30	8.80	10.20
2	57.0	67.0	76.0	86.0	95.0	115.0	134.0	27	4.30	4.90	5.60	6.30	7.10	8.50	9.80
3	38.0	45.0	51.0	57.0	64.0	76.0	90.0	28	4.10	4.80	5.40	6.10	6.80	8.20	9.60
4	29.0	33.0	38.0	43.0	48.0	57.0	66.0	29	3.90	4.60	5.30	5.90	6.60	7.90	9.30
5	23.0	27.0	31.0	34.0	38.0	46.0	54.0	30	3.80	4.40	5.10	5.70	6.30	7.60	8.80
6	19.0	22.0	25.0	29.0	32.0	38.0	44.0	31	3.70	4.30	4.90	5.50	6.10	7.40	8.60
7	16.0	19.0	22.0	25.0	27.0	33.0	38.0	32	3.60	4.20	4.70	5.30	5.90	7.10	8.40
8	14.0	17.0	19.0	21.0	24.0	29.0	34.0	33	3.40	4.10	4.60	5.20	5.80	6.90	8.20
9	13.0	15.0	17.0	19.0	21.0	25.0	30.0	34	3.30	3.90	4.50	5.10	5.60	6.70	7.80
10	11.0	13.0	15.0	17.0	19.0	23.0	26.0	35	3.20	3.80	4.30	4.90	5.40	6.50	7.60
11	10.0	12.0	14.0	16.0	17.0	21.0	24.0	36	3.18	3.70	4.20	4.70	5.30	6.30	7.40
12	9.5	11.0	13.0	14.0	16.0	19.0	22.0	37	3.09	3.60	4.10	4.60	5.10	6.20	7.20
13	8.8	10.3	11.8	13.0	14.7	17.6	21.0	38	3.02	3.50	4.02	4.50	5.00	6.00	7.00
14	8.2	9.5	11.2	12.3	13.6	16.4	19.0	39	2.90	3.40	3.90	4.40	4.90	5.90	6.80
15	7.6	8.9	10.2	11.5	12.7	15.3	17.8	40	2.80	3.30	3.80	4.20	4.80	5.70	6.60
16	7.2	8.4	9.5	10.7	12.0	14.3	16.8	41	2.78	3.27	3.70	4.15	4.50	5.63	6.48
17	6.7	7.8	9.0	10.0	11.2	13.5	15.6	42	2.73	3.24	3.64	4.10	4.43	5.56	6.37
18	6.3	7.4	8.5	9.5	10.6	12.7	14.8	43	2.66	3.18	3.55	4.00	4.39	5.38	6.22
19	6.0	7.0	8.0	9.0	10.0	12.0	14.0	44	2.60	3.04	3.47	3.90	4.34	5.22	6.10
20	5.7	6.7	7.6	8.6	9.6	11.5	13.4	45	2.55	2.96	3.38	3.80	4.23	5.11	5.95
21	5.4	6.4	7.3	8.2	9.1	10.9	12.8	46	2.49	2.90	3.32	3.70	4.15	5.00	5.80
22	5.2	6.1	6.9	7.8	8.6	10.4	12.2	47	2.45	2.85	3.25	3.64	4.07	4.89	5.70
23	5.0	5.8	6.6	7.5	8.3	9.9	11.6	48	2.40	2.80	3.18	3.58	3.98	4.78	5.60
24	4.8	5.6	6.4	7.2	8.0	9.5	11.2	49	2.34	2.72	3.12	3.51	3.90	4.68	5.47
25	4.6	5.3	6.1	6.9	7.6	9.2	10.6	50	2.29	2.65	3.05	3.44	3.82	4.58	5.35

Machinery

As the flywheel with which we have to deal is of cast iron, we will figure on a basis of 50 feet per minute as the cutting speed, when using a feed of 1/16 inch per revolution. Considerable care is necessary when figuring the cutting time for various surfaces, and due allowances must be made for the time required to index the turret and also for setting up and removing work.

Fig. 7 shows the form of a time study sheet properly filled out for the flywheel shown in Fig. 1 and the tool equipment illustrated. A quarter size sectional view of the wheel is pasted to the lower part of the time study sheet and the machined surfaces are lettered *A*, *B*, *C*, etc., so that they may be referred to readily in their proper column on the sheet.

In order to simplify the figuring of feeds and speeds, the writer designed and built for his own use the somewhat crude calculator shown in Fig. 9, and it has proved a considerable time saver on this class of work. A wooden framework about 14 inches long by 6 inches high contains two loosely hung rolls of wood which may be turned readily into any desired position by the knobs *A* and *B*. On the left-hand roll a blueprint containing cutting speeds for diameters from 1 to 50 inches is pasted. The right-hand roll contains machine speeds and feeds for various machines. A special slide-rule on the logarithmic principle is shown at *C*. The use of the two rolls is obvious and does not require any description; the use of the slide-rule is as follows: The sliding portion of the rule is moved to a position such that the selected revolution per minute on the upper half of the slide coincides with the feed desired for that particular cut. The length of the cut is then found on the lower half of the slide and directly under it on the base will be found the duration of the cut in minutes. The accompanying table gives the revolutions per minute for cutting speeds varying from 30 to 70 feet per minute and diameters from 1 to 50 inches.

For diameters greater than those given in the table, the following formula may be used, in which

D = diameter of work;
N = number of revolutions per minute;
C = cutting speed in feet per minute.

$$N = \frac{4 \times C}{D}.$$

This formula gives results which are within 5 per cent of being correct, and it will be found very useful as the calculation may be made mentally.

A rapid method of figuring the amount of time necessary to take a certain cut at a given speed and feed is as follows:

S = speed (R. P. M.);
F = feed (revolutions per inch of travel);
L = length of cut in inches;
T = time to complete cut, in minutes.

$$T = \frac{L \times F}{S}.$$

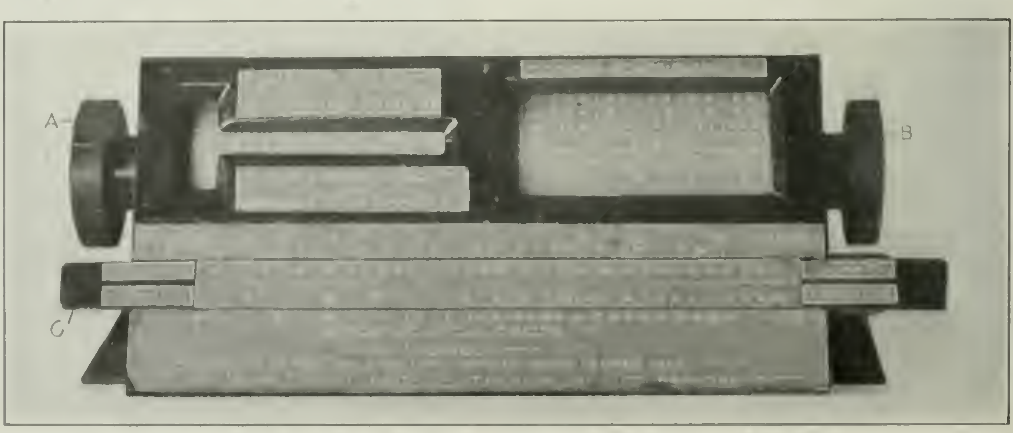
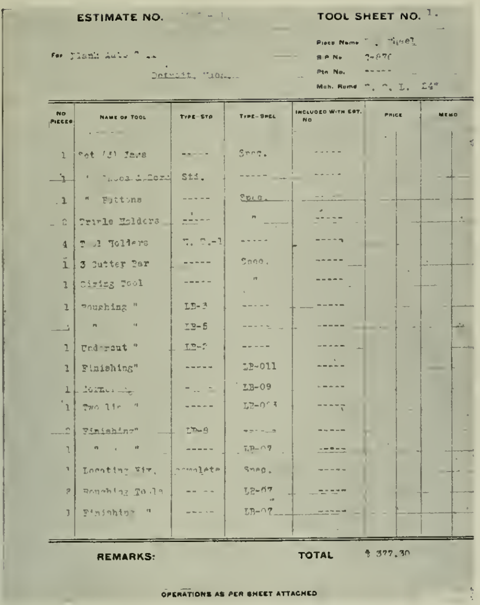


Fig. 9. Calculator for determining Time required for Cuts of Given Length at Various Speeds and Feeds



ESTIMATE NO. [illegible] - 1. **TOOL SHEET NO.** 1.

For Blank Auto Co.
Detroit, Mich.

Piece Name Fly Wheel
B P No. [illegible]
Ptn No. -----
Mch. Rcmd [illegible] 24"

No Pieces	Name of Tool	Type Std	Type Spcl	Included with Est. No	Price	Memo
1	Set (3) Jaws	-----	Spec.	-----		
1	" [illegible]	Std.	-----	-----		
1	" Buttons	-----	Spec.	-----		
2	Triple Holders	-----	"	-----		
4	Tool Holders	[illegible]	-----	-----		
1	3 Cutter Bar	-----	Spec.	-----		
1	Sizing Tool	-----	"	-----		
1	Roughing "	LB-3	-----	-----		
[illegible]	" "	LB-5	-----	-----		
1	Undercut "	LB-[illegible]	-----	-----		
1	Finishing"	-----	LB-011	-----		
1	Forming [illegible]	-----	LB-09	-----		
1	Two Lip "	-----	LB-0[illegible]3	-----		
2	Finishing"	LB-8	-----	-----		
1	" "	-----	LB-07	-----		
1	Locating Fix.	Complete	Spec.	-----		
2	Roughing Tools	-----	LB-07	-----		
1	Finishing "	-----	LB-07	-----		

REMARKS: **TOTAL** $ 377.30

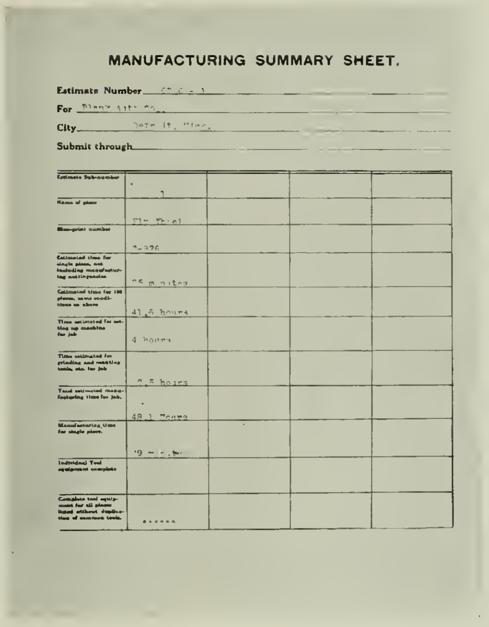
OPERATIONS AS PER SHEET ATTACHED

Fig. 10. Tool List for Flywheel Operation

The operation sheet shown in Fig. 8 gives in detail the various methods of holding the work and the operations performed. In addition to this, the upper part of the sheet contains the name of the part, the blueprint number, etc., and also the cutting speed on which the time estimate is based. There is also a note at the bottom of the sheet which refers to manufacturing conditions, etc.

List of Tools and Cost

Fig. 10 shows the tool list. Each tool is listed separately and the prices are given in the column indicated for that purpose. Individual prices have not been given on this sheet for obvious reasons and the total figure is an arbitrary one.



MANUFACTURING SUMMARY SHEET.

Estimate Number [illegible]
For Blank Auto Co.
City Detroit, Mich.
Submit through

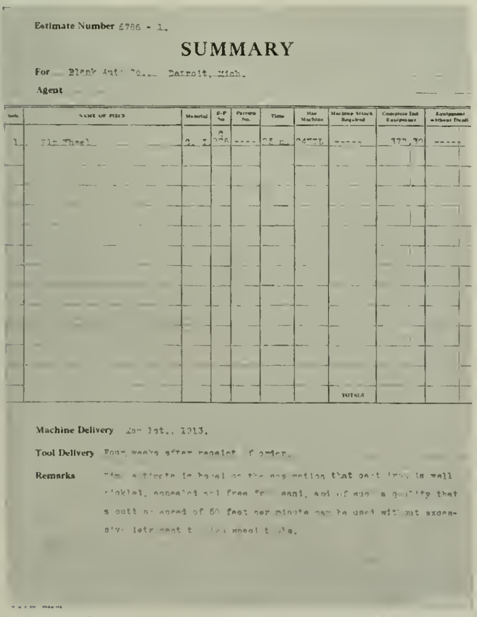
Estimate Sub-number	1			
Name of piece	Fly Wheel			
Blue-print number	[illegible]			
Estimated time for single piece, not including manufacturing contingencies	25 minutes			
Estimated time for 100 pieces, same conditions as above	41.5 hours			
Time estimated for setting up machine for job	4 hours			
Time estimated for grinding and resetting tools, etc. for job	2.5 hours			
Total estimated manufacturing time for job.	48.1 Hours			
Manufacturing time for single piece.	[illegible]			
Individual Tool equipment complete				
Complete tool equipment for all pieces listed without duplication of common tools.	......			

Fig. 11. Manufacturing Summary Sheet

If estimates are required on several different pieces the various estimates are numbered with the estimate number, and a sub-number 1, 2, 3, etc., is given to each succeeding estimate. As there is more or less duplication of tools when several pieces are to be handled, the customer does not always wish a complete individual equipment. The column marked "Included With Estimate No." is used for the purpose of indicating tools common to more than one estimate, and the prices, therefore, may be separated readily if desired.

Manufacturing Summary Sheet

An estimate of the ordinary kind takes no account whatever of lost time caused by grinding tools and re-setting, set-



Estimate Number 6786 - 1.

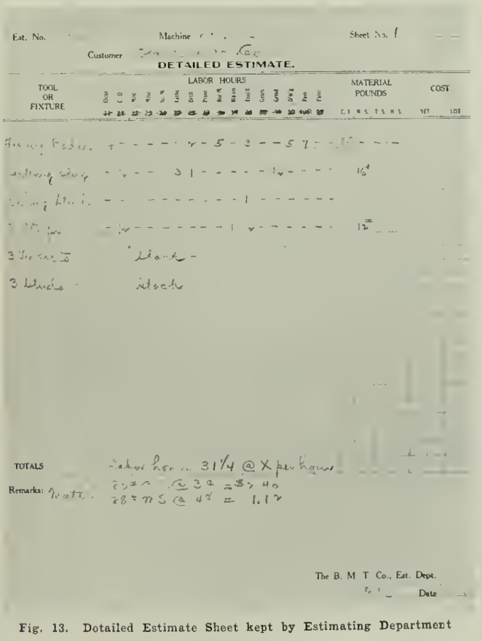
SUMMARY

For Blank Auto Co. Detroit, Mich.
Agent

No.	Name of Piece	Material	B-P No.	Pattern No.	Time	Size Machine	Machine Attach Required	Complete Tool Equipment	Equipment without Dupl.
1.	Fly Wheel	[illegible]	[illegible]	----	25 m.	[illegible]	-----	377.30	-----
							TOTALS		

Machine Delivery Jan 1st., 1913.
Tool Delivery Four weeks after receipt of order.
Remarks This estimate is based on the assumption that cast iron is well pickled, annealed and free from sand, and of such a quality that a cutting speed of 60 feet per minute can be used without excessive detriment to high speed tools.

Fig. 12. Final Summary Sheet used as Memorandum by Sales Department



Est. No. Machine [illegible] Sheet No. 1
Customer [illegible]

DETAILED ESTIMATE.

TOOL OR FIXTURE — LABOR HOURS — MATERIAL POUNDS (C. I. M. S. T. S. H. S.) — COST (NET LIST)

[illegible] 5 - 3 - - 5 [illegible]
[illegible] 3 1 - - - - - 1 - - - - 16#
[illegible] 1
[illegible] 1 12#
3 [illegible] Stock -
3 Studs Stock

TOTALS Labor hours 31¼ @ X per hour
Remarks: Matl. [illegible] @ 3¢ = $ [illegible]
28# M.S. @ 4¢ = 1.12

The B. M T Co., Est. Dept.
Date

Fig. 13. Dotailed Estimate Sheet kept by Estimating Department

ting up the machine for the job, or other manufacturing contingencies, such as extra hard castings or those which are full of sand holes. The manufacturing summary sheet is designed to take care of all these contingencies so that the customer may feel assured that the manufacturing time given on this sheet can be depended upon in a run of a hundred pieces or more and is conservative enough so that he may feel safe in using it as a basis from which to set his piecework prices. A reproduction of the manufacturing summary sheet is shown in Fig. 11, and it may be noted that there is sufficient room on the sheet to include estimates for several pieces.

Final Summary Sheet

This sheet is used as a memorandum for the sales department only, and is not sent out to the customer. Sufficient space is provided on this sheet to take care of the important points in a number of estimates so that the sales department will not be obliged to go through each estimate separately in order to gain the desired information. In addition to the general recapitulation, there is considerable space at the bottom of the sheet for remarks. The machine and tool delivery may also be noted here, and any note pertaining to the general character of the work in question. A reproduction of this sheet is shown in Fig. 12. Typewritten copies of all the foregoing sheets except the time study and final summary sheet are bound up in an attractive folder, together with blueprints of the tooling diagram, and are sent to both the customer and the salesman for the particular territory in which the customer is located. A more completely detailed estimate would be difficult to imagine and it leaves nothing to the customer's imagination. He has all the information he needs in a nut-shell.

Estimating Costs of Special Tools and Fixtures

In determining the cost of tools and special equipment, much depends on the method of production used in the factory where they are to be made. In some instances special tools are "routed" through the shop in the same way that the regular work is handled. In other cases the greater part of the work is done in a department devoted to special tool work. Sometimes work is put out on a premium or bonus system and again it is done on the day work system.

In the writer's experience with work of this kind a premium or bonus system based on the estimated cost of tools has been found most economical, the work being done in the department devoted to special tools. When large fixtures require surfacing, boring, or turning, it may be necessary to do this work in the boring mill department rather than to attempt it in the special tool department. When this becomes necessary, however, the instructions regarding accuracy and finish required should come from the tool-room itself and should not be left to the judgment of the boring mill operator.

In any kind of special tool work, much depends on the shop equipment. If proper equipment is used for this sort of work and care taken to see that the tool-room standards are well kept up, a great gain in the cost of production will be evident. There are occasional instances when work may be routed through the shop to good advantage, *viz.*, if several tools of the same kind are to be made there is an obvious advantage in carrying the work through on this basis.

Determining Weights, etc.

In making estimates for horizontal turret lathe work, the sizes of locating fixtures, etc., do not vary much and, therefore, it is comparatively easy for an experienced man to get a close approximation of the weight of a fixture almost at a glance. On larger work, however, when the fixtures vary in diameter from 6 or 8 inches to 40, 50, or 60 inches, and the height or thickness from 1 inch to 12 or 15 inches, it is evident that the weight of iron used in such a fixture would be quite an important item. It is also evident that a man would need to possess rare judgment in order to guess very close to the weight of some of these castings. The slide-rule will be found very convenient for figuring this class of work

Fig. 13 shows a detailed estimate sheet which is kept as a memorandum in the estimating department. On this sheet the operations necessary to complete a piece by special work may be plainly detailed in the columns marked. All work is given in labor hours, while material has a separate place at the right-hand side of the sheet and is given in pounds. Totals may be given at the bottom of the sheet, the labor hours being multiplied by a predetermined constant and the material cost readily figured. Safe prices for materials must take into consideration fluctuations in cost, cartage, etc.

Labor and Overhead Expense

The cost of labor must be based upon the average wage in the department where the work is to be performed, and the overhead expense for running the department must be added to it on the percentage basis. The overhead expense is determined by a number of items which have to do with power cost, wear and tear of machinery, tool upkeep, etc., and the percentage or constant used varies considerably in different factories. A marginal profit must also be added to the labor cost and overhead expense, for it is obvious that there must be a profit or there would be no advantage in manufacturing work. Some factories strike an average on their labor cost in all departments which have to do with tool manufacture and also average up their overhead expense in the same way, but this is not considered the best practice. The drafting-room, the pattern shop and the blacksmith shop are usually given an overhead expense varying from the other departments. In determining labor hour cost, let us take as an example the tool-room. The rate of pay averages about 38 cents an hour. Let us consider the overhead expense of the department at 100 per cent of the labor cost and let us also consider that a profit of 30 per cent is desired on all tools built by this department. We then have as a total hourly labor cost 0.38 plus 0.38 multiplied by 130 equals $0.988. This rate, therefore, must be used as a constant by which all labor hours in this department are multiplied.

Card System Giving Actual Costs

A card system for the estimating department giving actual costs of special tools and fixtures built from time to time may prove a valuable adjunct to the estimator's paraphernalia. Headings can be made for straight and taper reamers, boring-bars, forming tools, special jaws and locating fixtures, and the information thus collected will be found of great value.

Approximate Estimates for Rush Jobs

Occasionally the need arises for a rush estimate on the production time and cost of tools for six or eight different pieces of work. In cases of this kind an approximate estimate may be drawn up by the estimator in a short time by making rough free-hand sketches to serve as a basis on which to figure tool costs and general manufacturing data. A statement can be made and sent with the estimate to the effect that detailed estimate and layouts will be furnished later if a tentative order is secured. An approximate estimate of this kind made by an experienced estimator will not usually vary more than 10 per cent above or below the detailed cost determined later.

Estimating Department Records

It is of great importance to have a system in the estimating department such that work may be filed for ready accessibility, and as there are a number of things to keep track of, it is important that the system should be as simple and effective as possible. In the first place, there is the filing of a customer's blueprint sent in for estimating purposes. Two methods of filing have been used for this purpose by the writer. One of these methods is to clip all the blueprints together, marking each one with the estimate number and filing them flat in a large drawer numerically. The estimate number should, obviously, be in the same position on each blueprint. Another method which is somewhat more convenient is to use large yellow envelopes in which the blueprint can be placed when folded. These envelopes may be filed on edge in a filing cabinet and the estimate number written on one of the upper corners. This latter method leaves nothing to be desired. The estimate sheets are conveniently filed numerically, according to the estimate number, in manilla envelopes open on one side and without any flap so that the sheets can be quickly removed when desired. A card index is used in connection with these and is cross indexed under three headings, *viz.*, customer's name arranged alphabetically, numerical index and another heading classified according to the class of work. This latter index may be arranged as follows: sub-headings may be made for steam engine work, auto work, electrical work, etc. These may be subdivided in as many ways as may seem desirable so that various parts, like pistons, cylinders, motor frames, etc., can be located without difficulty. An index of this kind is often of great value in selecting work that is similar to blueprints submitted for estimate. It is often possible to save the labor and expense of another set of drawings by using something of a similar nature which has been previously made.

Other Demands on the Estimating Department

Many factories take in from time to time manufacturing work, such as jigs or fixtures for outside concerns, and, occasionally, these are made up at a fixed hourly rate. Frequently, however, the estimating department is called upon to estimate costs, and a fixed figure is given to the customer for the entire work. A wide experience is necessary in estimating work of this character and the one who attempts it must be a thoroughly practical man familiar with the necessary processes for producing the work so that a conscientious estimate may be made. If the work is manufacturing and requires a hundred or more mechanical devices of the same kind, the cost of jigs or fixtures necessary must be included in the estimated cost. A proviso may be made to dispose of these tools to the customer after the work has been completed. There are a number of items to be taken into consideration when estimating on work of this character as follows:

1. A list of operations should be made for all the component parts, taking into consideration filing, fitting and assembling.
2. Special tools, jigs or fixtures should be noted and their costs itemized.
3. Labor cost must be carefully worked out according to the department in which the work is to be done, and the overhead expense correctly proportioned.
4. Profit must not be forgotten, due allowance being made for same.
5. Cost of patterns, castings or other materials used must be carefully considered.
6. The accuracy required should be considered. If work is to be within close limits of accuracy and no gages are furnished by the customer, it may be necessary to make up something for this purpose. This item, therefore, should not be forgotten.

In conclusion, I will say that the methods here given are very thorough and leave practically nothing to chance. It has been proved that the customer who receives the carefully prepared estimate with tool layouts, etc., is much more likely to give it consideration than if he only received a production and cost estimate.

* * *

ON GRINDING PRACTICE[*]

Some years ago, the writer made extensive practical tests to determine the efficiency of grinding wheels. In one of these tests, a bar of steel was held with uniform pressure against a coarse wheel running at a peripheral speed of 3000 feet per minute. The speed was progressively increased, increments being 500 feet per minute until a speed of 8000 feet per minute was attained. At each of these speeds, the amount of emery worn from the wheel was determined and the cubic inches of metal removed was calculated.

In those days, the commonly accepted reasonably safe speed to operate a wheel was 5000 peripheral feet per minute. The step from 5000 feet to 5500 feet per minute increased the efficiency about 10 per cent. At 6000 feet per minute the gain was from 35 to 40 per cent over that of 5000 feet per minute, and at 6500 feet per minute the gain was 70 per cent, and from 7000 feet per minute up, the efficiency decreased, as the wheel appeared to melt the steel to such a degree that it flowed into the pores of the wheel and so loaded it as to destroy its cutting qualities.

In order to operate the wheels at the speed of 6500 feet per minute, it was considered necessary to use the tapered side type of wheel with concave flanges made of steel tapered ¾ inch to the foot on each side. The flanges had a diameter 4 inches less than the diameter of the wheel, tapered flanges 20 inches in diameter, for example, being used on a 24-inch wheel. When the wheel held between these flanges is worn down to 20 inches, a new set of 16-inch flanges is put on the machine, and so on.

In making these tests, it became quite evident that practically all the grinding machines on the market were entirely too light and the spindles were too small in diameter. The bearings were too short and the pulleys on the spindles were too narrow as it was impossible to secure the power required to do efficient work. One strong man in a steel foundry grinding a heavy gate from a casting can exert from 4 to 4½ horsepower, and in order to get maximum results from 24-inch by 2-inch or 24-inch by 2½-inch wheels, each machine should be supplied with 10 horsepower, as there are times, of course, when a man at each end of the spindle is grinding at the same time, and they will together consume about 9 horsepower. My experience has shown that for operations of this nature, a spindle of not less than 2 inches diameter should be used and the bearings should be about 12 inches long.

The use of grinding machines on any other than the ground floor is bad practice unless the floors are rigid enough to prevent vibration. Excessive vibration makes it difficult to keep the wheels true. Where it is possible, grinding machines should be mounted on a concrete foundation. These foundations will soon pay for themselves in saving of emery unnecessarily dressed away in keeping wheels true when mounted on insecure foundations.

When operating a swing frame grinding machine such as is commonly used in steel foundries, the operator is able to exert considerably more pressure on the wheel than at a floor stand, and a machine with a 20- by 2½-inch wheel should be supplied with 7½ horsepower. It is necessary in order to get production to keep the wheel moving at the recommended speed while it is under its heaviest load. If insufficient power is supplied, the operator will slacken the speed of the wheel and the percentage of efficiency secured is that of the speed at which the wheel operates under load.

A heavy planer type grinding machine such as is used in manganese steel foundries for grinding the tops of frogs and other heavy castings using a 20- by 2½-inch wheel, should be supplied with 20 horsepower plus the amount of power required to drive the machine and the wheel when it is not under load. In some cases, a wheel of this size will absorb 25 horsepower. Power is a very important factor in efficient grinding and should be given very careful consideration on all types of machines; in the installation of belt-driven machines the user will always find it more economical to put in machines with belts of sufficient width to give ample power for the heaviest work to be done.

* * *

MACHINE SHOP TERMS ILLUSTRATED

Pickling

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[*] Extract from a paper "The Increased Efficiency and Economy Obtained by the Introduction of Safety Devices in Grinding Practice" read by Charles G. Smith, president and general manager of the Pittsburg Emery Wheel Co., Rochester, Pa., before the Detroit Foundrymen's Association, December 10, 1914.

METHODS OF JOINTING ALUMINUM*

CAST WELDING OR BURNING–BUTT-WELDING–ELECTRIC WELDING–RIVETING–THREADING–FLANGING AND SEAMING

BY FOREMAN JOINTER

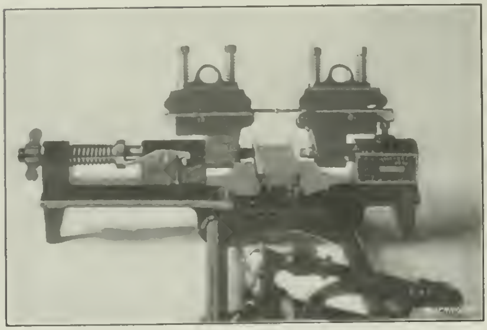
Fig. 1. Cowper-Coles Aluminum Welding Machine

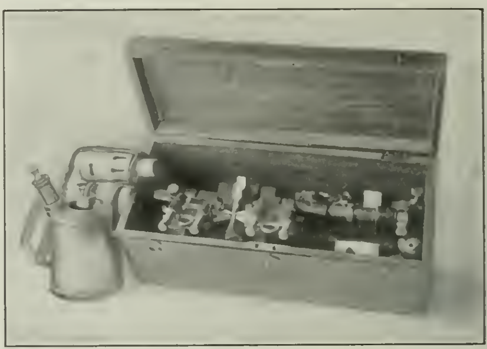
Fig. 2. Cowper-Coles Butt-welding Machine for Field Work

THE art of cast welding or burning has been known and practiced for many centuries. It was employed in Japan several centuries ago, where in bronze foundries the vases and ornamental objects were cast in a very simple form, the handles being burnt on. The process is generally used in engineering works and factories where modern welding methods are not employed, and is mostly used for jointing fractured parts of machines, etc. Small pieces that have broken off a large casting are sometimes renewed by this process, which is also applied to repairs that must be made as soon as possible. For such work, the process of cast welding or burning is generally considered economical, especially where a replacement requires a lot of machining.

With aluminum and its alloys, the essentials for good work are properly prepared molds in which the metal may be poured; the parts to be firmly secured to prevent twisting during pouring; provision that the first part of the pouring may run out by suitable gates, after passing over and heating the surfaces, an excess of metal being allowed; the surfaces where the weld is to take place to be thoroughly cleaned; and provision of sufficiently tall gates to provide a pressure that penetrates the oxide film on the metal surfaces to be joined. Another advantage of tall gates is that aluminum and its alloys readily oxidize upon exposure to the air and the metals containing it become "drossy" as they run. A long gate retains this dross, and it does not enter the weld. Finally, the pouring should be done methodically to insure a strong weld.

Butt-welding by Pressure

Butt-welding by pressure is rapidly being adopted for the jointing of aluminum rods, bars, etc. Many types of welding machines are now on the market, which heat up the ends to be welded by means of blowpipes or blowlamps to a temperature at which they become plastic; the ends are then forced together under pressure, so that they unite and become virtually homogeneous. Aluminum wire or rod from 1/16 inch to 2 inches in diameter can be welded easily by this method, and with care thick aluminum tubing can also be jointed.

Fig. 1 shows a patented machine for the butt-welding of small aluminum rods, which is manufactured by the Cowper-Coles Engineering Co., Ltd., Westminster, England. In the operation of this machine the two ends to be joined are butted together, after being faced square; heat from a gas blowpipe or benzine lamp is then applied to the joint. This operation actually assists in the formation of an oxide skin or film, and as the metal becomes fused it is retained within the tube of oxide. Sometimes a flux is applied, which assists in dissolving the oxide at the point of junction, and before the two bags of fluid metal have time to burst, the two ends are brought rapidly together by releasing a spring catch. Any remaining oxide skin is driven out by the pressure of the blow and the clean metal unites in a perfect joint. The rapidity with which the ends are forced in contact is an important factor, because if pressure is applied slowly there is no certainty that the weld will be a homogeneous one, as a portion of the oxide is likely to remain in the weld and lessen its strength.

The machine illustrated in Figs. 1 and 3 is operated by a blowpipe from town gas. The adjustable spring jaws *A* are lined with a refractory holder, so as to insulate the aluminum. The spring release is at *B*, and the adjustable stop *C* regulates the movement of the spindle. The blowpipe *D* is fitted with a spring universal joint *E*, and can be adjusted in position along the rod *F*. These rods are detachable so that the machine packs up very closely, as shown in Fig. 3. Owing to the fact that aluminum deteriorates rapidly when overheated, the most satisfactory results are obtained by the use of oxy-coal gas or oxy-acetylene, as an intense local heat can be obtained, and the welds are made in a few seconds. The machine can be supplied with town gas or Dowson producer gas blowpipe or with a benzoline lamp for field work, in which case it can be packed in a box 18 by 7 by 7 inches, weighing only 19 pounds. (See Fig. 2.)

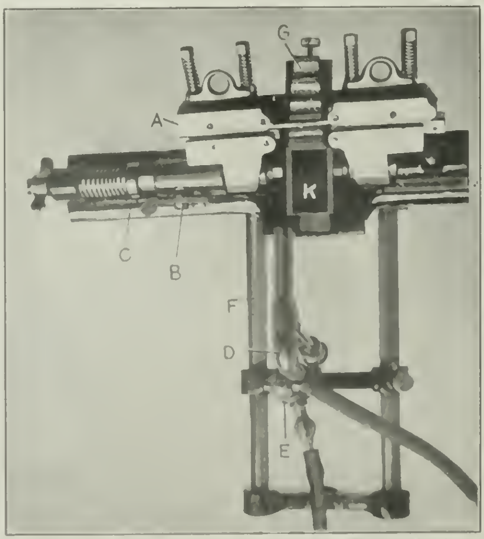

Fig. 3. Plan View of Cowper-Coles Aluminum Welding Machine

The formation of the oxide skin or film, which is almost imperceptible when soft soldering aluminum, is easily discernible in the process of butt-welding rods or similar sec-

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*For other articles on welding aluminum, see "Autogenous Soldering or Welding of Aluminum" in the January, 1915, number of MACHINERY.

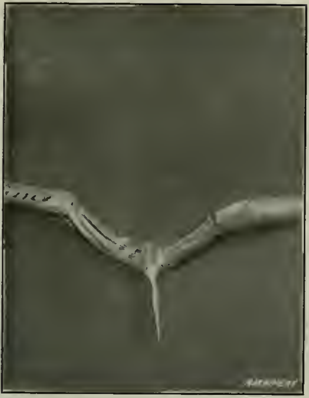

Fig. 4. View showing Flexible Oxide Skin or Bag containing Molten Aluminum

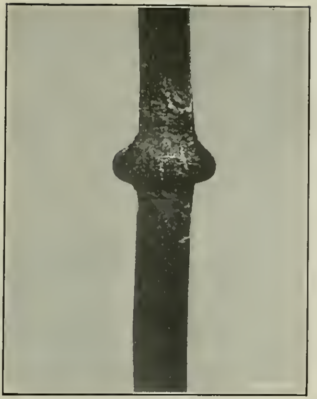

Fig. 5. Butt-welded Joint, showing Ring of Aluminum Oxide

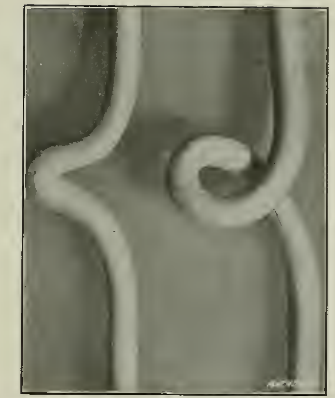

Fig. 6. Aluminum Joints that have been tested by bending and twisting

tions. A simple and interesting test may easily be made to enable the oxide film to be detected readily. Procure a piece of aluminum about 10 inches long by 1 inch in diameter; then secure the two ends on some supports, leaving a space of about 3 inches in the center for the flame of the blowpipe or blowlamp to play upon; when sufficient heat has been applied, it will be noted that the metal, having liquefied, has caused a flexible bag or oxide to sag; this bag contains molten aluminum. When in this condition, if the film or oxide skin is pierced with a pointed wire, molten metal will flow out instantly. The vast difference in the melting point of the metal and oxide is clearly demonstrated by this simple test. Fig. 4 shows clearly the bag of fluid metal after having been pierced, with the molten metal running out. Twelve consecutive welds made with a Cowper-Coles welding machine were subjected to a series of tests and the fractures, in every case, occurred at some distance from the weld, showing that the metal had not deteriorated at the weld.

Some examples of aluminum welding are shown in Figs. 5, 6 and 7. Fig. 5 shows a joint after welding. The ring of metal which has been squeezed out is largely composed of aluminum oxide. Fig. 6 shows a joint that has been tested by bending and twisting, after removal of the collar formed at the weld. The removal of this collar is not always necessary. Fig. 7 shows some specimens of aluminum rod welded by the same process and bent at the joints. A butt-welded aluminum rod is shown in Fig. 8 which has been subjected to a torsion test. As will be seen, the fracture occurred outside of the weld.

Sometimes it is found that cast aluminum welded by this process is tougher and stronger at the weld, but it is difficult to get accurate data due to the unreliable nature of cast aluminum. The welding machine referred to is very simple. Any intelligent workman can weld by this process after a little instruction, and it can be applied to almost any section of metal.

Electric Welding of Aluminum

There are two principal processes of electric welding, *viz.*, the arc welding process and the resistance method. The former is employed principally for repairing and filling up flaws in castings, etc., while the latter is adapted for use in metal-working factories producing duplicate work. Two forms of machines are used with the resistance method—the spot-welding machine and the butt-welder. In the spot-welding machine metal sheets are joined by welded spots, instead of using rivets. The electrodes are shaped to suit the work and generally take the form of truncated cones.

The method of working is practically the same in either butt- or spot-welding. The pieces to be joined are gripped in the clamps or placed between the electrodes and brought into contact. This may be accomplished in many ways, according to the type of machine; generally speaking, one of the clamps or electrodes is a fixture and the other is mounted movably on a slide or hinge and is pressed, when welding, toward the other electrode either by the hand or foot, or by springs, weights, cam and levers, screws or hydraulic pressure. In the welding of thin sheet metal the process is only of momentary duration. A development of spot-welding is seam-welding in which two sheets of metal are joined in an uninterrupted lap-weld under one or between two rotating disk electrodes.

In the welding of aluminum by the electric welding systems, we have precisely the same difficulties to contend with in respect to the persistent oxide film, as described in connection with other methods. However, aluminum wires, rods, and other sections can be butt-welded successfully, but the process of spot-welding is not so efficient, probably owing to the difficulty of eliminating the oxide film between the surfaces at the moment of contact, which affects the strength of the weld; moreover, owing to the soft nature of the metal, the depression formed on both sides by the pressure of the electrodes is, in many cases, an objectionable feature; hence, aluminum sheets are not readily spot-welded or lap-welded in a satisfactory manner.

Riveting Aluminum

To discuss all the points in connection with the riveting of aluminum would cover a very wide field. Satisfactory riveted joints, however, are made readily if care is taken in the manipulation of the work. It is sometimes stated that aluminum cannot be riveted as well as other metals on account of the softness of the metal. Such statements, however, are incorrect, for by continued rolling in the manufacture of aluminum, hard rolled sheets are now obtainable; in fact, aluminum manufacturers go so far as to term some of their sheets "dead hard." Admittedly, aluminum does not harden to that degree of hardness obtained in iron and steel. However, the more important types of riveted joints are as applicable to aluminum as to most other metals.

To be successful in riveting joints in aluminum it is best to forget all you know about riveting such metals as iron and steel, as aluminum will not withstand the ill treatment to which iron and steel can be subjected. Excellent machine-

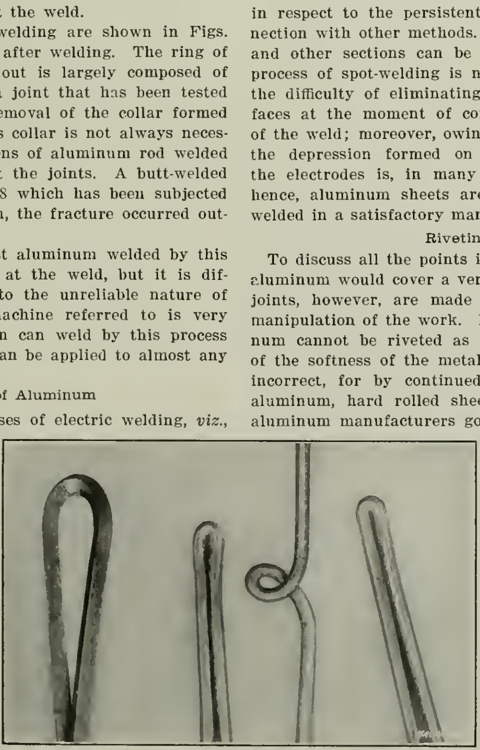

Fig. 7. Specimens of Welded Aluminum Rod bent at the Welded Joints

made rivets in aluminum, and of various shapes for all classes of engineering work, are now obtainable, and should be used in every instance when riveting aluminum. On no account should rivets made of any other metal be employed if it is desirable to avoid electrolytic action. An important factor in riveting aluminum is that the rivets should have ample clearance in the holes in order to allow for spread in hammering.

It is also essential that the holes be somewhat further from the edge of the plate than for iron and steel; where rivets are too near the edge, the metal occasionally shows a tendency to bulge outward slightly. For single-riveted lap joints in aluminum plates 1/16 inch to 3/16 inch in thickness, the lap should not be less than three and one-half times the diameter of rivet. As with other metals, the laying out and punching of the holes in the plates, however accurately performed, rarely gives the alignment of holes that one would desire; hence the holes frequently have to be reamed. Where the holes are not reamed, it is essential that the inside surfaces of the holes should be parallel to each other without undue overlapping before beginning to rivet, because aluminum rivets on account of their soft nature do not readily draw through the overlap in the holes, as do iron or steel rivets when riveting thin metal sheets.

The type of aluminum rivet generally used is the cup-head or spherical-head rivet. Both the head and riveted end are alike, although countersunk rivets are sometimes used on aluminum plates of the larger gages, in order to secure flat surfaces, and also on various sections of moldings, etc. More care, however, is required with countersunk rivets, in that accurate countersinking of the holes is essential; also it is necessary that the recesses formed should fit the angle of the rivet head. In order to secure exact uniformity of angle and depth when countersinking aluminum plates, it is advisable to use a device which consists simply of a steel plate that acts as a stop and is attached to the side of the drill, thus preventing the metal being drilled beyond the required depth. Uniformity of depth also makes it unnecessary to chip the protruding portion of the rivet. If it should be necessary to countersink a plate thinner than the depth of the rivet head, a punch and die to fit a punching machine, or hand tools consisting of a punch and an iron block recessed on the top, will be required so as to enable a recess to be formed in the sheet to suit the angle and depth of the rivet head. For cup-head rivets, especially in repetition work, it is usual for a number of holes to be punched at the same time, in multiple punching machines. Most of the common punching machines produce only one hole at a time so that the plates have to be shifted, reset and sometimes marked for each hole. Another evil nearly inseparable from punching is the overlapping of the holes (as already mentioned) when plates are punched separately.

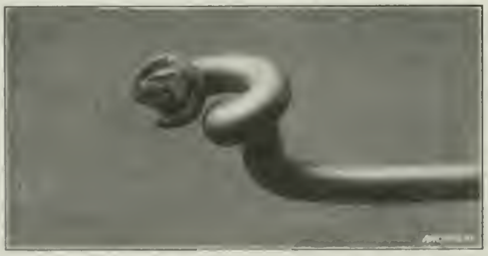

Fig. 8. Aluminum Rod which fractured Outside of Weld when subjected to Torsion Test

Riveted aluminum plates 1/16 inch to 1/8 inch in thickness are now extensively used in the construction of railway cars, especially for the external paneling. The plates are generally riveted to cross-ribs of tee or channel sections drawn in aluminum, and similar sections of steel, aluminum rivets mostly of the cup-head type, being used. In order to obtain the actual length of aluminum rivets, so as to form a suitable cup or spherical head when riveted, insert a rivet through the holes of the work to be connected. The tail should project a distance equal to one and one-half times its own diameter; thus a 1/8-inch rivet should project about 3/16 inch, while a 1/4-inch rivet should project about 3/8 inch. By this method a cup or spherical head is proportionately formed with a snap tool. If it is necessary for the riveted joints to be made water-tight the rivets must be spaced more closely. Calking or fullering can be resorted to in the usual way. An example of aluminum riveting is shown in Fig. 9.

Threading Aluminum Joints

In almost every case where bars or sections of aluminum have to be fastened together by screws and bolts, it is most essential that aluminum screws and bolts should be used for the purpose, any risk of corrosion being thus eliminated. It is frequently stated that aluminum cannot be threaded effectively, and it is true that the pure metal is not easily threaded, probably owing to its softness and toughness. With care, however, aluminum can be threaded, but owing to its soft nature the threads will not stand rough usage. Another drawback that is frequently experienced in the process of tapping the metal, is that if a suitable lubricant is not employed, the metal is likely to chip and adhere between the threads and the tap, the result being the formation of an imperfect thread. Better results are secured when aluminum is alloyed with other metals such as zinc and copper, in order to increase its strength and hardness. Some aluminum manufacturers supply a special alloy particularly adapted for making up into screws, bolts and nuts. These alloys give remarkably good results with the use of a lubricant, which is essential in order to obtain clean accurate threads.

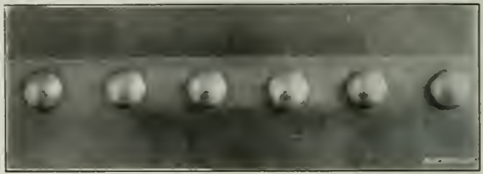

Fig. 9. Example of Aluminum Riveting

A large variety of lubricants have been tried with more or less success, *viz.*, petroleum, lard oil, kerosene, turpentine, gasoline, soda water, soap compounds, beeswax, etc. Perhaps one of the best is the first named, although many mechanics favor the use of turpentine, but this is not advisable owing to the liability of the liquid evaporating and leaving a resinous deposit on the work which tends to cause a screw to bind, whereas petroleum leaves a vaseline deposit that is most beneficial. A patented lubricant for use when threading aluminum, for which very good results are claimed, consists of 71.5 per cent gasoline, 14.25 per cent beeswax, and 14.25 per cent turpentine.

Flanging and Seaming Aluminum

The various methods of jointing aluminum already described do not include one of the most important mechanical methods of jointing the sheet metal. Many joints in sheet aluminum work are made in various forms that do not require soldering, welding, or riveting. The parts to be joined have the edges flanged at different angles to suit the type of joint decided upon; the edges are then lapped over each other, and finally closed by hammering.

Where the output is considerable, ingenious automatic flanging and seaming machines are used extensively that will produce a perfect double-seamed joint on cylindrical, square, or irregular work very quickly. Some idea of the output of these machines may be gathered from the fact that on one machine which will take work up to 8 inches wide and 12 inches high, it is possible to double seam more than 10,000 can ends of certain shapes per day. Jointing by this process is almost universally confined to thin gage stock from 1/64 to 1/16 inch in thickness.

Owing to its malleability and ductility, aluminum lends itself most satisfactorily to the various processes in jointing by flanging and seaming. The difficulty encountered in the formation of various joints, owing to the refractory oxide, naturally has no effect upon this mechanical process. Not only is the flanging and seaming of joints an economical method, but the joint is also remarkably strong and easily made. Care, however, should be taken to secure true edges, to enable accuracy to be obtained before finally closing the seams. Intricate aluminum articles are sometimes spun in sections in the spinning lathe; usually these parts are joined together by this method of flanging and seaming.

In the foregoing article, and in those previously published, no attempt has been made to enumerate all the methods by which aluminum is capable of beng jointed, but those selected illustrate the fact that during recent years considerable attention has been given to the devising of new methods, and more especially of jointing by autogenous welding and by various mechanical joints. It would appear that a very substantial advance has been achieved, and now that the problem has been solved, it may have a more than ordinary effect upon various industries.

* * *

DIAGRAM FOR DETERMINING CUTTING TIME

BY I. SCHELBECK*

The shop manager frequently finds it necessary to obtain a quick and more or less exact determination of the cutting time for a given piece of work that is to be handled on the lathe, milling machine, drill press, etc. For a piece of work handled on the lathe, the expression for the cutting time is:

$$\text{Cutting time} = \frac{\pi D L}{S F} \qquad (1)$$

where D = diameter of work in inches;

L = length of work in feet;

S = cutting speed in feet per minute;

F = feed in inches per revolution.

The diameter of the work and the length to be machined will be specified on the drawing, and the choice of a suitable speed and feed will be governed by the size of the work, the material, the type of tool used, etc. In addition to finding the cutting time, it will be required to know the number of revolutions per minute at which the work can be rotated while machining. When the diameter and the cutting speed are known, the number of revolutions per minute is:

$$\text{Revolutions per minute} = \frac{S}{\pi D} \qquad (2)$$

where S and D are the same as before.

The preceding formulas are easily solved with the slide-rule, but to afford an even easier method of securing the desired results numerous charts for the graphical solution of these problems have been developed. The fault with most of these is that they give only a partial answer to the problem, and the remainder has to be figured out. As a result, such charts are of relatively little value. The diagram gives a complete solution of both problems, and its use is as follows:

Consider a piece of work 3 inches in diameter by 8 feet in length, which is to be machined with a tool that will permit a cutting speed of 50 feet per minute to be employed. Operating at this speed, the lathe on which the work is to be done is capable of taking the cut at a feed of 0.040 inch per revolution. With this data at hand and making use of Formula (1), the cutting time is found to be:

$$\text{Cutting time} = \frac{\pi \times 3 \times 8}{50 \times 0.040} = 37.7 \text{ minutes.}$$

Similarly we find from Formula (2) that the number of revolutions per minute at which the work will run is:

$$\text{Revolutions per minute} = \frac{50 \times 12}{\pi \times 3} = 64.$$

With the preceding results as a guide we will now proceed to solve the same problems by means of the chart. Entering the diagram from the left-hand side along the horizontal line through a cutting speed of 50 feet per minute, and following it to the vertical line coming down from the top of the chart through a diameter of 3 inches, a diagonal line showing the number of revolutions per minute to be 65 is located. Then by entering the diagram along the horizontal line from the right-hand side marking a feed of 0.040 inch per revolution, and following it to the vertical line coming down from the top of the diagram indicating a length of 8 feet, a second diagonal line is located. At the point where the two diagonal lines intersect, the vertical line is followed to the base of the diagram and shows the resultant cutting time to be a little less than 40 minutes. The same system may also be used in determining the cutting time for milling and drilling machine operations.

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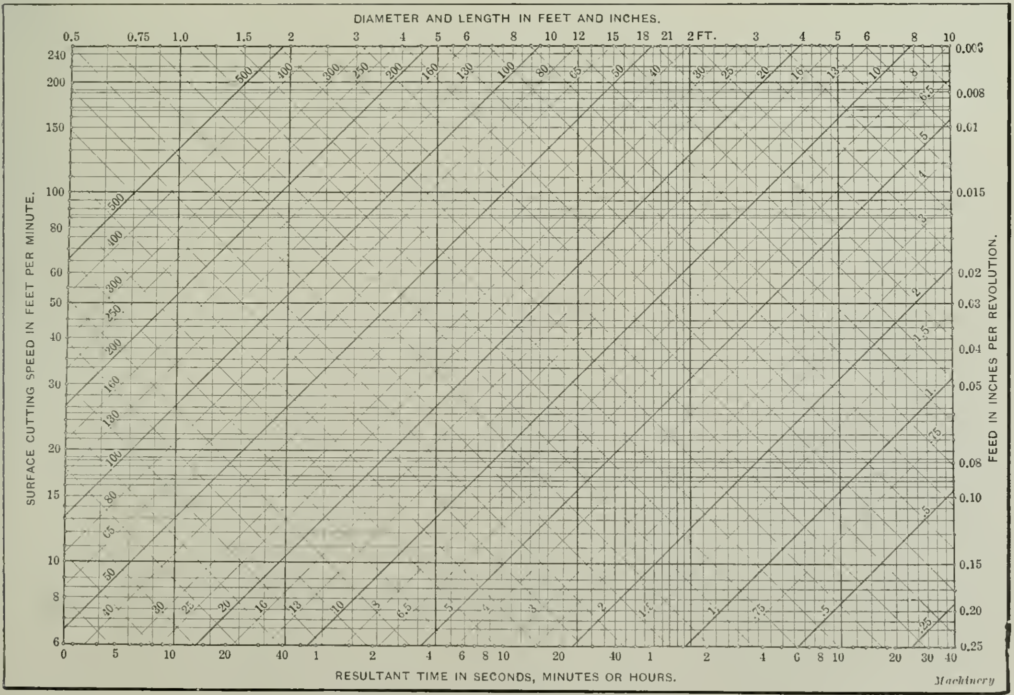

Diagram for the Rapid Determination of Cutting Time

A. S. M. E. TAP LIMITS

BY CORRESPONDENT

The general use of large quantities of American Society of Mechanical Engineers standard machine screws and taps has made it interesting to note that in hardly any case do the makers of these taps take advantage of the admittedly large limits specified in the A. S. M. E. tables for these taps. The reason, presumably, is to be found in the fact that the difference between the maximum diameter tap and a minimum diameter screw is so great that the fit between a minimum screw and a hole tapped with a maximum tap could hardly be called a fit, and as such, would be practically useless.

Now what interests the writer is this: Why were these large limits specified in the A. S. M. E. tables if they were not practical and if they could not be used? That they are entirely too great, and hence impractical, has been admitted by several makers of these taps; it is further admitted by them, because of the fact that they are not working to the specified limits when making taps of this standard. If the limits on screws remain as they are given in the A. S. M. E. tables, the limits of the taps must be made smaller and their minimum size nearer the basic size than is now the practice. (The basic size equals the maximum screw size.) The foregoing would, of course, be to the disadvantage of those making these taps, making them more troublesome and more expensive to manufacture.

If, on the other hand, the limits on the taps should remain as given in the A. S. M. E. tables, then the limits on the screws must be made smaller and nearer their maximum or basic size, a requirement to which the screw makers naturally will object. However, this latter does not seem to be the case, as tap makers in general seem to have taken care of the closer limits necessary by making the taps within closer margins.

A. S. M. E. TAP LIMITS

A. S. M. E. LIMITS FOR STANDARD TAPS

NOTE:—Minimum sizes given are the standard sizes

Diameters to which A. S. M. E. taps are actually made, with very slight deviations, by several tap makers.

No.	Basic Size			Outside Diameter		Pitch Diameter		Root Diameter		Pitch Diameter		Root Diameter	
	T. P. I.–O. D.	P. D.	Root	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
0	80—0.060	0.0519	0.0438	0.0609	0.0632	0.0528	0.0537	0.0447	0.0466	0.0522	0.0528	0.0441	0.0447
1	72—0.073	0.0640	0.0550	0.0740	0.0765	0.0650	0.0660	0.0560	0.0580	0.0643	0.0650	0.0553	0.0560
2	64—0.086	0.0759	0.0657	0.0871	0.0898	0.0769	0.0780	0.0668	0.0689	0.0762	0.0769	0.0660	0.0668
3	56—0.099	0.0874	0.0758	0.1002	0.1033	0.0886	0.0897	0.0770	0.0793	0.0877	0.0886	0.0761	0.0770
4	48—0.112	0.0985	0.0849	0.1133	0.1168	0.0997	0.1010	0.0862	0.0888	0.0988	0.0997	0.0852	0.0862
5	44—0.125	0.1102	0.0955	0.1263	0.1301	0.1116	0.1129	0.0968	0.0995	0.1105	0.1116	0.0958	0.0968
6	40—0.138	0.1218	0.1055	0.1394	0.1435	0.1232	0.1246	0.1069	0.1097	0.1221	0.1232	0.1058	0.1069
7	36—0.151	0.1330	0.1149	0.1525	0.1569	0.1344	0.1359	0.1164	0.1193	0.1333	0.1347	0.1152	0.1167
8	36—0.164	0.1460	0.1279	0.1655	0.1700	0.1474	0.1489	0.1294	0.1323	0.1463	0.1477	0.1282	0.1297
9	32—0.177	0.1567	0.1364	0.1786	0.1835	0.1583	0.1598	0.1380	0.1411	0.1570	0.1586	0.1367	0.1383
10	30—0.190	0.1684	0.1467	0.1916	0.1968	0.1700	0.1716	0.1483	0.1515	0.1692	0.1708	0.1475	0.1491
12	28—0.216	0.1928	0.1696	0.2176	0.2232	0.1944	0.1961	0.1713	0.1745	0.1936	0.1952	0.1704	0.1721
14	24—0.242	0.2149	0.1879	0.2438	0.2500	0.2167	0.2184	0.1896	0.1931	0.2157	0.2175	0.1887	0.1904
16	22—0.268	0.2385	0.2090	0.2698	0.2765	0.2403	0.2421	0.2108	0.2144	0.2392	0.2410	0.2097	0.2115
18	20—0.294	0.2615	0.2290	0.2959	0.3031	0.2634	0.2653	0.2309	0.2346	0.2622	0.2641	0.2297	0.2316
20	20—0.320	0.2875	0.2550	0.3219	0.3291	0.2894	0.2913	0.2569	0.2606	0.2882	0.2901	0.2557	0.2576
22	18—0.346	0.3099	0.2738	0.3479	0.3559	0.3118	0.3138	0.2758	0.2795	0.3106	0.3125	0.2745	0.2765
24	16—0.372	0.3314	0.2908	0.3740	0.3828	0.3334	0.3354	0.2928	0.2968	0.3321	0.3341	0.2915	0.2935
26	16—0.398	0.3574	0.3168	0.4000	0.4088	0.3594	0.3614	0.3188	0.3228	0.3581	0.3601	0.3175	0.3195
28	14—0.424	0.3776	0.3312	0.4261	0.4359	0.3797	0.3818	0.3333	0.3374	0.3783	0.3804	0.3319	0.3340
30	14—0.450	0.4036	0.3572	0.4521	0.4619	0.4057	0.4078	0.3593	0.3634	0.4043	0.4064	0.3579	0.3600

A. S. M. E. LIMITS FOR SPECIAL TAPS

NOTE:—Minimum sizes given are the standard sizes

Diameters to which A. S. M. E. taps are actually made, with very slight deviations, by several tap makers.

No.	Basic Size			Outside Diameter		Pitch Diameter		Root Diameter		Pitch Diameter		Root Diameter	
	T. P. I.–O. D.	P. D.	Root	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
1	64—0.073	0.0629	0.0527	0.0741	0.0768	0.0639	0.0650	0.0538	0.0559	0.0632	0.0639	0.0530	0.0538
2	56—0.086	0.0744	0.0628	0.0872	0.0903	0.0756	0.0767	0.0640	0.0663	0.0747	0.0756	0.0631	0.0640
3	48—0.099	0.0855	0.0719	0.1003	0.1038	0.0867	0.0880	0.0732	0.0758	0.0858	0.0867	0.0722	0.0732
4	40—0.112	0.0958	0.0795	0.1134	0.1175	0.0972	0.0986	0.0809	0.0837	0.0961	0.0972	0.0798	0.0809
	36—0.112	0.0940	0.0759	0.1135	0.1180	0.0954	0.0969	0.0771	0.0803	0.0943	0.0954	0.0762	0.0774
5	40—0.125	0.1088	0.0925	0.1264	0.1305	0.1102	0.1116	0.0939	0.0967	0.1091	0.1102	0.0928	0.0939
	36—0.125	0.1070	0.0889	0.1265	0.1310	0.1084	0.1099	0.0901	0.0933	0.1073	0.1084	0.0892	0.0904
6	36—0.138	0.1200	0.1019	0.1395	0.1440	0.1214	0.1229	0.1034	0.1063	0.1203	0.1214	0.1022	0.1034
	32—0.138	0.1177	0.0974	0.1396	0.1445	0.1193	0.1208	0.0990	0.1021	0.1180	0.1193	0.0977	0.0990
7	32—0.151	0.1307	0.1104	0.1526	0.1575	0.1323	0.1338	0.1120	0.1151	0.1310	0.1326	0.1107	0.1123
	30—0.151	0.1294	0.1077	0.1526	0.1578	0.1310	0.1326	0.1093	0.1125	0.1297	0.1313	0.1080	0.1096
8	32—0.164	0.1437	0.1234	0.1656	0.1705	0.1453	0.1468	0.1250	0.1281	0.1440	0.1456	0.1237	0.1253
	30—0.164	0.1423	0.1207	0.1656	0.1708	0.1439	0.1455	0.1223	0.1255	0.1426	0.1442	0.1210	0.1226
9	30—0.177	0.1553	0.1337	0.1786	0.1838	0.1569	0.1585	0.1353	0.1385	0.1556	0.1572	0.1340	0.1356
	24—0.177	0.1499	0.1229	0.1788	0.1850	0.1517	0.1534	0.1246	0.1281	0.1502	0.1520	0.1232	0.1249
10	32—0.190	0.1697	0.1494	0.1916	0.1965	0.1713	0.1728	0.1510	0.1543	0.1705	0.1721	0.1502	0.1518
	24—0.190	0.1629	0.1359	0.1918	0.1980	0.1647	0.1664	0.1376	0.1411	0.1637	0.1655	0.1367	0.1384
12	24—0.216	0.1889	0.1619	0.2178	0.2240	0.1907	0.1924	0.1636	0.1671	0.1897	0.1915	0.1627	0.1644
14	20—0.242	0.2095	0.1770	0.2430	0.2511	0.2111	0.2133	0.1789	0.1826	0.2103	0.2122	0.1778	0.1797
16	20—0.268	0.2355	0.2030	0.2699	0.2771	0.2374	0.2393	0.2049	0.2086	0.2362	0.2381	0.2037	0.2056
18	18—0.294	0.2579	0.2218	0.2959	0.3039	0.2598	0.2618	0.2238	0.2276	0.2586	0.2606	0.2225	0.2245
20	18—0.320	0.2839	0.2478	0.3219	0.3209	0.2858	0.2878	0.2498	0.2536	0.2846	0.2865	0.2485	0.2505
22	16—0.346	0.3054	0.2648	0.3480	0.3568	0.3074	0.3094	0.2668	0.2708	0.3063	0.3081	0.2655	0.2675
24	18—0.372	0.3359	0.2998	0.3739	0.3819	0.3378	0.3398	0.3018	0.3056	0.3366	0.3385	0.3005	0.3025
26	14—0.398	0.3516	0.3052	0.4003	0.4099	0.3537	0.3558	0.3073	0.3114	0.3523	0.3541	0.3059	0.3080
28	16—0.424	0.3834	0.3428	0.4260	0.4348	0.3851	0.3874	0.3448	0.3488	0.3841	0.3861	0.3435	0.3455
30	16—0.450	0.4094	0.3688	0.4520	0.4608	0.4114	0.4134	0.3708	0.3748	0.4101	0.4121	0.3695	0.3715

Machinery

In the case of one maker the outside diameters were made smaller and with smaller limits in the same proportion as the pitch diameter and root diameter. As however the outside diameter has no bearing upon the fit between the screw and the tapped hole, the outside diameter limits have been allowed to remain as above.

After making an analysis of the A. S. M. E. tables, one will find that the limits for screws are even greater than those given or allowed on taps, a fact which to the writer at least is unexplainable. The screws generally are left soft and are not likely to develop the inaccuracies caused by the hardening operation. Taps, on the other hand, are not only subject to these inaccuracies but also to those caused by an interrupted (by the flutes) thread surface which, in hardening, may cause them to swell unevenly, to get out of round, warp, etc.

While the writer firmly believes that it would have been more practical to reduce the limits of machine screws, which were greater than those for taps in the first place, it seems that practically all tap makers—some beginning immediately after the introduction of the A. S. M. E. standard—are making these taps to closer limits than those specified. In order that readers of MACHINERY who, like the writer, have to make and use taps and screws to this standard may avoid the troubles which he has experienced, tables are here given of limits for these taps as, with slight variations, they are made by most makers at present. No figures for limits on outside diameters have been given, the outside diameters having no effect upon the fit between the screw and the tapped hole, and those given in the A. S. M. E. tables can be used. Some makers, however, make the outside diameter to the same proportional limits as the limits given for the pitch diameter. It is interesting to note how close the limits for pitch diameter actually are; if they are adhered to by those making taps it must be confessed that the art of making taps has reached a pretty high standard.

* * *

RECENT LEGAL DECISIONS INVOLVING MACHINERY

Implied Warranty in Sale of Engine

(Indiana.) A manufacturer who undertakes to construct a machine for a particular purpose of which he has knowledge impliedly warrants that it is suitable for the purpose for which it is designed.

A manufacturer of gas engines, who undertook to construct a gas engine for a particular purpose, impliedly warrants the suitability of the engine for the purpose desired, and the giving of an express warranty that the engine should be built in a thorough, workmanlike manner of proper materials does not supplant the implied warranty that it shall be of a suitable design. *(Penn American Plate Glass Co. v. De La Vergne Machine Co., 106 N. E. 722.)*

An Invention to be Patentable Must be Useful

(Federal.) Both the constitutional and statutory provisions relating to the granting of patents emphasize the requirement that an invention, to be patentable, must be useful, and, to entitle a patent to protection, it must appear that the device is operative. *(Troy Laundry Machinery Co. v. Columbia Mfg. Co., 217 Fed. 787.)*

Comparative Negligence

(Federal.) In an action for injuries to a servant by getting his hand caught between the rolls of a wool-finishing machine, the court charged that if defendant was careless in giving plaintiff proper instructions, and plaintiff was heedless, his heedlessness, cooperating with that of the defendant, would not prevent recovery because the injury would not be the sole result of the boy's fault, the fundamental fault being that of defendant in not giving him proper instructions. Held erroneous, as submitting the doctrine of comparative negligence, which is not a part of the law of New Hampshire, where the accident occurred. *(American Woolen Co. v. Stewart, 217 Fed. 1.)*

Suit in Equity for Infringement of Patent

(New York.) An injunction will not be granted against the use of a machine or structure which infringed a patent during its life after the patent has expired, even though it was made and put in use by the owner prior to such expiration. *(American Sulphite Pulp Co. v. Hinckley Fiber Co., 217 Fed. 57.)*

Contract for Purchase of Electric Crane

(Federal.) Where a proposal to purchase an electric crane provided that the terms were 50 per cent cash thirty days, balance in four notes of equal amount, payable three, six, nine and twelve months, at 6 per cent and that all communications between the parties, whether verbal or written, with reference to the subject of the contract, were superseded by the proposal and its acceptance by the purchaser, followed by its approval by an officer of the seller, should constitute a binding contract, and no modification should be binding on either party, unless it should be in writing, signed and accepted in the same manner as the original contract, a letter written by the seller's Southern representative, confirming an agreement as a part of the proposal that the seller should take an electric machine of the buyer and allow $2300 on the price of the new one, not accepted or signed by any of the seller's officers, and not shown to have been submitted to the seller for acceptance, was ineffective to supersede the terms specified in the accepted proposal.

For the breach of a seller's contract the buyer may recover such damages as are the natural, proximate, and certain consequences thereof, but cannot recover those which are remote, speculative, and contingent. *(Norfolk Sand & Gravel Corporation v. Ohio Locomotive Crane Co., 217 Fed. 26.)*

Delivery and Acceptance of Machinery

(Federal.) A buyer may accept the delivery of machinery sold under a warranty, and invoke the seller's breach of warranty by way of counter-claim in reduction of damages, when sued for the price. *(In re Lane Lumber Co., 217 Fed. 555.)*

Implied Agreements as to Sale of Machinery

(New York). In an action for the price of machines, returnable at the end of 30 days from delivery, if not suitable, in which the defence was an implied agreement, made within the 30 days, that the purchaser should have further time to test the machines, as he was not then satisfied with them, questions relative to the use to which the machines were to be put, and conversations with plaintiff's representative within the 30 days as to how the machines were working, and whether the purchaser desired to continue their use, were proper, as the answers might tend to show the implied agreement pleaded. *(Underwood v. New Netherland Bank of New York, 150 N. Y. S. 487.)*

Action for Price of Machinery

(New York.) Plaintiff, doing business under a corporate name, having no connection with another corporation of a similar name, who sold machinery to defendant to a certain amount and allowed him certain credits, could recover the balance, without any credit to the buyer for an amount claimed to be owed him by the other corporations. *(March v. Hyman, 150 N. Y. S. 460.)*

* * *

THE LJUNGSTROM TURBINE

The electric propulsion of ships is likely to be more and more considered by naval engineers. Steam turbines are used for driving generators which, in turn, supply the electricity for the motors driving the propeller shafts. A turbine especially suitable for installations of this kind has recently been developed in Sweden and is known from its inventor as the Ljungström turbine. This turbine is remarkable for high efficiency, small size, and the reduced space required by the accessory plant. The performance of a turbine of this type recently installed in a municipal power station in London affords valuable evidence as to its qualities. A 1000-kilowatt turbine will consume at full load 12.75 pounds of steam per kilowatt-hour; at half load, 14.7 pounds; at quarter load, 17.8 pounds. A 5000-kilowatt unit will consume at full load 11.8; at half load, 13.4; and at quarter load, 15.9 pounds of steam per kilowatt-hour. Attention should be called to the steam consumption when the turbine is working at less than its rated capacity. The turbine is of peculiar construction, having two elements rotating in opposite directions. It is stated that notwithstanding the high speed of 3000 revolutions per minute, or 6000 revolutions per minute between the two rotating elements, there is almost complete absence of noise or vibration, a point which is of great importance on board ship, where the use of speed reducing gears between high-speed turbines and propeller shafts aggravates the noise and vibration from the turbines themselves.

AIR-OPERATED CHUCKS AND MANDRELS

CONSTRUCTION, OPERATION, ADVANTAGES, EXAMPLES OF WORK FOR WHICH THEY ARE ADAPTED

BY E. F. LAKE*

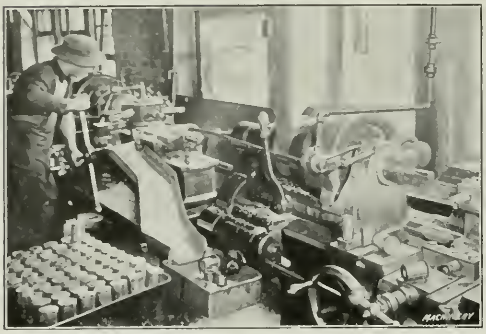

Fig. 1. Machining Babbitt Bearings at the Studebaker Corporation with the Aid of Air-operated Chucks

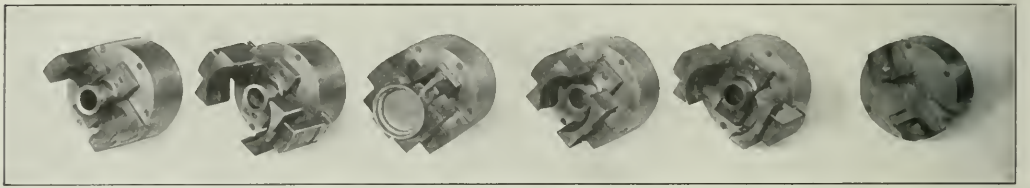

Fig. 2. Hannifin Mfg. Co.'s Two-jawed Air Chucks with Pilot Bushings and Special Jaws for Extra Capacity

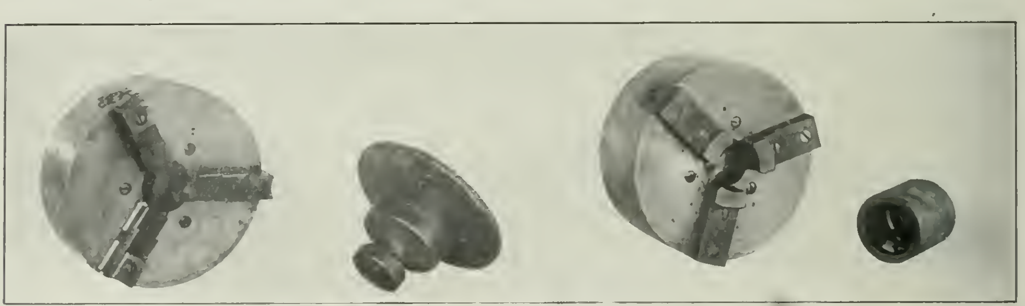

Fig. 3. Three-jawed Air-operated Chucks which grip Outside or Inside Diameter of Work

AIR-OPERATED chucks, expanding mandrels and vises, such as are made by the Hannifin Mfg. Co., Chicago, have enabled many kinds of machine work to be done with greater accuracy and much faster than by the methods employed before air was used to operate such tools. Thus they have effected a considerable saving in the cost of production. The Studebaker Corporation uses many of these tools for holding different automobile parts while they are being machined in its Detroit shops. The accompanying illustrations show how they are fitted to the different machines, and the styles of chucks, mandrels, and vises used. In giving the time on the various jobs only the average is stated and the weekly or monthly output can be based on these figures.

One notable example of the use of an air-operated chuck and mandrel is shown in Fig. 1. Here two machines are used for the inside and outside machining of an all babbitt bearing that is rough cast in iron molds. The Warner & Swasey turret lathe to the left is fitted with a two-jawed air chuck which grips the outer circumference of the cast bearings that are shown on the stand. The chucking merely consists of holding the casting between the chuck jaws and turning a lever to release the air. This is done so quickly that it is hard to follow it with the eye. The operator then bores and reams the holes, faces the end, and turns the outer diameter of the collar on these bearings at the rate of fifty per hour. As the casting costs forty-four cents, one can easily figure the total cost of the bearing up to this point. When these operations have been completed the air is turned off and the operator drops the bearing into the trough so it will slide down the chute into the box in front of the second lathe.

This second machine is a LeBlond heavy-duty lathe that is fitted with an air-operated expanding mandrel. The operator takes the bearing from the box, places it on the mandrel and turns on the air. This expands the mandrel so it will grip the work on the inner surface that was bored and reamed. The operator then turns the outside of the bearing, faces the other end and straddle-faces the collar at the rate of fifty per hour. This machines them all over. When they have been split into two and the oil grooves have been cut they are ready to go into the automobile.

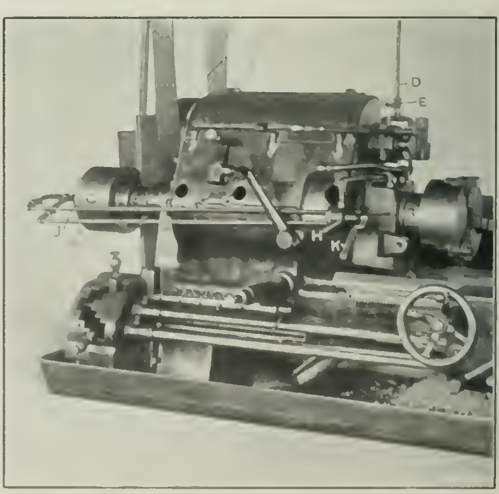

Fig. 4. How Compressed Air Chucks are Installed on Lathes

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* Address, 412 Pennsylvania Ave., Detroit, Mich.

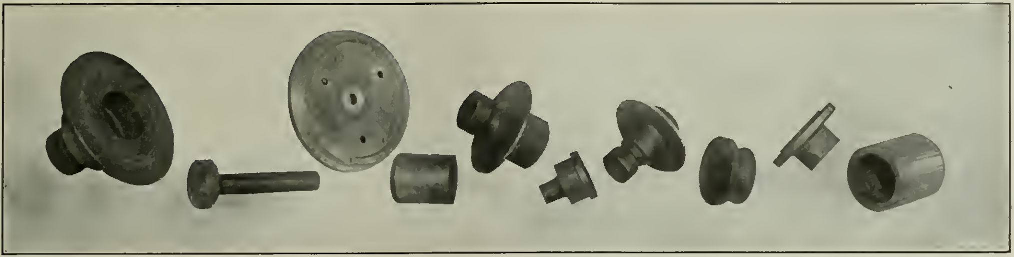

Fig. 5. A Few Automobile Parts that are machined in these Chucks

The bearings seem to flow in a steady stream through these two machines and the Studebaker Corporation claims they are cheaper than die-castings. The bearings are also considered much better, as the metal is dense and solid and does not contain the air bubbles so often found in the center of die-castings. It is also claimed that the bore will be more truly round and accurate in size, as there is no danger of its warping out of round.

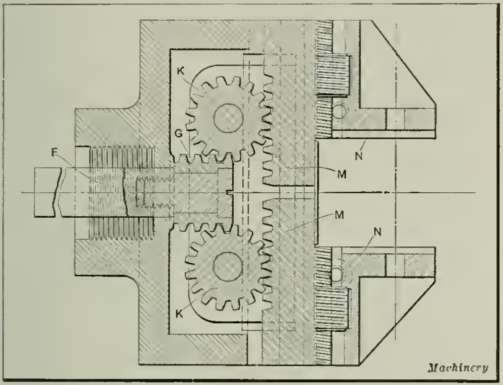

Fig. 6. Section through Center of Two-jaw Chuck showing Gear-operated Jaws

In Fig. 2 are shown a number of two-jawed, air-operated chucks such as are used in the machine to the left in Fig. 1. These have been fitted with special master jaws which give them an extra capacity. They are also fitted with extra pilot bushings to guide the piece while it is being chucked. This gives an idea of the range of work that can be held in this kind of chuck. In Fig. 3 is shown the three-jawed chucks with samples of the work they will hold. One chuck grips the work on its outside diameter and the other on the inside diameter.

The way these chucks are installed on a lathe is shown in Fig. 4. In this case a three-jawed chuck is being used with the standard jaws that go with it. The chuck is placed in its usual position as at *B*. At the opposite end of the lathe spindle is located an air cylinder *C*. Inside cylinder *C* is a piston that is operated by air. It is connected to the chuck by a shaft through the spindle of the lathe. The air is brought down from overhead at *D*, and valve *E* is provided so the air can be entirely shut off. The air valve that operates the chuck is located at *H* so lever *K*, which operates the valve, will be within easy reach of the man who is working on the machine.

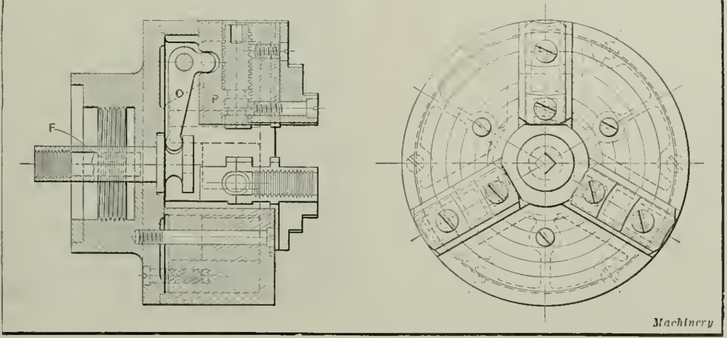

Fig. 7. Section through Center of Three-jaw Chuck showing Lever-operated Jaws

Pipe *J* conducts the compressed air from valve *H* to the inside air chamber in cylinder *C*. This pushes the piston out, causing the chuck jaws to draw in and grip the outside diameter or surface of the piece to be machined. Moving valve handle *K* switches the air pressure over to pipe *L* and this transmits it to the outer air chamber in cylinder *C*. This action pushes the piston forward and moves the chuck jaws outward to release any work that has been gripped on the outer surfaces. The chuck will also grip the inside diameter of any hollow piece, and passing the air back through pipe *J* will release the work. Thus it is only necessary to reverse the motion of lever *K* to grip the work on either the outside or inside. Both outside and inside jaws can be used in the same chuck, and thus a large variety of shapes can be gripped. Fig. 5 shows a number of automobile parts that were held in such chucks while being machined.

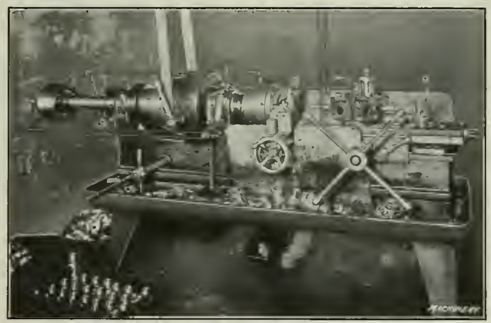

Fig. 8. Machining Studebaker Universal Joint Bodies at the Rate of Fourteen per Hour, with an Air Chuck of the Draw-in Collet Type

Fig. 6 shows a sectional view of the two-jawed chuck through the center of the jaws. The piston in cylinder *C*, Fig. 4, is connected to shaft *F* in this view. When the air moves the piston in and out it moves shaft *F* back and forth through the head of the lathe. This moves gear rack *G*, which, in turn, revolves gear wheels *K* so they will move the racks *M* on chuck jaws *N*. Thus the faces of jaws *N* are moved enough to grip the work or release it. The operator only inserts the work between the jaws and turns lever *K* (Fig. 4). Then the air in-

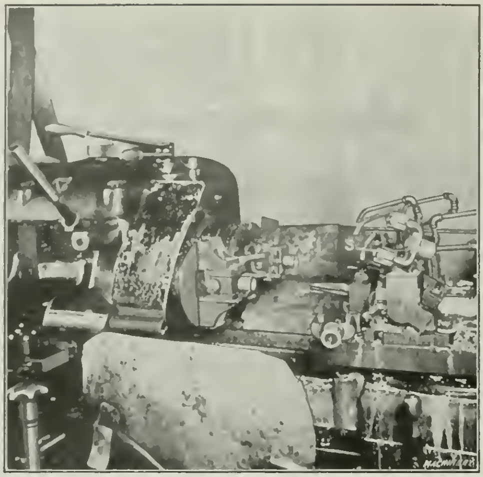

Fig. 9. Turning, facing, boring and reaming a Universal Joint Yoke at the Rate of Twenty per Hour

stantaneously moves jaws *N* so they grip the work. When the machining has been completed the work is released just as quickly by turning lever *K* in the opposite direction.

Fig. 7 is a sectional view through the center of the three-jawed chuck. Here in place of racks and gears the lever principle has been applied. Thus when shaft *F* is operated by the air its grooved end moves lever *O*. As this fits into a groove in jaw *P*, it moves the jaw in and out. Each jaw has the same lever mechanism so they will move in unison. The levers have a 4 to 1 ratio between shaft *F* and jaw *P*. Thus it will take an enormous amount of power to make any kind of work move or slip when it is gripped in the jaws.

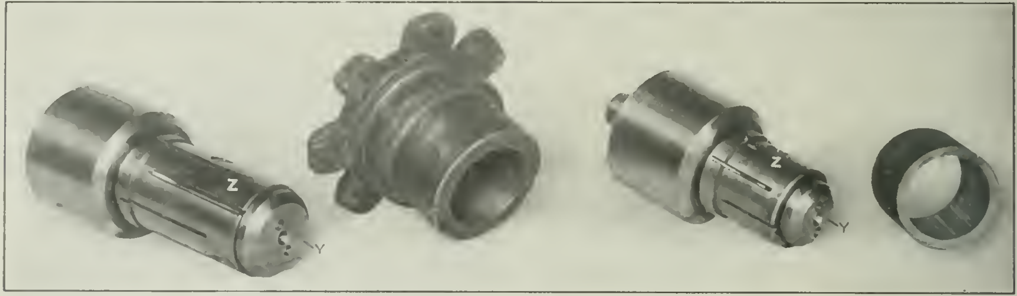

Fig. 10. How Expanding Mandrel operates

In Fig. 8 is shown the method employed for machining the universal joint body of the Studebaker automobile. Here the air chuck has been installed in a No. 6 Warner & Swasey turret lathe to hold the universal joint body shown at *R* and also lying in the pan of the machine. The wings of this body have previously been turned to a true circle on their outer circumference and the air chuck grips the body on this surface. A hole is then drilled through the hub. This hole is bored and reamed to a taper. The outside diameter and end of the hub are then rough-turned, finish-turned and faced. This universal joint body is made from a hard steel forging, and all of these operations are performed at the rate of fourteen per hour—that is, fourteen finished pieces leave this machine every hour during a week's or a month's run.

In Fig. 9 special jaws have been fitted to a two-jawed air chuck to hold the universal joint yoke shown at *S*. Two of these steel forgings are operated upon at one time in this double-spindle lathe. Here the outside of the hub is rough-turned, finished and faced. It is then drilled and bored and reamed to the correct taper. On this job the operator averages twenty per hour, while before the air chuck was installed, from thirteen to fourteen was considered a good hour's work. At *T* in Fig. 12 is shown the Studebaker differential bearing support as it was machined in the special jawed air chuck *U*. This is the first of four operations on this piece. Here it was rough-bored, finish-bored, recessed, threaded, faced and turned on the outside down to the arm. These operations are performed at the rate of thirteen pieces per hour. For the second operation the piece is gripped on the inside finished surface by the expanding mandrel *W* in Fig. 11. Here the opposite side is faced and the outside turned in as far as the bosses at the rate of twenty-eight per hour. A finished piece is shown at *X*.

The operation of the expanding mandrel is best illustrated in Fig. 10. The mandrels and the pieces held on them are shown side by side. The outer shell of the mandrel is split, as can be seen. When the work is put in place, the air is turned on and the piston draws in the head of the mandrel shown at *Y*. This head is beveled to fit the corresponding bevel on the inside end of the split shell. Thus when the head is drawn in, it expands split shell *Z* enough to make it grip the surface around the hole in the piece so tight that it will not move while it is being machined on the outside. The third job on this same piece is shown in Fig. 13. Special jaws have been fitted to the chuck to enable it to grip the outer diameter of the piece and center it, sideways, by the two faces. The arm or stem is then turned, centered and threaded at the rate of thirty-five per hour. Finished pieces can be seen lying on the machine. The fourth and last operation on this piece is shown in Fig. 14. Four pieces are clamped to a revolving table at one time. Then the bosses are straddle-milled on the outside and the support is split through the center of the bosses at the rate of thirty-one per hour. Two completely finished differential bearing supports are shown on the platen of the machine.

Still another type of air-operated chuck is shown in Fig. 15. In the chuck to the right the pins shown at *A* are forced out by the air operating a bar that passes through the center of the chuck. Beveled rings are turned on this bar where it comes in contact with the pins. Four other

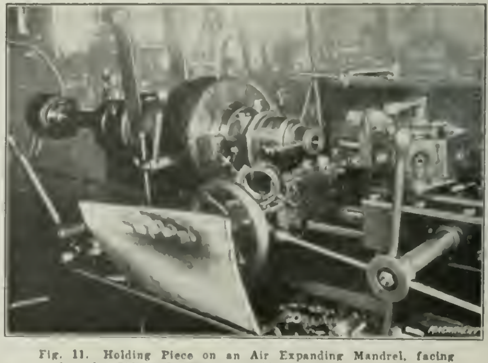

Fig. 11. Holding Piece on an Air Expanding Mandrel, facing Opposite Side and turning Outside as far in as Bosses at the Rate of Twenty-eight per Hour

pins are on the opposite side of the chuck spindle. These pins grip the inside of the piston that is shown between the two chucks. Each piston is first faced so it will fit tight against the face of the chuck at *B*. When it is gripped on this chuck the outside and the ends are turned and the pin holes are drilled and reamed. To use the chuck to the left of Fig. 15, the edge of the piston must be faced and the piston pin hole must be bored and reamed. Then the piston is slipped over the spindle, and pin *C* is passed through the pin hole and the hole in the end of the spindle. Then the air is turned on and this draws pin *C* back until the piston is clamped against the face of the chuck at *D*. This will hold it securely while it is being machined all over the outside.

There are so many devices of this kind that can be rigged up to be operated by compressed air for holding work that it is impossible to mention them all. When so rigged the operator can chuck the work and remove it from the machine so much faster that a large saving of time is effected. In some cases as much as 50 per cent has been saved and in many cases the saving is from 20 to 25 per cent.

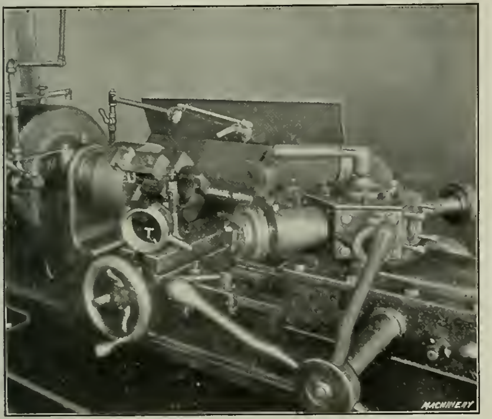

Fig. 12. Rough- and finish-boring, recessing, threading, facing and turning Differential Bearing Support at the Rate of Thirteen per Hour

Air-operated vises have been designed for holding work in the milling machine, shaper, planer, slotter, etc., and also for holding it while doing bench work. Numerous shapes of hinged jaws have also been incorporated in the draw-in collet chucks, and thus air-operated tools can now be obtained for holding nearly all shapes of work while being machined on nearly all the different kinds of machine tools now being built. Air-operated countershafts are also being marketed by the Hannifin Mfg. Co. of Chicago to operate all of these machines with, and it would seem as though the only thing left to do was to apply an air brake for stopping the machines quickly. Reversing the air countershaft, however, will probably give all the braking effect required.

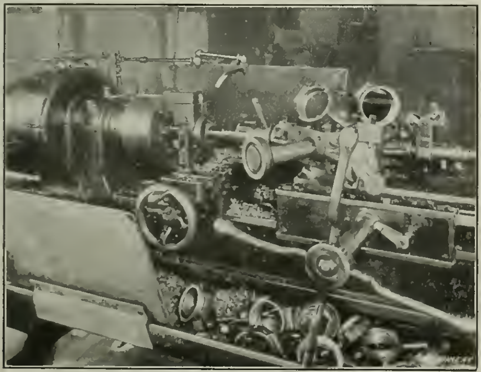

Fig. 13. Special Jaws to grip Entire Piece on its Outer Diameter. Arm is then turned, centered and threaded at the Rate of Thirty-five per Hour

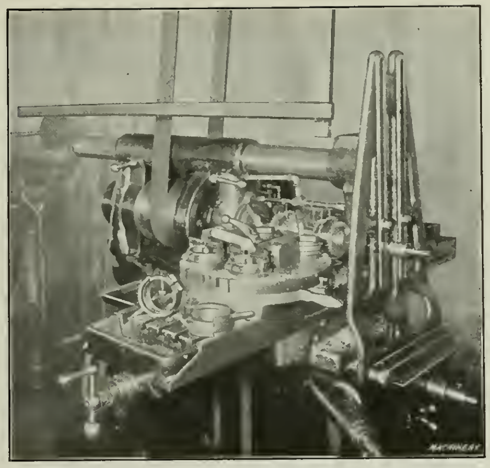

Fig. 14. Final Operation of straddle-milling the Bosses and splitting the Differential Bearing Support at the Rate of Thirty-one per Hour

* * *

The Cunard liner *Transylvania*, the first Atlantic liner equipped with geared turbines, completed a most successful series of trials previous to her sailing on her maiden voyage to New York. The vessel is of 19,400 tons displacement and is provided with twin propellers, each propeller shaft being driven by a high-pressure and low-pressure Parson's reaction turbine, these being placed side by side and both engaging with a gear on the propeller shaft. This gear is 10 feet in diameter and 5 feet wide. When running full speed, the turbines make 1630 revolutions, while the propeller makes 130 revolutions per minute, the ratio being 12.5 to 1. The full power developed is 9500 horsepower, and the speed, 16½ knots. The steam consumption of the turbines is 11½ pounds per horsepower-hour. Either the high-pressure or low-pressure turbine can be worked independently, the steam pipes being arranged accordingly, so that disablement in any one of the turbines does not interfere with the driving of the ship by both propellers. With each low-pressure turbine is also incorporated a turbine of the Parson impulse reaction type for running astern. The construction marks a new development in the propulsion of ocean-going vessels of this size. The vessel has accommodations for nearly 2500 passengers and is intended for the New York-Mediterranean service of the Cunard Line.

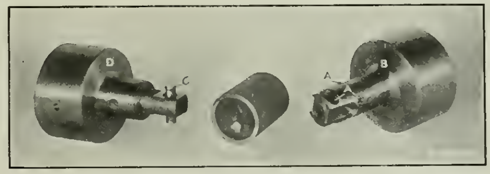

Fig. 15. Special Air-operated Chucks for holding Gas Engine Pistons

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The Aeronautical Society of America in collaboration with many national engineering organizations will, on February 5 and 6, 1915, consider the inventions tending to increase the stability and safety in flight of heavier-than-air machines. Inventors wishing to submit their inventions are invited to communicate with the technical board of the society, 29 West 39th St., New York City, and to submit to it all the data in their possession, such as descriptions, information relating to tests, etc. If the inventor is in position to submit a model or can show an apparatus of working size, this information should be given. All material so submitted will be presented in public meeting and, therefore, no inventions or data of a secret nature should be communicated.

PLOTTING THE INVOLUTE CURVE

A SIMPLE METHOD OF LOCATING POINTS WITHOUT LAYING OUT TANGENTS TO THE BASE CIRCLE

BY JOHN EDOAR[*]

THERE are many times when it would be convenient to plot the involute curve by means other than that of laying off tangents on the base circle. For instance, it may be desired to locate a single point on the curve with a degree of accuracy that is not possible by graphical means. In my study of the involute gear tooth I have many times found myself in this position, and as a solution I have adopted a method of procedure that may be of value to many readers of MACHINERY and probably of interest to all of them. The more we know of the involute curve the better we will be able to adapt it to our designs and to take advantage of its many favorable properties in the transmission of uniform motion; and its adaptation can then be profitably made in other forms than the now common gear tooth. That it is a practical curve for cams is not so generally known as it should be. The modern methods of generating the teeth of gears make it possible to obtain many varied forms of the involute, as it relates to the angle of pressure between the teeth, and this widens the field of study in the matter of proper proportions of teeth and the relative length of the teeth above and below the pitch line. These generating machines make it an easy matter to treat those cases which need special treatment, since the question of special cutters need not stand in the way, as a wide range of form may be had with standard tools.

The more obvious applications of the plotted involute are those instances where a tool or pattern is to be made to an original curve. The points on the curve are obtained by ordinates from a given line, and their values are calculated in preference to the graphical method of laying off tangents on the base circle of the involute. The purely mathematical treatment of the problem is not adaptable to our purpose, as the lack of sufficient terms makes it impossible to obtain any practical results. The method adopted is not so nice a mathematical proposition but is of more practical value even if it would not pass muster in a mathematical light. The pure mathematical expression for the involute is:

$$X = \cos I + I \sin I$$

$$Y = \sin I - I \cos I$$

Fig. 1 is an explanatory diagram of the preceding notation. These two expressions are complete and appear simple enough until one tries to put them to use and finds that he has a nice combination of unknown quantities to work with. Thus for instance, suppose that he wishes to locate the point on the curve at a definite distance from the base circle, which gives him the value of Y; in order to find the corresponding value of X, the value of I must be known, which is not the case. For this reason, the formula has been abandoned and a different method of procedure arranged in which a greater number of known quantities are available. If we divide the angle I into parts A and B by means of the radial line through the point on the involute, as in Fig. 2, we obtain means of solving the problem. The angles in the illustrations and the expressions already given are in radians. This may need explaining for the benefit of some readers, and to make the matter clear we will state that a radian is an angle of 57.296 degrees; and to convert degrees into radians, it is simply necessary to divide the number of degrees by 57.296. Technically, a radian is the angle subtended by the arc of a circle of the same length as the radius of that circle. Since we will make use of angles expressed in both radians and degrees in the method that is to be described, it will be convenient to have tabulated values to refer to in the calculations, and these will be found in Table I. This table is arranged in regular intervals and other values than those tabulated can be obtained by addition. Thus the equivalent value of 0.625 radian is found to be:

0.600 radian = 10 × 3 degrees 26.28 minutes = 34 degrees 22.8 minutes.

TABLE I. EQUIVALENT VALUES OF ANGLES IN RADIANS AND DEGREES

Radians	Degrees	Minutes	Radians	Degrees	Minutes
0.0001	..	0.3438	0.0070	..	24.0660
0.0002	..	0.6876	0.0080	..	27.5040
0.0003	..	1.0314	0.0090	..	30.9420
0.0004	..	1.3752	0.0100	..	34.3800
0.0005	..	1.7190	0.0200	1	8.7600
0.0006	..	2.0628	0.0300	1	43.1400
0.0007	..	2.4066	0.0400	2	17.5200
0.0008	..	2.7504	0.0500	2	51.9000
0.0009	..	3.0942	0.0600	3	26.2800
0.0010	..	3.4380	0.0700	4	0.6600
0.0020	..	6.8760	0.0800	4	35.0400
0.0030	..	10.3140	0.0900	5	9.4200
0.0040	..	13.7520	0.1000	5	43.8000
0.0050	..	17.1900	1.0000	57	17.7600
0.0060	..	20.6280	......	..	....

Machinery

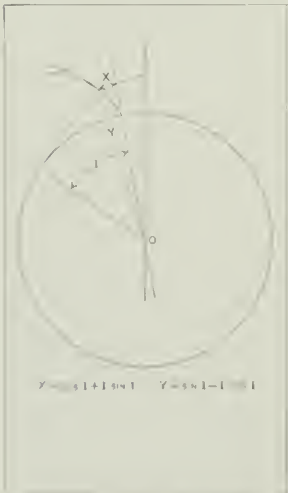

Fig. 1 Notation used in Pure Mathematical Treatment of Involute Curve

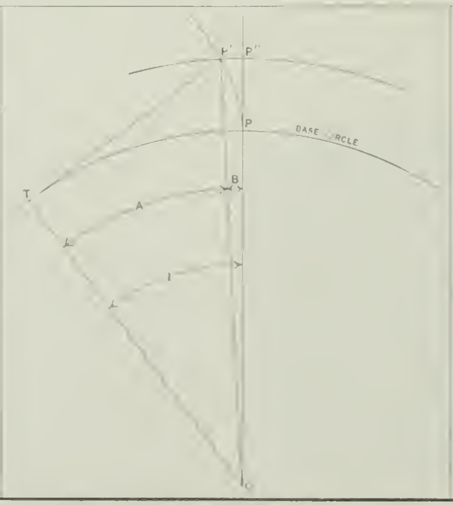

Fig. 2. Diagram Illustrating Substitute Method of treating Involute Curve

Fig. 3. Diagram Illustrating Definition of Term "Radian"

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0.020 radian = 1 degree 8.76 minutes.
0.005 radian = 17.19 minutes.
0.625 radian = 35 degrees 48.75 minutes.

Fig. 3 shows the radian to the scale of unity. When the radius of the circle is other than unity (or 1) the arc of the circle can be reduced to radians by dividing the length of the arc expressed in inches by the radius of the circle in similar terms; thus if the length of the arc is 8 inches and the radius 4 inches, the value of the arc or angle in radians is 8 ÷ 4 = 2 radians. The angle in degrees is then 2 × 57.296 = 114.592 degrees. The mistake must not be made of thinking that an arc of 1 inch on a circle of any radius is one radian, as an arc 1 inch in length is equal to the radian only in a circle of unit or 1 inch radius. The radian is actually another method of measuring the angle of the arc, differing from the degree in that it is based on the linear measurement of the arc instead of as a proportional part of the circle. It is for this reason that it is of value in the case in hand. Knowing the number of degrees in the arc of any circle we find the length by dividing the number of degrees in the arc by 57.296 and multiplying by the radius of the circle.

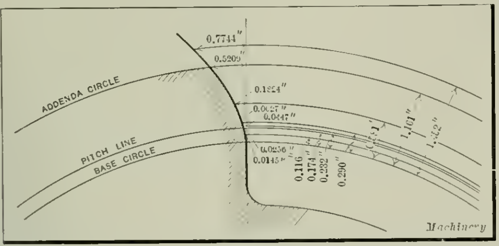

Fig. 4. Plotted Tooth Curve for Pinion with Twelve Teeth of 1 Diametral Pitch

Referring again to Fig. 2: The angle *I* is subdivided into two parts by the radial line *OP'* (the angles *A* and *B* as previously mentioned) which gives us a clue to the solution of the problem. The tangent *TP'* is equal in length to the arc *TP*, since all tangents to the base circle represent a tightly drawn cord unwound from the base circle from the point of origin of the curve at *P*. The tangent *TP'* is obviously the tangent of the angle *A* and its length in inches equals that of the arc of the angle *I*. If the radius *OP* equals *R*, the tangent *TP'* and the arc *TP* are each *R* × tan *A* inches long. The length of the radial *OP'* is *R* × sec *A*. The increment $PP'' = (R \times \sec A - R)$. Taking *A* and *I* in radians, the angle *B* is then obtainable and the length of the arc *B* can be calculated. The arc is found by the proportion:

$$\frac{OP'}{OP} = \frac{P'P''}{B}$$

$$\frac{OP'}{OP} \times B = P'P''$$

As an example, assume the value of *R* to be unity and find the deflection of the curve from the radial through the origin of the curve, knowing the height of *P'* above the base line: With the value of *R* unity or 1, the radial length *OP'* is equal to the secant of the angle *A*. Referring to a table of trigonometrical functions, the angle *A* may be found, and likewise its tangent. Since *R* × tan *A* equals the length of the arc *I*, and since the radius of the circle is 1, the length of the arc equals the angle *I* in radians. Converting the angle *A* to radians by using Table I, or directly by dividing by 57.296, we obtain the value of *B* in radians. As the radius of the circle is 1, the value of *B* in radians is equal to the length of the arc in inches; otherwise, the length of the arc would be obtained by multiplying the angle in radians by the radius. The deflection *P'P''* of the curve is then found to be:

$$\frac{OP'}{OP} \times B = \sec A \times B$$

The curve can be plotted by taking a number of values for the distance of the point *P'* from the base circle and obtaining the corresponding values for the deflection. In fact, the values for the points *P'* can be tabulated for the curve, from a base circle of unit radius, and the table used to obtain the points on any involute by multiplying the values by the radius of the base circle. Table II gives values for *PP''* and *P'P''*, and corresponding values for the angle *A*, tan *A*, sec *A*, and the angle *A* expressed in radians; also the angle *B* expressed in degrees and in radians, and the functions of angle *B* are given. In using the table, the distinction between *P'P''* and *B* (radians) should be understood, *i.e.*, the former is the actual length of the arc at the distance *PP''* from the base circle and *B* is the length of the arc of the same angular value, divided by the radius of the base circle.

As an aid to better understanding of the table and its use, a few examples will be given: Suppose it is required to plot the tooth curve for a twelve tooth pinion of one diametral pitch, using the standard or 14½-degree involute. The pitch diameter of the gear will be 12 inches and the radius of the base circle will be one-half the diameter multiplied by the cosine of the pressure angle, or 6 × 0.96815 = 5.8089 inches. First draw the base circle as in Fig. 4, and a vertical line through the center of the circle and projecting up above it. In order to use Table II the radial ordinates *PP''* must be made to correspond with the diameter of the base circle; and this is done by multiplying the values from the first column by the radius of the base circle. The ordinates selected as best suiting the example and the value corresponding to the increase in the radius are found in Table III; the values for *P'P''* are found by a similar process and also tabulated. The measurement of the deflection of the curve from the vertical

TABLE II. VALUES REQUIRED IN PLOTTING THE INVOLUTE CURVE

PP'', Inches	P' P'', Inches	Angle A		Tan A	Sec A = P' O	Angle A, Radians	Angle B, Radians	Angle B		Sin B	Cos B
		Degrees	Minutes					Degrees	Minutes		
0.01	0.00094	8	4	0.14173	1.0100	0.14079	0.00094	0	3.23	0.00094	1.00000
0.02	0.00253	11	22	0.20103	1.0200	0.19855	0.00248	0	8.53	0.00248	1.00000
0.03	0.00494	13	52	0.24686	1.0300	0.24206	0.00480	0	16.50	0.00480	0.99999
0.033	0.00573	14	30	0.25862	1.0329	0.25307	0.00555	0	19.16	0.00556	0.99998
0.035	0.00639	15	..	0.26795	1.0353	0.26179	0.00616	0	21.18	0.00617	0.99998
0.04	0.00772	15	57	0.28580	1.0400	0.27838	0.00742	0	25.51	0.00741	0.99997
0.05	0.01078	17	45	0.32010	1.0500	0.30983	0.01027	0	35.31	0.01030	0.99995
0.06	0.01430	19	22	0.35150	1.0600	0.33801	0.01349	0	46.38	0.01353	0.99991
0.0642	0.01585	20	..	0.36397	1.0642	0.34908	0.01489	0	51.19	0.01493	0.99989
0.07	0.01815	20	51	0.38086	1.0701	0.36390	0.01696	0	58.30	0.01658	0.99987
0.08	0.02228	22	12	0.40809	1.0801	0.38746	0.02063	1	10.93	0.02042	0.99979
0.09	0.02668	23	27	0.43377	1.0900	0.40929	0.02448	1	24.16	0.02443	0.99970
0.10	0.03138	24	37	0.45819	1.1000	0.42966	0.02853	1	38.08	0.02850	0.99959
0.11	0.03832	25	43	0.48162	1.1099	0.44710	0.03452	1	58.67	0.03473	0.99940
0.12	0.04171	26	46	0.50441	1.1200	0.46717	0.03724	2	8.03	0.03714	0.99931
0.13	0.04732	27	46	0.52650	1.1301	0.48462	0.04188	2	23.97	0.04152	0.99913
0.14	0.05300	28	41	0.54711	1.1399	0.50062	0.04649	2	39.83	0.04655	0.99892
0.15	0.05908	29	35	0.56769	1.1499	0.51632	0.05137	2	56.61	0.05146	0.99867
0.20	0.09326	33	34	0.66356	1.2001	0.58584	0.07772	4	27.20	0.07481	0.99720
0.25	0.13331	36	52	0.74991	1.2499	0.64327	0.10665	6	6.66	0.10661	0.99430

Machinery

Note: The table gives all values corresponding to a base circle of 1 inch radius. The tabulated values of P'P'' are on circles whose radii are equal to secant A. To determine the proper values of PP'' and P'P'' for any given base circle, multiply the tabulated values by the radius of that circle. To get PP'' and P'P'' as rectilineal quantities, multiply P'O by cosine B and sine B, respectively, P'O being distance of P' from center of circle.

TABLE III. VALUES USED IN PLOTTING CURVE SHOWN IN FIG. 4

PP'' (R = 1 inch)	PP'' (R = 5.8089 inches)	P'P'' (R = 1 inch)	P'P'' (R = 5.8089 inches)
0.02	0.116	0.0025	0.0145
0.03	0.174	0.0044	0.0256
0.04	0.232	0.0077	0.0447
0.05	0.290	0.0108	0.0627
0.10	0.581	0.0314	0.1824
0.20	1.161	0.08967	0.5209
0.25	1.452	0.13331	0.7744

Machinery

line must be along the arc and not the chordal distance.

As another example let it be required to find the thickness of the tooth at the pitch line. First find the value of B at the pitch line. Its value corresponding to a base circle radius of unity is found in Table II to have a value of 0.00555, for a pressure angle of 14 degrees and 30 minutes. Converting this value to degrees we get $0.00555 \times 57.296 = 0.3180$ degrees, and reducing this to minutes we have 19.16 minutes. This is the angle made by the radial flank with the radial line through the pitch point. The angle that is included between the pitch points on the opposite sides of the tooth is equal to $360 \div 2 \times 12 = 15$ degrees, and half of this is 7 degrees 30 minutes. This angle plus the angle B is the angle B' in Fig. 5. Then B' has a value of 7 degrees 49.16 minutes. Reducing this to radians we find the result to be 0.13645 radian. The angle at the pitch line is then expressed in radians, as $0.13645 - 0.00555 = 0.13090$ radian. The length of this arc at the pitch line is found by multiplying the radians by the pitch radius and is equal to 0.7854 inch; this is obviously but half of the thickness of the tooth at the pitch line, the thickness being $0.7854 \times 2 = 1.5708$ inch.

The preceding example was given more to show the working of the method than because it has any practical value, since we already knew the tooth thickness at the pitch line. Let us now take the case of determining the thickness of the tooth at any other point than the pitch line, for instance at a radius of 6.1 inches. In this case we do not have the angle normal to the curve at the point given, but can obtain it by finding the secant of the angle by dividing the radius given by the radius of the base circle. Sec $A = 6.1 \div 5.8089 = 1.0500$, and the angle corresponding to the secant 1.0500 is 17 degrees 45 minutes. This angle expressed in radians is $17.75 \div 57.296 = 0.3098$. Tan A is 0.3201 and angle B is then found to be $0.3201 - 0.3098 = 0.0103$. The value of B' as shown in Fig. 5 (see also former example) is 0.13645 radian. One-half the angle of the arc between the tooth faces at the radius of 6.1 inches is then found to be $0.13645 - 0.0103 = 0.12615$ radian. The angle is 0.2523 radian. The thickness of the tooth at this point is found by multiplying the angle in radians by the radius at the given point. Performing this operation we get 1.53903 inch as the required thickness.

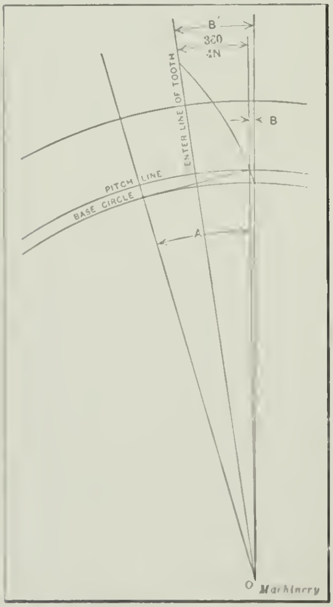

Fig. 5. Diagram showing Method of Procedure in determining Tooth Thickness

In laying out the curve for very coarse pitches it may be more convenient to have the rectilinear ordinates instead of polar, and the latter may be converted into the former by multiplying the values of $P'O$ corresponding to PP'' and $P'P''$ at the increased radius by the cosine and sine of B. $P'O$ is the distance of P' from the center of the circle. When the radius of the base circle is unity $P'O$ is the secant of A. The cosine and sine of B are given in Table II. The origin of the curve is at the base circle, and in laying out the curve with the rectilinear ordinates they are to be parallel with and at right angles to the line intersecting the origin of the curve at the base circle and passing through the center O of the circle. The values for PP'' are carried out in Table II only to 0.25, as this value for a base circle of 1 inch will cover all cases of gear teeth with standard addenda of larger pitches, but if the case in hand should have a longer addendum than standard, larger values can easily be calculated.

* * *

BROACHING CONNECTING-RODS

A good example of the adaptability of the broaching machine for producing accurate holes quickly is shown in the accompanying illustration. This shows a double fixture which is in use in the plant of the Willys-Overland Co., Toledo, Ohio, for broaching both ends of connecting-rods at one time, the operations being handled on a Lapointe Machine Tool Co. broaching machine. The connecting-rods are reversed end for end as shown in the illustration, so that when the large hole in one connecting-rod is being broached, the small hole in the other is being broached simultaneously. The hole in the large end is 1⅞ inch diameter, by 1¾ inch long, while the hole in the small end is 1⅛ inch diameter by 1½ inch long. 0.040 inch of stock is removed from the diameter of each hole, and the cutting speed of the broach is 40 inches per minute. The production is 400 connecting-rods in nine hours.

Broaching Both Ends of Connecting-rods simultaneously—Note Method of supporting Broaches

An interesting attachment connected with this operation which should not be overlooked is the follow-rest shown at A. This follow-rest has been found necessary in order to keep the broaches in proper alignment so that the correct center distances between the two holes in the connecting-rods will be obtained. The broach for both holes, as the illustration clearly shows, is provided with lands to support it and keep it straight, but this was not sufficient to prevent the broach from having a slight whipping action, causing the holes to be slightly out of line. This follow-rest is free to move on a special base comprising two ways on which the rest slides, which has been attached to the machine. The broach for the large hole is fastened to the follow-rest which keeps it straight in line, whereas the smaller broach is free to slide in the rest, but as the latter is tied to the large broach, they carry the rest toward the head of the machine as the broaches are drawn through the work. The broaches, which are approximately 47 inches long, were found to dull very quickly and produce a poor hole before this attachment was added to the machine. By keeping the broaches straight and supporting them in this manner it was found that their life was materially increased, and the production was practically doubled. D. T. H.

MAKING THE "GILBERT" WOOD PULLEY*

MACHINES AND METHODS USED BY THE SAGINAW MFG. CO. IN THE PRODUCTION OF HIGH-GRADE WOOD PULLEYS

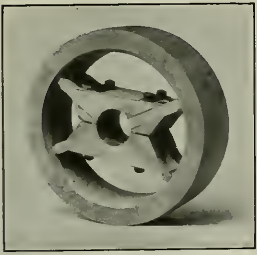

Fig. 1. Style B Four-spoke "Gilbert" Wood Pulley

To satisfactorily design and manufacture a wood pulley is not an easy matter. First there is the selection of the wood to take into consideration, then the treating of this wood to prevent warping and to produce a pulley which will run true under all conditions. A wood pulley which is unevenly balanced will not run true at all, and it is also hard on the belt and line-shafting. The wood pulley to be described in the following article is made by the Saginaw Mfg. Co., Saginaw, Mich., and is known as the "Gilbert" wood pulley, this type of construction being patented. Upon referring to Figs. 1, 3, 4 and 5, it will be seen that the pulley is of somewhat artistic design and is constructed for strength and trueness of running. The design of this pulley is unique in many respects, and to a large extent requires a special machine equipment to handle its manufacture satisfactorily. This pulley is designed on sound mechanical principles, and is built not merely to run fairly well under favorable conditions, but to give lasting service under double belt duty.

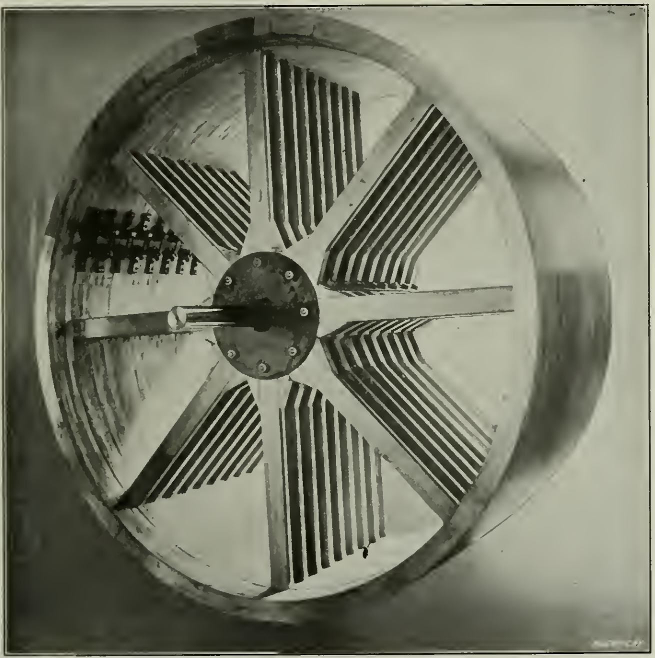

Fig. 3. Special Style A Wood Pulley with Eight Sets of Spokes

Different Types of "Gilbert" Wood Pulleys

The "Gilbert" pulley is built in two stock types known as style B and style C. Style B is the spoke pulley, two sizes of which are shown in Figs. 1 and 4. These pulleys are built in sizes ranging from 12 inches in diameter up to and including 120 inches in diameter. Style C, which is a solid pulley as shown in Fig. 5, is built in sizes ranging from 3 inches in diameter up to and including 14 inches in diameter.

These two stock types of pulleys may each be further distinguished as follows: style B pulleys from 12 inches in diameter up to and including 24 inches in diameter are built with four sets of spokes, as shown in Fig. 1, these spokes being arranged on the truss principle; style B pulleys made in sizes from 25 inches in diameter up to 70 inches in diameter, inclusive, have six sets of spokes, as shown in Fig. 4; style B pulleys above 70 inches in diameter have eight sets of spokes.

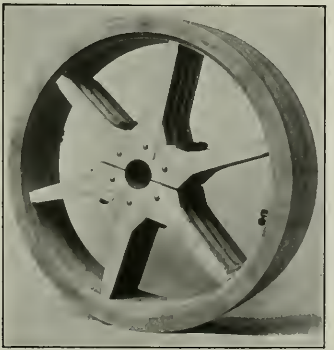

Fig. 4. Style B Six-spoke "Gilbert" Wood Pulley

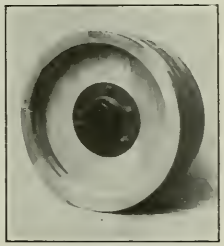

Fig. 2. "Gilbert" Dynamo Pulley with Iron Hub

The pulley shown in Fig. 3 is a special pulley 138 inches in diameter, 74-inch face, and is provided with nine sets of spokes. Style C pulleys made in sizes 3, 4 and 5 inches in diameter are clamped together by means of stove bolts, and those sizes from 6 to 14 inches diameter, inclusive, are clamped with hanger bolts, the heads of which are covered by sectional blocks held in place by stove bolts, as shown in Fig. 5.

Points on the Design of "Gilbert" Wood Pulleys

In designing a wood pulley, the width of the face is generally made from ¼ to ½ inch greater than the width of the belt that is to be used with it, whereas, the thickness of the rim is made a certain proportion of the diameter. The table gives the thickness of the rim for different diameters of standard pulleys:

Diam. of Pulley, Inches	Thickness of Rim, Inches
12 to 15	1⅞
16 to 20	2¼
21 to 34	2½
35 to 47	2¾
48 to 60	3¼
61 to 72	3¾
73 to 108	4

The strength of the spokes of all stock pulleys is based on the standard formula used for determining the centrifugal force. Standard pulleys are worked out for a rim surface speed of 5000 feet per minute. The standard formula is utilized by taking the center of the hub as the point at which the lever is fastened, the arm or spoke as the lever, the rim, of course, being the extreme point where the force is applied. The hub must be made strong enough to take the torsional strain imposed upon it by the centrifugal action on the rim and arm. A point which is very important in the design of steel pulleys, but does not need to be considered in the de-

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* For further information on pulley making, see "Manufacturing 'American' Steel Pulleys" in the April, 1914, number of MACHINERY, and articles there referred to.

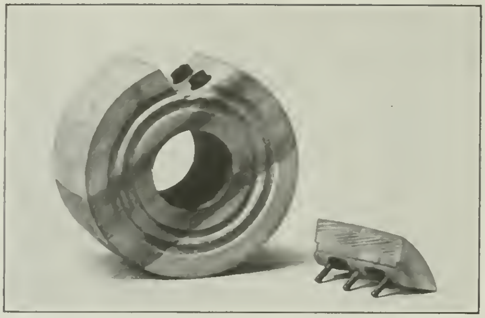

Fig. 5. Style C "Gilbert" Solid Wood Pulley

sign of wood pulleys, is crystallization. Steel pulleys become crystallized from the hammer action of the belt rotating around them, whereas wood pulleys do not encounter this condition, but are, of course, eventually subject to decay. However, it has been proved, in many cases, that a wood pulley has a longer life than a steel pulley because the latter will crystallize before the former decays, that is, when both pulleys are working under normal conditions. Another point in which the wood pulley shows greater efficiency than the steel pulley is in its greater belt pull; that is, the belt clings better to a wood pulley and gives a longer arc of contact than it does to a steel or iron pulley; hence it transmits a greater amount of power.

First Step in Manufacturing Wood Pulleys

In the manufacture of the "Gilbert" wood pulley, there are over eighty distinct steps, and the following is a summary of some of the most important ones: The first step is the seasoning of the wood. In addition to being air seasoned for eighteen months or more, the lumber is thoroughly kiln dried. The stock is then dressed. The next step in the making of the pulley is to cut out the rim cants. These are cut in semicircular form and are nailed together to form the rim. The cutting out of these cants is a comparatively simple operation and is accomplished by a special double bandsawing machine. The rim cants are next cut to length by another special machine.

Building Up the Rim

Before nailing, the rim cants are assembled in an iron hoop which is slightly larger than the required diameter of the pulley. When two of these have been assembled, they are taken to the nailing machine shown in Fig. 10. Here the cants as assembled are laid upon one another and nailed together. The machine used is semi-automatic and is provided with a hopper of the endless belt type, which carries holders for the nails. The nails are placed in these holders by a boy, a special elevated structure being constructed for this purpose at the rear of the machine. As this hopper rotates, the nails are removed from it and deposited into two chutes, from which they pass down through spring tubes to the hammer head. The chutes run into the hammer head at an angle, and the hammers work in a slot at the rear of the nail feeding slots, so that as a nail drops down the hammer comes down on top of it and drives it into the wood. It is necessary to feed the nails in by hand because they are coated with cement, which would prevent them from being fed automatically. The rim cants are put together and built up in this way until the required width of rim has been attained. The production of this machine on pulleys of from 6 to 8 inches face is 300 pulleys in ten hours. After the rim cants are built up in a circle they are glued and clamped together before being nailed, which practically makes the rim one solid mass.

Truing Up the Inside of the Rim

After the rims are built up, nailed and glued, they are then turned on the outside to a true circle. For performing this operation the rim goes to a turning machine and is held in a special four-arm chuck as illustrated in Fig. 6. This chuck is furnished with blocks operated by screws which carry studs, the latter coming in contact with the outside of the rim and holding it in position. The truing up of the rim is accomplished with a special cutter of the combination type. The first part of the cutter is a series of saws of circular construction, and the final or finishing part comprises wide-faced cutters. The construction is such that the forward end is smaller than the rear, so that the cutter starts in with a light cut and gradually finishes up to the required inside diameter of the rim. This cutter has been found to work very satisfactorily. The head carrying the cutter has a worm feed which is power-driven longitudinally as the work is rotated. One man runs two machines of this kind and turns out 300 rims on an average per day. The operation just described is one of the most important steps in the manufacture of the style B pulley, as will be mentioned later.

Boring the Holes for the Spokes

Upon truing up the inside of the rim, the next step is to bore the holes for the spokes. For this operation the rim is held in a special four-arm chuck, as shown in Fig. 9, which is of the same construction as that shown in Fig. 6. The boring of the holes in the rim is done with a regular machine bit, fed by hand. The bit is rotated at 500 revolutions per minute. The head carrying the chucks and rim is indexed by hand after each successive hole has been bored, by means of an index plate which gives four or six indexings as the case may require. The holes in the rim are first bored, and then in a subsequent operation the intervening space between the hole and the inside of the rim is slotted out to fit the spokes. This form of construction permits of rigidly keying the spokes, as will be described later.

Assembling the Hub and Spoke Combination Into the Rim

Following the boring of the holes for the spokes, the rim is taken to a slotting machine and the holes are slotted out to the inside of the rim. The building up of the spoke and hub combination is a comparatively simple operation and need not be described in detail. Before assembling, a tenion is cut in the spokes to fit a key for holding the spokes to the rim. Upon the completion of the building up of the spoke and hub combination, the spokes are forced into the rim by a special machine which has a capacity of exerting a pressure of 60,000 pounds. This operation is illustrated in Fig. 11, where it will be seen that the machine is of the screw type, the screw being rotated by a belt from the lineshaft which transmits power through a pinion to a large bevel gear fastened to the screw. This machine, in addition to forcing the spokes into the rim, also subjects the rim and spokes to considerable vibration, which is a sufficient test to bring out any imperfections that may exist. This operation therefore serves a double purpose, that of assembling the spokes in the rim and also giving the pulley a severe test.

The unique method of joining the spokes to the rim is very clearly shown in Fig. 8. Here it will be seen that the end

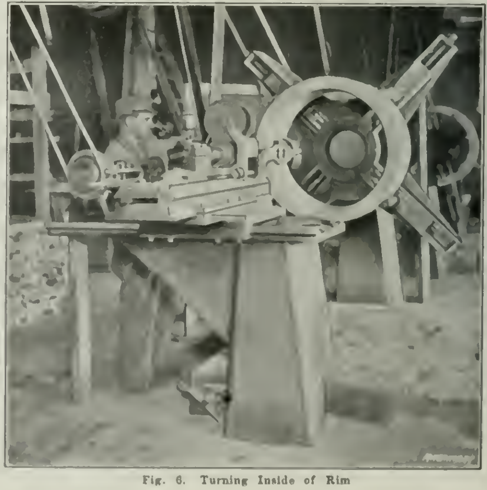

Fig. 6. Turning Inside of Rim

of the spoke is rounded to fit in the previously bored hole and is also tenioned out to fit an elliptical maple key, one of which is driven in at each side of the spoke. These keys hold the spokes absolutely firmly and at the same time do not weaken the rim.

After the spokes have been forced into the rim, the exact center of the hub is found by describing four arcs from the true inside surface of the rim, and the pulley is then bored; that is, the hub is bored out. The side cants are then added, and are nailed and glued in place. These side cants give additional strength to the pulley, as they overlap the joint where the pulley is split or divided.

Turning the Outside of the Rim

The last important machining operation on the pulley is the turning of the outside of the rim to the correct diameter and crown. For this, the pulley is held on an expanding arbor in the machine shown in Fig. 7. The particular pulley being turned is 36 inches diameter by 10 inches face and is rotated at a rim travel of from 4000 to 6000 feet per minute. A blunt "diamond" shaped tool made from Firth-Sterling self-hardening steel is used. This tool is fed across the work by hand and takes a cut about ⅛ inch deep. The slide carrying the tool is so arranged that the crowning is done at the same setting. At the same time that the pulley is held in this machine, another operator faces up the sides and sands it, so that it is complete when it leaves the machine. The actual time to complete a pulley of this diameter is 2 minutes and 35 seconds.

Principal Operations in Making Style C Pulleys

The style "C" pulleys are built of layers of kiln dried maple lumber, with the grain running parallel. Before being glued together, these layers of lumber are subjected to a further heat-treatment. The layers are then glued and compressed. Next the shape of the pulley is laid out on the edge of the block, and the pulley is sawed out by this pattern. After this, the bolt holes are bored, and the pulley is then sawed into shape. Following this operation, the sectional blocks are sawed out. The pulley then goes to the boring machine where the center is bored out to fit the bushing, and finally the pulley is turned on the face and ends. An interesting point is the design of the sectional blocks which cover the heads of the compression bolts. These are short and deep and are held in place by stove bolts in each block, which are released from the face of the pulley. These blocks offer no corners to be picked up by the belt, but tend rather to be forced in by the action of the belt passing over the pulley. Furthermore, they are short and do not warp. Another good feature is that the pressure obtained is also evenly distributed throughout the length of the hub. The three, four and five inch sizes, which are too small to be built up with sectional blocks, are clamped together with stove bolts which are easily accessible from the face, making a simple and neat looking pulley.

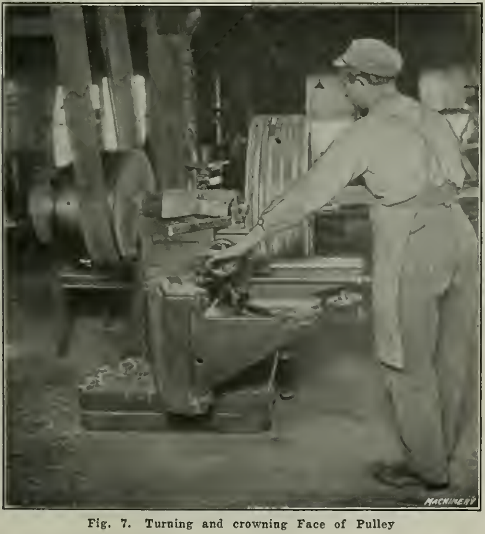

Fig. 7. Turning and crowning Face of Pulley

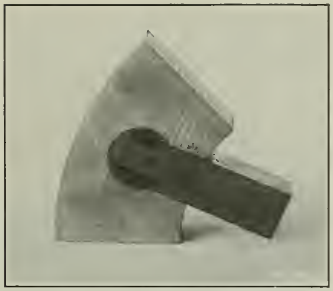

Fig. 8. Section of Spoke and Rim showing how Spoke is tenioned into Rim

Pulley Bushings

A good pulley with a poor bushing is useless. In order that a bushing be of any use, it should be made with the same care as the pulley itself; that is, it should be turned perfectly true and concentric, have a straight bore and a straight outside diameter. "Gilbert" pulley bushings are made from selected clear Michigan maple lumber which, after being air-seasoned for eighteen months or more and thoroughly kiln dried, is cut into blanks 18 inches long, which receive a further warehouse seasoning. These blanks are then turned, both halves at once, in a woodworking lathe, which is rotated at a speed of 500 revolutions per minute. The halves of the bushing are then roughly bored, one at a time, with a routing bit. Finally both halves are bored out together as carefully and accurately as an engine cylinder, in a special boring machine which clamps them rigidly together and avoids the slightest vibration. The result is a bushing which is bored perfectly true and smooth.

It is, of course, understood that bushings form a convenient means of applying the same pulley to different sized shafts, but the effect of bushing quality on gripping power is not nearly so well understood. It will be readily seen that the gripping power of a bushing varies with the pressure upon the points of abrasion, and that a bushing whose entire inner surface contacts with the shaft will stand a greater pressure before abrasion of its fibers takes place than one whose surface only contacts at high spots. Also a true fitting bushing will give the necessary grip on the shaft without any appreciable compression of the bushing itself or any movement of the pulley halves beyond bringing the latter into the proper relation with each other. On the other hand, an ill fitting bushing will distort the entire pulley in adapting itself to the shaft. It is, therefore, evident that a bushing requires the same careful attention as a pulley.

General Uses of Pulleys

Stock pulleys as made by the Saginaw Mfg. Co. are recommended for practically all uses where running conditions are what might be termed normal, but under unusual conditions where excessive loads or sudden shocks from shifting loads are imposed on the pulley, such as in cement making machinery, or grinding and crushing machinery, it is necessary that the pulley be especially designed for withstanding this heavy duty. For other uses, such as on trip hammers, power presses, shears, electrical equipment, circular saws, idlers, tighteners and main drives, the stock pulleys are all that could be desired, but, of course, if they are to be used under the conditions mentioned above, but subjected to unusually severe shocks, it is necessary to have them especially designed for the purpose. "Gilbert" special pulleys in style A, as shown in Fig. 3, and style D, as shown in Fig. 2, made with iron centers are designed for use under these trying conditions of service. Special pulleys of styles A and D have been operated with perfect safety at a peripheral speed of 10,000 feet per minute, and by actual test these two special styles of pulleys have been found to run without failure at a peripheral speed of 25,000 feet per minute, which was the limit that could be reached by the testing apparatus, and which is more than twice the speed used in the best engineering practice even under the most severe conditions. It is possible to make the styles A and D pulleys with this greater capacity for resisting the centrifugal force of high speeds, because the centrifugal force of bodies revolving with the same velocity at the same distance from the center is as their respective weights, and wood is the lightest material practical for this type of pulley construction. Maple wood, of which "Gilbert" pulleys are constructed, offers the maximum resistance to compression and yet has sufficient spring to relieve itself of sudden shock.

Another type of pulley made by this company is the motor pulley, shown in Fig. 2, which is made from the smallest type of a belt pulley up. These pulleys are being more and more generally used because of their stiffness and durability.

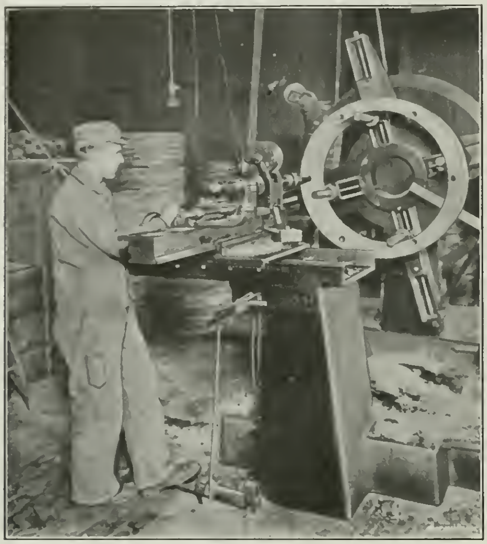

Fig. 9. Boring Holes for Spokes in Rim

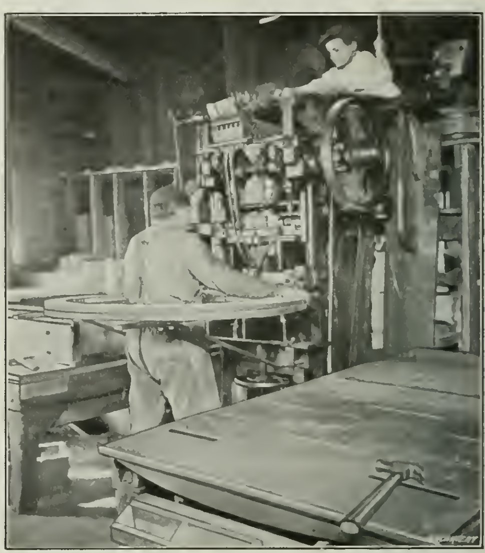

Fig. 10. Nailing Cants which form Rim of a Spoke Type B Pulley

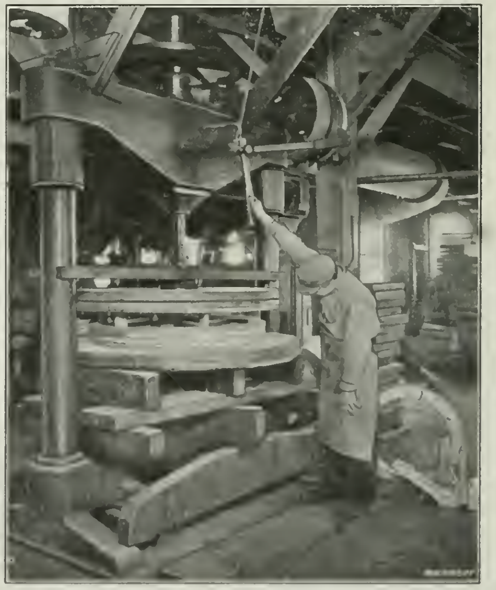

Fig. 11. Forcing Spoke and Hub Combination into Rim

Stock styles B and C are guaranteed for double belt service and under normal conditions of load are recommended up to a peripheral speed of 5000 feet per minute, while they have been tested to run without signs of failure at a speed of 13,000 to 17,000 feet per minute. Special pulleys of styles A and D are recommended, as previously stated, for any speed not limited by centrifugal force causing the belt to fly from the face of the pulley. Truly shaped and accurately turned faces of both stock and special pulleys, however, give them the condition necessary for the best possible belt adhesion and consequently the greatest friction at the lowest possible belt tension.

Conclusion

In "Gilbert" pulleys all rims are both nailed and glued, and nothing but a full hide glue of the best quality is used, each lot being tested to a certain standard. All nails are coated with asphaltum cement which makes them grip the wood with a very steady hold. In style B over 14 inches in diameter heavy iron plates are used under the heads of the compression bolts instead of round washers, thus distributing the compression equally throughout the length of the hub. All pulleys go through a casehardening process which preserves the surface from the effects of dampness. All varnish must stand a twenty-four hour water test without fading, and a test to provide against chalking up. The varnish is put on by brush work and is not dipped. The best grade of Michigan maple is used, which does not crack or warp and which contains no acids to deleteriously affect the glue. Furthermore, all stock used is carefully selected and seasoned.

* * *

ALLOWANCES AND TOLERANCES

In making mechanical fits, certain allowances are made on the diameters of a part, for instance to insure a tight or loose fit in a hole. In the old days when each mechanic made allowances according to his own judgment for press, drive and running fits, using a caliper and a steel scale, he had little idea of tolerances as that term is applied in modern interchangeable manufacture, but he did appreciate keenly that allowances must be varied to suit the conditions at hand.

An allowance in the manufacturing sense is a definite amount to be added or subtracted from a nominal dimension when fitting one part to another in order to provide for the kind of fit required. For example, a piston must be made somewhat smaller than the cylinder in which it is to work. If 0.001 inch for each inch of diameter is the allowance fixed on, it is a definite dimension smaller than the cylinder to which the piston must be made in order to conform with the specifications of the designer. But in actual manufacturing, it is not feasible, of course, to hold the cylinder bore or the piston diameter exactly to the specified dimensions. A certain amount of variation over or under size must be expected. Hence, the inspector is instructed to tolerate slight variations from the standard size, and when inspecting, he is provided with gages of the "go" and "not go" type, the difference between the two representing the tolerance allowed.

HOW MACHINE TOOLS AND APPLIANCES ARE SIZED

DATA OF PRACTICAL VALUE TO PURCHASING AGENTS, SUPERINTENDENTS, FOREMEN AND ALL WHO ORDER METAL-WORKING MACHINERY

BY FRED HORNER*

A COMMON difficulty which arises in the machine shop is that of sizing machines, etc., in order to specify their capacity. To those familiar with the numerous machines and tools employed, the matter presents no difficulty; but those not used to constant reference to this subject often become confused. What, for instance, is the length of blade of a 6-inch steel square? What diameter is a 2-inch chucking drill? Why should an 8-inch riffle file actually be shorter than an ordinary 7-inch file? Why is one kind of milling cutter sold by its diameter, and another by the radius of the work it mills? Why are some kinds of taps of standard diameter, and others larger by one or two threads depth, though both are listed as the same size? Why are some grinding machines rated by the size of work they admit, others by the table area, and still others by the diameter of wheel? Why is a shaper rated by its stroke, while a hack-saw machine is not? Many other questions might be put in this way. The first one is a regular "catch," which is explained by the fact that plain or hardened steel squares are rated by the length of blade measured inside, that is from the stock, while in graduated squares the whole length of blade is taken as a selling dimension.

I have endeavored to prepare a comprehensive list showing the numerous ways in which machines and appliances are listed, the principal dimension being stated in each case, with an alternative when there is one. Some little confusion is caused in this latter direction, not only by the practice in different countries, but by a want of agreement among manufacturers or users. In some cases a portion of the machine is measured for the principal dimension; in others, the maximum stroke of a working portion; and in still others, the maximum size of the work that can be admitted. The reasons for these apparently stupid differences are clear after a little study. Obviously, in certain kinds of work the stroke or area covered by a tool is the vital consideration, when there is no limit to the size of the work that can be accommodated on the machine; but in other cases a definite restriction is put upon the length and breadth, and perhaps depth, of the piece tooled, and this is taken as the most convenient medium for indicating the size of the machine to the purchaser. In certain cases, the particular dimensions of the work may be ignored, and the capacity of the machine be stated by what sized hole it will drill, or broach, or grind.

Some specialized types of machines have no really vital dimension, either because they are so special, or because they have never been made in more than one size, or perhaps in two sizes which have always been designated by No. 1 or No. 2 so that all users understand this notation. Numbers are used in other cases by manufacturers to denote a series of machines or tools, simply for convenience of cataloguing and ordering, and generally they bear no relation to other manufacturers' sizes of similar numbers. But an exception occurs in certain well-defined types of machines, existing in more or less standard forms. Column-and-knee milling machines may be mentioned specifically, since there is close agreement in the three vital dimensions of such machines of a given number, built by various makers. Standard tapers, or wire-gage sizes are another example of uniformity by numbering or lettering, so that it is sufficient to specify a number or letter size in a gage, and thus indicate a particular dimension of gage, or reamer, or tap, without the necessity for remarking its actual size in inches or millimeters.

LATHES

Machine	How Sized
Engine Lathes and all other not specified below:	In American nomenclature: by the swing over the bed. In British nomenclature: by the height of centers from top of the bed.
Pulley Lathes:	Maximum diameter of work admitted.
Driving Wheel Lathes:	Swing over bed. (This is often a few inches in excess of the listed size.) Or diameter of faceplate.
Turret Lathes:	Swing (American practice). Height of centers (British practice).
Screw Machines (Wire Feed):	Chuck capacity by length turned.
Automatic Screw Machines:	By standard chuck capacity, and sometimes by length turned as well.
Boring and Turning Mills:	Maximum diameter admitted, i.e., "swing."
Boring and Turning Mills With Movable Housings:	The two dimensions, as 10-16 feet or 20-30 feet indicate housings forward, and moved back, respectively.

PLANING MACHINES

Machine	How Sized
Ordinary Planing Machines:	Length, width and height planed. (Listed briefly by width, i.e., a 48-inch machine takes that dimension between the housings.)
Portable Planing or Slotting Machines:	Length of stroke.
Open-Side Planers (With one upright):	By the range of capacity. Length, width and height covered by the tool.
Side-Planers (Richards' type):	Stroke and width planed.
Vertical and Horizontal Planers:	Length of planing stroke and length of slotting stroke. (There is no limit to the size of work that can be admitted.)
Plate-Edge Planers:	Length planed.

SHAPING, SLOTTING, KEYSEATING, AND FILING MACHINES

Machine	How Sized
Shapers:	Length of stroke.
Shapers, traveling-head type:	Stroke by length of feed.
Slotting Machines:	Length of stroke. (The listed size is often exceeded, especially in heavy shapers and slotters, by ½ inch or 1 inch.
Keyseaters:	Length of stroke. Occasionally by the maximum dimensions of the keyway slotted.
Keyseaters for Shafts:	Sometimes by maximum diameter of shaft taken.
Filing Machines:	Length of stroke.

SAWING MACHINES

Machine	How Sized
Cold or Hot Circular Saws:	Diameter of saw. Sometimes maximum capacity of machine for sections, square or special.
Metal Band-Saw Machines:	Sometimes diameter of saw pulleys. Or, distance from blade to gap of frame.
Hack-Saw Machines:	Size of cross-section of material representing maximum capacity.
Jig-Sawing Machines:	Length of stroke.

DRILLING AND BORING MACHINES

Machine	How Sized
Upright or Column Drilling Machines:	Diameter admitted. (The actual swing is slightly greater, i.e., a 28-inch machine may drill to the center of a 29-inch circle.)
Radial Drilling Machines:	Distance from face of column to center of spindle when at maximum radius.
Sensitive Drilling Machines:	Swing. Or occasionally, the maximum size of hole is taken as a list dimension.
Hand Bench Drilling Machines:	Maximum diameter of hole drilled.
Horizontal Boring Machines:	Usually by diameter of spindle. Occasionally the area of the working surface of table is given as a rating dimension.
Car-Wheel Boring Machines:	Maximum diameter of wheel admitted, measured on the tread.

MILLING MACHINES

Machine	How Sized
Lincoln Milling Machines:	Traverse, and lateral adjustment of table.
Column and Knee Machines: (Plain or Universal) Vertical Spindle Machines:	Range of table movements—longitudinal, traverse and vertical. (Example, 34 inches by 9 inches by 20 inches.) In some vertical-spindle machines, the table area alone is stated.
Profiling Machines:	Working surface of table.
Rotary Planers:	Diameter of cutter-head over tools.

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* Address: 13 Forester Ave., Bath, England.

Machine	How Sized
Keyway Milling Machines:	Maximum width, depth, and length of slot in one cut.
Portable Keyseat Milling Machines:	Maximum diameter of shaft admitted.
Circular Milling Machines:	Largest diameter milled. Occasionally, the distance from center to center of the work-spindle and cutter-spindle is specified.
Plano-Milling Machines: Duplex Milling Machines:	Table area. Or range covered by spindles.
Screw Milling Machines:	Diameter by length of work threaded.
Twist Drill Milling Machines:	Maximum diameter and length fluted.
Screw Slotting Machines:	Largest diameter of screw received.

GRINDING MACHINES

Cylindrical Grinding Machines: (Plain or universal.)	Diameter and length admitted.
Surface Grinding Machines:	Longitudinal and transverse feed, and height received. In some cases only the table area is stated, or the diameter of the wheel employed.
Hole Grinding Machines:	Maximum swing for work. Or, diameter by length of largest hole dealt with.
Ring Grinding Machines:	Maximum diameter of ring ground.
Disk Grinding Machines:	Diameter of disk.
Tool Grinding Machines: (Plain hand rest.)	Diameter of grinding wheel.
Tool Grinding Machines: (With mechanical control for lathe and planer tools, etc.)	Size of largest tool shank admitted in holder.
Cutter Grinding Machines:	Largest diameter of cutter admitted, and length between centers.
Twist Drill Grinding Machines:	Minimum to maximum diameter of drills.
Circular-Saw Sharpening Machines:	Maximum diameter of saw ground.
Polishing Heads:	Height from base to center of spindle.
Swing-Frame Grinding and Polishing Machines:	Size of wheel or buff carried.
Lapping Machines:	Diameter of copper disk.
Portable Grinding Machines:	Diameter of wheel.

MISCELLANEOUS MACHINES

Gear-Cutting Machines:	Maximum diameter and width of face admitted.
Rack-Cutting Machines:	Length of rack and width of face accommodated at one setting.
Tooth-Rounding Machines:	Maximum diameter of gear swung.
Centering Machines:	Maximum diameter of bar centered.
Cutting-Off Machines:	Maximum capacity for bars.
Bolt Cutters: Tapping Machines:	Maximum diameter of screw-threads produced.
Straightening Presses:	Maximum diameter and length of shaft dealt with.
Plate-Bending Rolls:	Maximum thickness and length of plate taken.
Punching and Shearing Machines:	Maximum thickness of plate punched or sheared.
Bending Machines for Sections:	Size of section dealt with.
Broaching Machines:	Maximum capacity for square holes.
Steam Hammers: Drop Hammers:	Weight of falling parts.
Sheet-Metal Presses:	Stroke of ram.
Hydraulic Riveting Machines:	Pressure in tons.
Blow or Spinning Type Riveting Machines:	Maximum diameter of rivet closed.
Hydraulic Wheel Presses:	Maximum size of wheel taken.
Valve Reseaters:	Maximum diameter of seat faced.
Marking Machines: (For rolling names on tools, etc.)	Maximum length dealt with.

MACHINE ATTACHMENTS AND FITTINGS

Tapping Attachments:	Maximum size of tap driven, or minimum to maximum
Index Centers:	Diameter swung over table. (Is slightly in excess of stated size.)
Faceplate Jaws:	Length of body.
Ball-Turning Rests:	Maximum diameter of sphere turned.
Boring-Bars:	Diameter of bar; or, maximum capacity for boring.
Facing-Heads for Boring-Bars:	Maximum diameter faced.
Angle Plates:	Length; or length, height, and width of base.
Portable Tables for Various Machines:	The area of the working surface
Sleeves or Sockets for Taper-Shank Drills, etc.:	No of Morse taper, or tapers if outside and inside
Taper Arbors for Chucks:	Size of taper; or tapers if ends differ.

TOOLS, ETC., USED IN MACHINES

Machine	How Sized
Tools for Turning, Planing, Shaping, Etc.:	Size of shank, i.e., 1 inch square, or 1 inch by 1½ inch. Length is sometimes specified.
Cutting-Off Tools:	Thickness of blade.
Chasing Tools for hand or slide-rest:	Size of screw and number of threads.
Chasers for threading tools or fitting in dies or die-heads:	Pitch, or number of threads per inch.
Box-Tools:	Maximum capacity.
Hollow Mills:	Diameter cut.
Hollow Mills with inserted blades:	Maximum diameter cut.
Knurling Tools:	Diameter of knurling wheel.
Hack-Saw Blades:	Distance from center to center of holes. Sometimes total length is taken instead, particularly in the longer blades.
Fret-Saw Blades for Metal:	Total length (no holes).
Grinding Wheels:	Diameter by width.
Cup Form Grinding Wheels:	Diameter by width by thickness of rim.

CHUCKS

Lathe Chucks, with three or four jaws:	Usually the diameter of the body. Their holding capacity usually exceeds this slightly.
Box-Body Chucks, with two jaws:	Length of body, or diameter if round. Their capacity is roughly one-half the diameter.
Valve Chucks:	Diameter (or length) of body.
Drill Chucks:	Maximum capacity.
Elliptic Chucks (called oval chucks):	Largest size of ellipse turned, i.e., major and minor axes.
Magnetic Chucks:	Diameter of holding face. Or length by breadth in rectangular types.

DRILLING AND ALLIED TOOLS

Flat, Twist or Fluted Drills:	Diameter in inches or millimeters; or size by gage or letter number.
Chucking Drills: Four-Lipped Boring Tools:	These are often under size instead of to exact diameter, to allow for reaming.
Countersinks:	Largest diameter.
Combined Centering and Countersink Drills:	Diameter of body by diameter of drill.
Counterbores:	Diameter of pilot or guide, and of counterbore. (In standard screws it is sufficient to state the diameter of the screw.)
Reamers:	Some are made slightly under size, to be followed by a finishing tool.
Adjustable Reamers:	Minimum and maximum sizes are stated when the blades have considerable range.
Taper Reamers:	No. of taper, Morse or B. & S.
Taper-Pin Reamers:	No. of taper, or diameter at small end.
Locomotive Taper Reamers:	Diameter at small end, or ½ inch from small end.
Bit-Brace Taper Reamers:	Diameter, measured ½ inch from large end.
Pipe Reamers:	Range of capacity for pipes from minimum to maximum.
Flue-Hole Cutters:	Minimum to maximum diameter.
Washer Cutters:	Largest diameter cut.

MILLING CUTTERS

Ordinary Milling Cutters:	Diameter.
Angular Cutters:	Largest diameter.
Convex and Concave Cutters:	Diameter of circle milled.
Cornering Cutters:	Radius of circle milled.
Cutters for Fluting Twist-Drills, Taps, or Reamers:	Usually by the diameter of the blank to be fluted.
Screw-Slotting Cutters:	Thickness in decimal sizes, or by wire-gage sizes.
Gear-Cutting Cutters:	By the pitch (diametral or circular) dealt with. (Cutters have numbers by which the various pitches can be ordered.)

TAPS AND DIES

Taps and Dies:	Diameter of thread. ("Over size" taps are from 1/64 inch to 1/32 inch larger than standard.)
Machine-Screw Taps:	Specified by numbers of screw gage sizes.
Mud-Plug or Washout Taps:	Specified by numbers corresponding to taper plugs.
Hobbing Taps (for cutting threads in split dies):	Are the whole depth of one thread over standard size. (Those for cutting the threads in Whitworth three-die stocks are double the depth of thread larger in diameter.)
Pipe Taps:	Listed by bore of pipe, but are actually equal to the nominal diameter outside the pipe
Die-Heads:	Largest diameter to be threaded.

FILES AND SCRAPERS

Machine	How Sized
Ordinary Files, also Scrapers:	Length, excluding tang.
Riffle Files: **Needle Files:** **Machine Files:**	Length over all.
Rotary Files:	Diameter.

VISES

Machine	How Sized
Bench Vises:	Width of jaw.
Machine Vises:	Width of jaw by amount of opening.
Tube Vises:	Minimum to maximum capacity.
Pin Vises:	Maximum capacity.

TOOLS AND APPLIANCES

Machine	How Sized
Ordinary Wrenches:	Size of bolt or bolts fitted.
Wrenches for Square-Head Set-Screws:	Size of set-screw fitted.
Wrenches, Pin or Hook Type:	Size of circle they fit on.
Wrenches, Face:	Distance, center to center of pins.
Wrenches, Tap:	Size or sizes of taps taken. Or length of wrench.
Wrenches, Adjustable Tap:	Maximum size taken.
Screwdrivers:	Length of blade (usually).
Ratchet Braces:	Length of handle, i.e., "throw."
Cranked Braces:	Sweep described by center of handle.
Drilling Posts:	Height by diameter.
Geared Hand-Drills:	Chuck capacity.
Tube Expanders:	Size of tube—external diameter.
Pipe Cutters:	Maximum diameter of pipe cut.
Hacksaw Frames:	Length of blade received.
Hacksaw Frames, Adjustable:	Minimum to maximum length of blade.
Soldering Iron or Bits:	Weight of copper in bit.
Cutting Pliers and Nippers:	Total length.
Bolt Croppers:	Largest diameter of bolt cropped.
Blacksmiths' Tongs:	Length.
Blacksmiths' Anvils:	Weight.
Blacksmiths' Mandrels:	Diameter of base by height.
Rail Benders:	Maximum weight of rail—pounds per foot.
Vise Clamps:	Width.
Steel Clamps:	Width of opening of jaws.
Adjustable Packings—of screw, wedge, or serrated types:	Minimum to maximum height.
Lathe Carriers:	Maximum capacity. In certain jaw types, by minimum to maximum capacity.
Lathe Mandrels:	Diameter (which is stamped at large end).
Expanding Mandrels:	Minimum to maximum range.
Mandrel Presses:	Largest diameter admitted.
Oil-Cans:	Capacity.
Locomotive Oilers:	Length.
Oil-Pumps:	Capacity in quarts per minute (at specified number of revolutions per minute).
Lead-Melting Ladles:	Diameter of bowl.
Oil-Stones:	Length. Or length, width and thickness. (Tapered slips involve additional dimensions to indicate the size at the smaller end.)

PERCUSSIVE TOOLS

Machine	How Sized
Hammers:	Weight in ounces or pounds.
Rawhide Mallets or Boxwood Hammers:	Often specified by diameter.
Set-Hammers and Flatters:	Area of working face.
Fullers:	Size of rounded working face.
Swages:	Size of recess.
Cold Chisels:	By weight, or size of cross-section plus length.
Punches:	Diameter. (Are slightly larger, by an amount stated in decimals, than the nominal diameter of rivet.)
Center-Punches:	Length. Diameter at point sometimes stated.
Automatic Center-Punches:	Length and diameter of body.
Bell-Centering Punches:	Maximum capacity.
Steel Drill Drifts: (For extracting drills from spindles and sockets.)	By number of socket.

LEVELING AND TESTING APPLIANCES

Machine	How Sized
Surface-Plates and Marking-Out Tables:	Area of surface = length by breadth.
Straightedges:	Length.
Spirit-Levels:	Length of base.
Plumb-Bobs:	Weight.

SCRIBING TYPE OF TOOLS

Machine	How Sized
Dividers:	Length of legs.
Scribers:	Length.
Scratch-Gages:	Length of beam.
Trammel Points:	Size of cross-section of bar they are used on.
Surface-Gages:	Height of spindle.

CALIPERS AND GAGES

Machine	How Sized
Calipers, outside and inside:	By length of legs. (The capacity is about one-third more.) An exception occurs when outside calipers are rated by the diameter of shaft they will caliper.
Slide Calipers: **Caliper Squares:**	Maximum opening between jaws.
Gear-Tooth Calipers:	The range from minimum to maximum. In English measure, diametral pitch, or in metric measure.
Micrometer Calipers:	Width gaged, or from minimum to maximum, by 0.001 or 0.0001 inch, or 0.01 millimeter.
Screw-Thread Micrometer Calipers:	Width of opening and range of pitches covered.
Beam Micrometer Calipers:	Maximum capacity, which is less for round work owing to contact with beam.
Micrometer Heads:	Travel of spindle.
Inside Rod or Tubular Gages: (Ordinary or micrometer.)	Range from minimum to maximum.

MISCELLANEOUS GAGES

Machine	How Sized
Standard and Tapping Gages:	Range of sizes from minimum to maximum.
Morse Taper Gages:	By the taper number.
Screw Pitch Gages:	By the range of pitches.
Wire Gages:	By numbers covered, as from 1-30, or 1-36.
Wire and Twist-Drill Gages:	By letters, from A-Z, or numbers, 1-70.
Thickness or Feeler Gages:	The range of thickness of the leaves. Varying by 0.001 inch, or 1/50th or 0.01 millimeter.

RULES, SQUARES, AND BEVELS

Machine	How Sized
Rules:	Length of graduated portion. The width also is specified in the case of "narrow" steel rules.
Steel Squares, graduated:	Total length of blade.
Steel Squares, plain or hardened:	Length inside of blade.
Steel Squares, large cast ribbed squares for testing machine tools:	Length of long side.
Combination Squares:	Length of blade.
Set-Squares or Triangles:	Length of longest side.
Steel T-Squares:	Length of blade, measured from the working face of head.
Center-Squares:	Length of blade.
Bevels:	Length of blade.

* * *

Attention is called in the *Engineering Record* to the fact that a tunnel has been built in Baltimore which pays for its own construction. Through this tunnel will flow Jones' Falls, a small stream running through the heart of Baltimore, and it will thus bury an open sewer which has been an eye-sore to the city. The remarkable feature about the improvement is that although it costs $2,000,000 and is for general public use, for which no direct charge is made, it will eventually cost the city nothing, because over the stream a new north and south street running from the heart of the business district to the railroad depots has been created, and the back lots of the properties adjoining the old stream have thus been converted into valuable lots for business purposes, facing this broad new boulevard; the increased taxes thus derived by the city will pay the interest on the bonds necessary for the construction of the tunnel, and will probably give a surplus which would be enough to create a sinking fund to redeem the bonds. It is apparent, however, that Baltimore, like all other American cities, was not awake to the opportunity of paying for the improvement not only by the increased taxation in the future, but by the increase of the value in the land immediately created. If this or any other city, through general expenditures causes an increase in the value of the land along a thoroughfare, why is the city not entitled to this increased value created solely by the efforts of the city as a whole, and in no way created by the efforts of any individual land owner?

* * *

Bismuth bronze is an alloy which contains 69 per cent copper, 21 per cent zinc, 9 per cent nickel and 1 per cent bismuth, with traces of tin. This alloy may be considered a low-grade German silver.

SNAPSHOTS ON THE ROAD

SOME NOTES PICKED UP AT RANDOM BY MACHINERY'S FIELD SERVICE EDITORS

The traveling editors of mechanical journals meet all classes of shop managers, from the courteous, well informed general superintendent to the working proprietor in greasy overalls and what-the-devil-do-you-want air. While it might seem impossible that such differences in management ideals could exist in manufacturing lines closely allied and in many cases highly competitive, it is, nevertheless, true. They meet the genial manager who is glad to see the visitor, who always has something interesting to show and talk about, whose plant is open for inspection at any time, and then perhaps in the next shop is encountered his opposite who meets all strangers with suspicion if not insult; he has nothing to show and apparently cares nothing about what is going on in the mechanical world. If he ever reads a trade paper the fact is concealed or credit is grudgingly given.

—"from the courteous well-informed superintendent"—

Between the ideal shop superintendent and the narrow-minded boss are many managers of varied characteristics but all are eager to make two dollars where one is being made now. In the following notes which will be published month by month, it will be shown how the representatives of MACHINERY have been of service in the field, the intent being to impress on managers generally that modern engineering has many phases, not the least of which is intelligent and aggressive publicity work.

—"to the working proprietor in greasy overalls and what-the-devil-do-you-want air."

A shop not a thousand miles from Elmira, N. Y., makes steel specialties. It is not large; perhaps twenty-five is the total number of employes in the machine shop and foundry together. It could hardly be called a growing concern, except in a backward sense; it is said that the number of men have increased inversely with the number of years it has been in business. Throughout is every evidence of decadence.

The old man who runs the concern is of the old school, and his two sons who are now taking hold of the business are following in the same footprints or ruts. A visitor to this shop is somebody who never existed, for no visitors are allowed. The old man admits that he has no secret work or special methods, but he simply "doesn't believe in allowing visitors in the shop." He admits that he has visited other shops with interest and that he has obtained valuable ideas from the mechanical papers, but with him the rule of publicity works only one way.

This man is representative of a class who have not yet realized that the editorial visitor would gladly give them many good suggestions and ideas; that because of his traveling he has seen the latest things in shop practice and is able to answer or suggest answers to many troublesome problems that confront the shop manager.

And speaking of hospitality, this old man's shop reminds us of another concern in New York state because it is so different. At this latter shop, an editor called recently and was received in quite a different way. After having been shown some of the different jobs that were going through, the freemasonry that exists between mechanics in general brought out the fact that the visitor knew of other ways of producing the same result at less cost. It was from this visitor that the proprietor obtained a suggestion on which he started to act at once.

And that suggestion might interest others. It concerned the working of fiber for making thumb-screws. The ordinary way of making a fiber grip thumb-screw is to turn the fiber and the steel insert, and force the insert into place. The new way of doing it, however, is to make the insert first, place it in the die with a ring of fiber and press the fiber, upsetting it so as to flow around the insert and fill up the corrugations in the die that form the knurl on the outside of the fiber. It works fine.

On account of the workmen's compensation law, the subject of guarding machinery is important in the factories of New York State. The requirement to safeguard machinery receives all sorts of receptions from shop managers. There is the man who sees the wisdom of the measure and the other who "has been running that shop for thirty years and can't see now the necessity of guarding the machinery." Of course he had lots of accidents but they were all due to "the carelessness of the workman." While safeguarding machines may be costly work at the start, it certainly pays well, and benefits are realized immediately in the lowered rate for insurance granted to the well guarded shop. There is one enterprising manager in this state employing publicity to educate his employes in accident prevention. To circulate in this factory, which is a large one, a bulletin is gotten out every month to give the news of the factory and to cultivate class spirit. Special prominence is given to any cases of accident prevention brought about by employes who have given special attention to the rules. Quite often the picture of the man who prevented the accident is used and all the details of the case are held up in the limelight. It is just one more instance of the value of publicity.

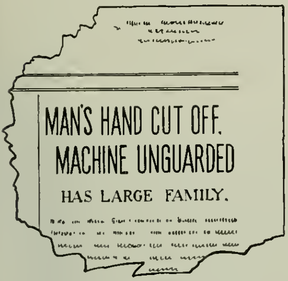
One of the good-sized motor car plants of the Middle West that turns out about fifty cars a day, was buying its transmission gear blanks, and the superintendent had come to the conclusion that the shop could make them at lower cost. But after figuring on equipment it was found that in order to install a forge plant capable of handling this work, the outlay would be large and very little profit would be realized on the investment. So he was looking around for a different method of manufacture than that which required the use of steam hammers.

About this time an editorial representative of MACHINERY called on this concern, and in talking the matter over with the superintendent suggested a way of forging these gear blanks which was not only faster than the steam hammer method but was cheaper and better. The superintendent saw its advantages at once and immediately wrote for quotations on the necessary equipment, and soon after installed it.

The improved method consists in taking a

"The superintendent saw the advantages and immediately wrote for quotations."

bar of alloy steel about two inches in diameter, heating it to a white heat in the furnace, and then placing it in the impression of a forging machine die, where with three blows of the machine a gear blank is completed at the rate of about 1200 in nine hours. The production was about double that which could be turned out under a steam hammer. Instead of using a rectangular bar for making the gear blanks and wasting considerable stock, a round bar was used and no stock at all was wasted. The metal punched out to form the hole was pushed back to form an integral part of the bar and was worked into the next gear blank.


MAN'S HAND CUT OFF.
MACHINE UNGUARDED
HAS LARGE FAMILY.

"He had lots of accidents but they were all due to the carelessness of the workmen."

In making a rear axle housing of the full-floating type, another automobile concern was pressing it out of ¼-inch sheet steel, making it in two parts, divided in the center, and then was punching holes in these parts and riveting the two members together. It was found upon figuring out the shop operations that this was a rather expensive way of handling the work, and the superintendent in talking with the editor was told that this work could be handled by an electric welding machine. To him this operation appeared to be impossible of accomplishment in this manner, but he was willing, he said, to be shown. He was told the name of an electric welding concern to whom he could write for information, and was informed upon receipt of his inquiry that the job could be welded satisfactorily by the electric method.

* * *

ALLOWANCES FOR GAS ENGINE PISTON FITS*

It is of prime importance that the fit of a gas engine piston in the cylinder be the best obtainable—sufficiently free to allow for the necessary oil film and to provide for slight distortions in shape under heat but still close enough to prevent "piston slap." The condition is not that of a solid plunger working in a heavy cylinder of unchanging form and copiously lubricated, but that of a comparatively delicate piston working in a cylinder, the walls of which are as thin as the designer dares to make them and which is subject to great variations of temperature at different points. Lubrication must be held down to a minimum, in order to conform to various smoke ordinances.

The question of the ideal allowance to make is considered apart from that of manufacturing tolerances. Some engineers use the very convenient rule of making the piston 0.001 inch small for each inch diameter of the cylinder bore but it is believed that the following rule comes closer to actual requirements: Allow from 0.002 to 0.0025 inch as a maximum for each inch of cylinder diameter above two inches. These allowances are shown graphically in the accompanying chart.

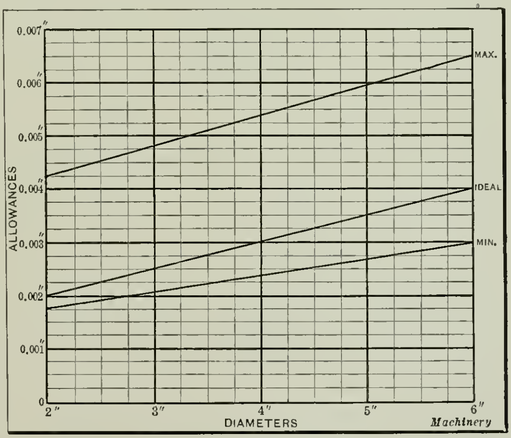
As it is commercially impossible to manufacture parts that are all exactly alike, due allowance must be made for variations. The engine builder has a choice of three methods: (1) Putting the limits on the drawings and holding the inspection so close that any piston will work in any cylinder; (2) sorting the cylinders and pistons according to size, and assembling the large pistons in the large cylinders and so on; (3) making all the pistons a closer fit than they are expected to run with, and lapping them to the proper fit, each in its own cylinder. In this paper, the first method only—that of strictly interchangeable production—is discussed. The fixing of the limits to which the shop is to work is very important as it affects directly the cost of the product. The drawings should represent what the engineer expects, what the shop will guarantee and what the company will pay for.

Considering the cylinder first, a permitted variation between maximum and minimum size of 0.0015 inch is absolutely necessary—0.002 inch is the ordinary allowance—and the cylinder must not be tapered or out of round in any way exceeding the given allowance. A variation of 0.001 inch between the maximum and minimum for the piston is the usual allowance. If wider limits are given, more care must be exercised in assembling.

The head of the piston being exposed to the intense heat of the explosion, must be made considerably smaller than the skirt. The amount is usually fixed at from 0.002 to 0.0025 inch small for each inch diameter.

The fit of the piston ring in the groove is another particular matter. The ring must be loose enough to operate freely but close enough to prevent gas from leaking past. The minimum allowance that is safe is 0.0005 inch and the tolerance on both ring and groove must be given in such a way that this allowance is not diminished. The closest limits that are being worked to commercially are 0.0005 inch variation between the minimum and maximum of both ring and groove width. This would be expressed on the drawing as $\substack{0.2500''\\0.2495''}$ for the width of groove and $\substack{0.2490''\\0.2485''}$ for the ring. Allowances must be made between the ends of the piston ring for expansion under heat, and from 0.006 to 0.015 inch is the usual amount.

Great care must be exercised in making the fit of the piston pin in the piston, the proper allowance for the fit being 0.001 inch. The hole in the piston, being reamed or broached, can be held to exact size or to 0.005 inch under size. In the case of a 1-inch piston pin, the hole in the piston should be dimensioned 1.000 to 0.9995 inch, while the piston pin should be dimensioned 0.9990 to 0.9985 inch, thus insuring a minimum allowance of 0.0005 inch and a maximum allowance of 0.0015 inch.



Allowances for Gas Engine Fits

A company making a specialty of the manufacture of gas engine pistons and cylinders for the automobile trade is acutely aware of the advantage to be gained by having an accepted standard for the nominal sizes of cylinder bore. For instance, with a nominal diameter of four inches, one engine maker may give tolerances of ± 0.001 inch while another maker may give tolerances of ± 0.002 inch. These variations, of course, necessitate carrying special tools and gages for each size that is made.

The foregoing limits suggested apply especially to water-cooled engines and are not recommended for air-cooled engines, the author having had no experience with this type.

* * *

What is stated to be a record in ship construction has been established in the building of the cruiser *Caroline*, by the Cammel, Laird & Co.'s works at Birkenhead. The keel of this cruiser was laid January 28, 1914, she was launched September 21, and delivered complete on December 17, after having passed satisfactory trials.

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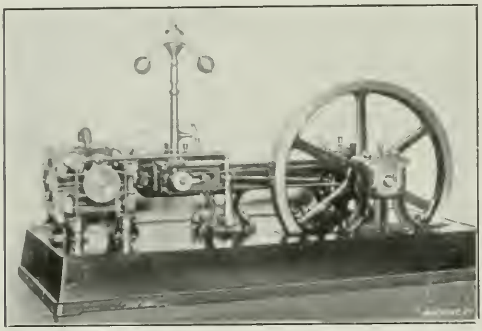
* Abstract of a paper presented by E. W. Weaver of the Ferro Machine & Foundry Co., Cleveland, Ohio, at the annual meeting of the Society of Automobile Engineers, January 6-7.

HISTORICAL NOTE ON REYNOLDS GIRDER FRAME CORLISS ENGINE

In the class room of the College of Engineering, University of Wisconsin, Madison, Wis., is a small working model of a Reynolds-Corliss engine built about twenty-five years ago by the E. P. Allis Co., and exhibited at the World's Fair in Chicago. An article was recently published in the *Wisconsin Engineer* by E. T. Adams on the design of this engine of historical interest from which the following extracts were made:

"The model of the girder frame Reynolds-Corliss engine recalls a story of its design as told me by the designer, Edwin Reynolds. Mr. Reynolds' fame as an engineer rests chiefly on greater and bolder undertakings but I know of no work which he did more characteristic of the man, or that better illustrates the qualities which mark a master. I think that this design was made during the early seventies. Prior to this date, Mr. Reynolds was superintendent of the George H. Corliss Engine Works at Providence, R. I. Mr. Corliss was at this time at the height of his fame and Mr. Reynolds, as his superintendent, held what was probably the best mechanical position in the country.



Working Model of Reynolds-Corliss Engine, 1 inch by 4 inches, belonging to College of Engineering, University of Wisconsin

"Mr. Reynolds visited Milwaukee to meet Mr. E. P. Allis about this time, and concluded an agreement to become general superintendent of the E. P. Allis Co. and to build up in the West a Reynolds-Corliss engine business which was very soon to completely overshadow the work of the Providence plant.

"The E. P. Allis Co. was at that time very far indeed from being in the prosperous condition to which it later grew under Mr. Reynolds' superintendency. The shops were most miserably equipped and the company had no money. The machine shop was a light wooden affair, part or all of which had been bought cheap, floated down the Milwaukee river on a scow and re-erected on land which at that time was almost a marsh.

"Poor as the machine shop was in tools and equipment of every kind, the foundry was far worse. It was situated at a short distance from the machine shop and in wet weather the space between was a morass, almost impassable. Through this horses floundered as best they could, dragging a "flat" on which castings were transferred from the foundry to the machine shop. A casting lost from the "flat" in transit was lost forever. The foundry had been equipped as a pipe foundry and a swinging crane arranged to serve the pipe pits was the only mechanical aid in the place. 'When I came to look the ground over,' said Mr. Reynolds, 'the outlook was discouraging, for while the machine shop could handle a fair-sized casting, we could not make such a casting in the foundry, neither could we have transported it from the foundry through the morass to the shop and the company had no money with which to provide equipment of any kind. The problem then was to design something which could be built with such equipment, in tools and men, as we had, and which could be sold for more than it cost us to build it.'

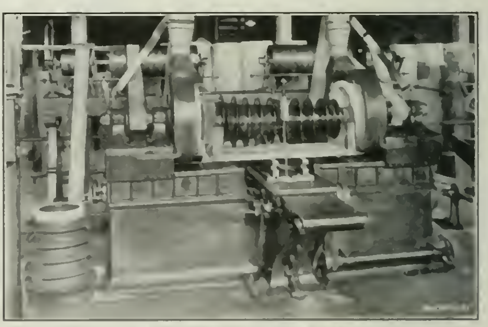
"Having decided to establish himself at Milwaukee, Mr Reynolds returned East to end his connection with the Corliss Works at Providence, and it was during this return journey that he worked out, on the back of old papers taken from his pockets, the design of at least a large portion of the engine of what was to be the Reynolds-Corliss engine. The frame is made in two pieces on account of the poor foundry equipment and the morass, and also arranged so that either a right-hand or a left-hand engine or one of the longer or shorter stroke could be built from the one set of patterns, a vital consideration where money was lacking. The design was marked by extreme simplicity and the ease with which the variations in hand or stroke could be made. The foundry was weak and the men employed were in no sense molders. Mr. Reynolds saw that there must be as few cores as possible, and only one core was needed in the frame, that being the one for the jaw of the main bearing which was so formed that the casting would come right no matter how the core was set. The joint in the frame was so placed as to make a simple shop operation suited to poor equipment and unskilled mechanics, and second the parts were so placed as to give the greatest stiffness at the points of greatest stress."

* * *

GRINDING THE ENDS OF PORCELAIN INSULATORS

At the Schenectady plant of the General Electric Co. an interesting grinding operation is performed on the ends of large porcelain insulators. These insulators are molded and fired; in the firing, shrinkage takes place so it is necessary that they be ground to bring the ends to an exact distance from their centers. Therefore the machine to handle this work had to be so arranged that each head could be moved independently and the ends brought to a certain distance from the center of the insulator.

For this purpose, a special double-head "Diamond" grinding machine is used that works on both ends of the insulator at the same time. The insulator is held as shown in the illustration, being mounted on a cradle that is, in turn, held on the carriage of the machine. Owing to the unequal shrinkage of the porcelain it is often necessary to grind as much as three-fourths inch from one end in order to bring the insulator to the right size. The grinding operation is performed without lubricant and the dry porcelain dust is removed by an exhaust system over each wheel. The wheels run at a speed of 1600 revolutions per minute. There is no tendency for cracking or crumbling away at the edges, and the finish is true and smooth. This is necessary, as the insulators are mounted end to end, and if they were not true the entire stack would be out of plumb.



A Porcelain Grinding Operation

The facing off of the ends of these insulators formerly took from two to three hours, but with the machine described the work is done at an average of one insulator in thirty-five minutes.

C. L. L.

* * *

The fastest motor boat in the world at present is *Disturber IV*, which has been driven at the rate of 57.20 miles an hour by two twelve-cylinder internal combustion engines. Each of the twenty-four cylinders is 6¾ by 7½ inches, and the rating of the two engines is 1800 horsepower. Each cylinder has four spark plugs and each of the twelve cylinder engines is fitted with six Bosch two-spark magnetos.

LETTERS ON PRACTICAL SUBJECTS

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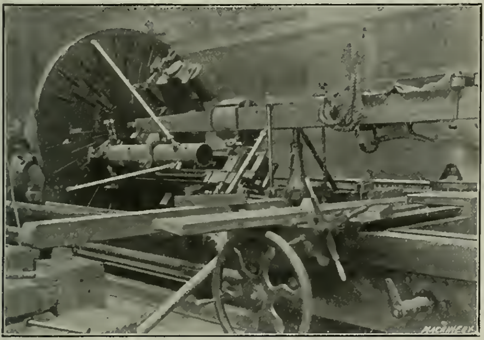
AN UNUSUAL LATHE JOB

The accompanying illustration shows the operation of machining the bearing on a davit. This bearing is made up of four pieces of composition secured to the I-beam davit by rivets and then machined by the method shown. As this operation is not often done, the average shop equipment will be found to lack a machine adapted for doing it. The operation was performed as follows: First, a 14-inch lathe with a bed about 5 feet long was selected, and the legs, headstock and tailstock were removed, leaving the carriage and tool-holder intact. Then a heavy angle plate was mounted on the faceplate of a 72-inch lathe. The small lathe-bed was next secured to the angle plate on the 72-inch lathe, and after providing the proper stays, it was found to be quite rigid. The heavy davit was then bolted securely to the carriage of the 72-inch lathe and carefully centered. It will be noticed that the top end of the davit is centered and supported by the 72-inch lathe center. With everything ready, the feed-screw was attached to the carriage of the small lathe and fed by hand with the use of the gear on the lead-screw. By taking several cuts, the bearing was reduced to the proper diameter very satisfactorily, four of these davits being machined in this manner.



Unusual Method of handling a Heavy Lathe Job

Somerville, Mass. N. I. Mosher

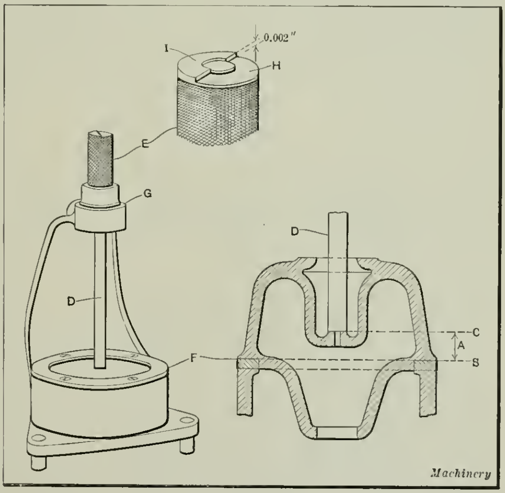
LIMIT GAGE FOR DISTANCE BETWEEN AN INSIDE AND AN OUTSIDE SURFACE

In machining the product of a certain carbureter factory, limits of ± 0.001 inch are required on all finished surfaces. Ordinarily, this would not be difficult to attain but where the rate of production runs from 8000 to 10,000 carbureters per week, the problem is far from being a simple one. In determining the accuracy of the product, both the machine operators and inspectors use limit gages which enable the work to be handled quite rapidly. In designing many of these gages, little difficulty was experienced, but one problem was encountered which proved quite difficult to cope with, and the ultimate solution was so ingenious that it will probably prove of interest to many readers of Machinery. In finishing the part shown in the accompanying illustration, it is required to have the distance *A* within 0.001 inch of the specified dimension, this dimension being the vertical distance between the face *B* on the outside and surface *C* on the inside of the work. The odd shape of the piece made it difficult to produce a limit gage for determining the accuracy of this dimension.

The method finally developed consisted of making a gage with a feeler *D* which is carried in a knurled handle *E*. The gage is provided with a work-holding fixture which has a ground surface *F* on which the finished surface *B* on the work rests. The surface *G* at the top or head of the work-holding fixture is also accurately ground, and the handle *E* of the gage—which is carefully ground on its lower surface—rests on this finished head. The feeler *D* is made the proper length to determine whether the surface *C* is at the proper distance from the surface *B*. For this purpose, the top of the handle *E* in which the feeler *D* is held, is so designed that the operator merely draws his finger across it to determine if the dimensions of the work are within the specified limit.

It will be seen that there is a step finished on the top of the handle *E* which is 0.002 inch in height. When the work has been finished to exactly the specified dimension, the feeler *D* is in such a position that its upper end is exactly half way up the 0.002-inch step at the top of the handle. The low limit is exceeded when the feeler is below the surface *H* on the top of the handle, while the high limit is exceeded if the upper end of the feeler projects above the surface *I* at the top of the handle. This can be easily determined by simply drawing the finger across the top of the handle *E*.

The feeler *D* is held in the handle *E* by means of a pin which passes through a slot in the feeler but does not prevent it from moving up and down within the range of the limit gage. A light spring in the handle *E* serves to keep the feeler *D* pressed tightly down against the surface *C* of the work. In using the gage, the operator puts the work in the fixture, pushes down the handle *E* tightly against the ground surface of the head of the fixture, and then runs his finger across the top of the handle as previously described, the work being passed or rejected as the result of this test. The entire operation is completed in less time than it has taken the reader to run through this paragraph. C. S. R.



Limit Gage for rapidly determining Accuracy of Height between Inside and Outside Surface

A BROACHING OPERATION DONE IN THE PUNCH PRESS

It was required to finish a large number of sheet steel punchings with one edge beveled to 60 degrees as shown at *A* in Fig. 1. The stock was 3/32 inch thick and the punchings were of different widths, *viz.*, 3⅛, 3¾, 4¼ and 5 inches. We first tried to finish the beveled edge on these pieces by grinding, but this method proved too slow and expensive; and the same difficulties were experienced when it was attempted to do the work on the milling machine. Finally a broaching fixture was made for use in the punch press, and this solved the problem; the work was produced 75 per cent quicker

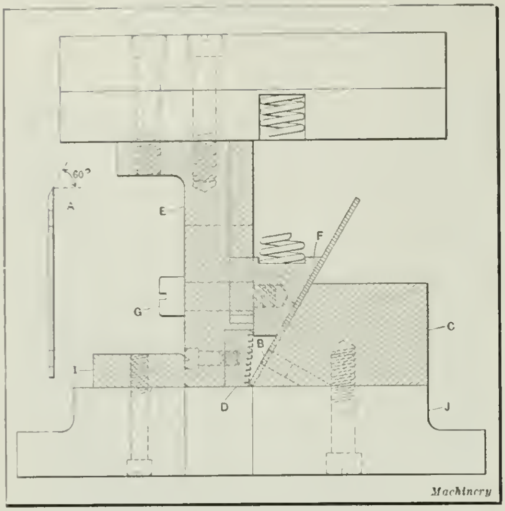


Fig. 1. Broaching Fixture and Work to be broached

than by any other method tried and the finish obtained was very satisfactory.

The broaching fixture needs very little explanation to make its use clear to any mechanic after reference has been made to the accompanying illustrations. Fig. 1 shows the broach and stock in position to start the cut, and when the ram is at the top of its stroke, there is plenty of room to remove the work *B* from the block *C*. It will be seen that the broach *D* is secured to the broach-holder *E* by means of cap-screws, while the spring pad *F* is provided with a tongue fitted to a groove in the broach-holder *E*, the pad being held to the broach-holder by means of screws *G* which slide in slots *H*, Fig. 2. The pad *F* holds the stock in place on the block *C*, while the broaching operation is taking place. It will be seen that the block *C* is inclined at an angle of 60 degrees and this block is provided with hardened tool steel pins which fit into holes in the work to locate it in place.

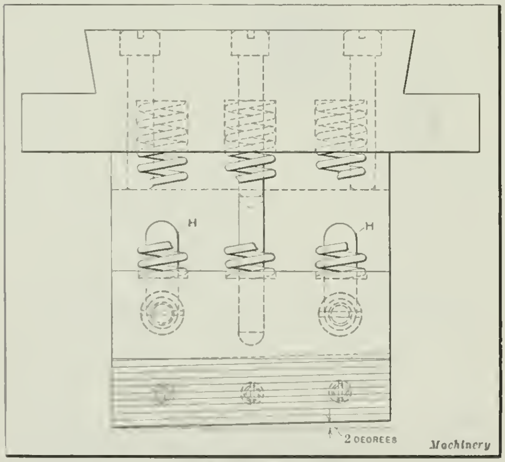


Fig. 2. Front View of Broach and Broach Holder

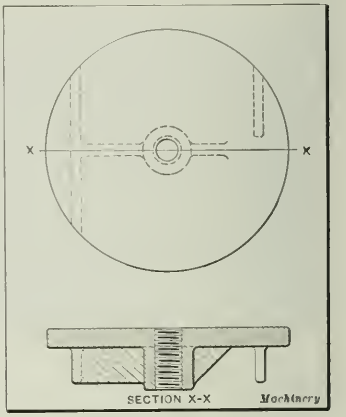
The block *I* acts as a support for the broach-holder *E* to prevent the broach from springing away from the cut. Owing to the short stroke of the punch press, which is only 2 inches, the teeth on the broach *D* could not be spaced according to the usual practice in broach design. The teeth were spaced $\frac{1}{8}$ inch apart and given a shear angle of 2 degrees as shown in Fig. 2. No trouble was experienced in the cutting action of the broach The chips came off in long spirals, and it will be seen that a slot is provided in the holder *J* for the chips to drop through.

Windsor, Conn. F. K. Hudson

DRAFTING CROSS-SECTIONS OF RIBS

Referring to the question and answer regarding the proper method of cross-sectioning ribs on page 413 of the January number, I would say that of the two Fig. 1 is correct. Nevertheless, the method shown in Fig. 2 is occasionally used for no other purpose than to distinguish the ribs from the main structure which is very desirable, especially when on account of large size and number of views it becomes necessary to employ several sheets of drawings. While Fig. 2 is not drawn in accordance with the strictest theory, it is like most things in drawing, merely a convention which, personally, I do not think to be a very good one, as it is likely to lead to confusion.

A very good method seen by the writer about two years ago is shown in the accompanying illustration. This method of cross-sectioning ribs constitutes a very simple and useful convention without infringing on the theory of drawing. I have used it ever since and found it to be entirely satisfactory.



Drafting Cross-sections of Ribs

Flint, Mich. M. Terry

INTERNAL GRINDING ATTACHMENT

Fig. 1 shows an improved internal grinding attachment that can be applied to the Landis grinders Nos. 3 and 7. The demand for grinding the internal surfaces of hardened bushings from 1 to 5 inches in diameter suggested to the writer the idea of having a number of spindles of various lengths and diameters, that could be used in one attachment. This idea was successfully carried out, and reference to Fig. 1 will clearly convey the principle of construction that has been employed. The attachment consists of a well ribbed casting, with bearings of ample diameter and length. The spindle *A* is made of annealed tool steel, with one end bored to receive a No. 3 Morse taper shank and the other end threaded for a flanged oil retainer ring. This spindle has a hole bored through it to receive the bolt for holding the taper shank in place, thus preventing the shank from working loose while in operation. The hardened steel bushings *B* and *C* are ground all over and forced onto the spindle *A*. This method does

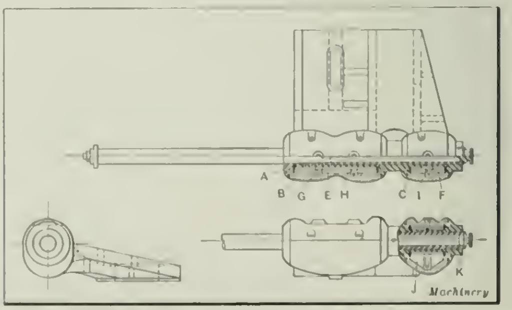


Fig. 1. Design of Improved Internal Grinding Attachment for Landis Grinders

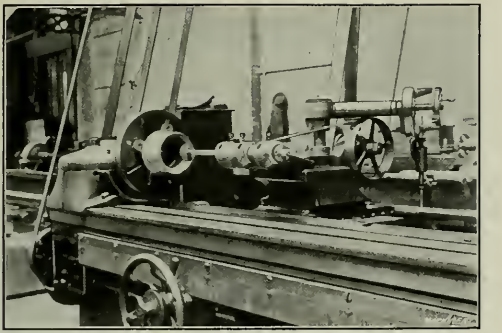


Fig. 2. Internal Attachment mounted on a No. 7 Landis Grinder

away with the expensive operation of grinding the taper shank socket, which would be necessary if the spindle was hardened, as hardening will invariably distort the true running of the spindle.

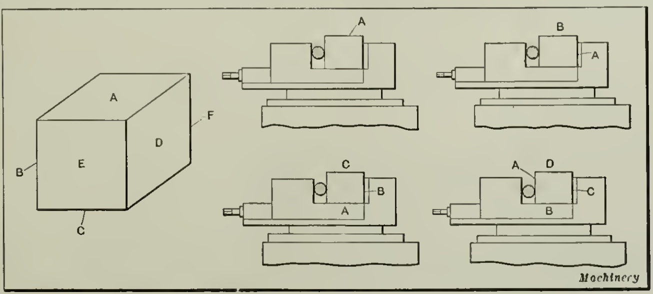
Another very important feature of this shell bushing is that it can be renewed when worn out much cheaper than the whole spindle. The hard bronze bearings *E* and *F* are machined to fit into the holes bored in the fixture and caps. The bearings are kept from turning by dowel pins, and are cut at *G*, *H* and *I* for oil rings, as liberal and positive oil lubrication is very necessary in the bearings of a high-speed spindle of this type. The arrangement of the oil reservoir *J* and also of the oil rings, oil retaining flanges *K* and fiber thrust collars are clearly shown in the cross-sectional view. The design of the oil retaining grooves causes centrifugal force to tend to throw the superfluous oil into the cavity of the fixture, to be drained back into the reservoir *J*. By this special feature, the possibility of oil being thrown out is very nearly eliminated.

This fixture is adapted to the Landis grinders Nos. 3 and 7, but the construction of the spindle is adaptive to any high-speed duty. Two of these fixtures are at present in use and prove very efficient; but it was found that at 5000 revolutions per minute some vibration was noticeable, and to lessen this the spindles were bored hollow. Fig. 2 shows the attachment assembled and in use on a No. 7 Landis grinder where it has been used quite extensively in the machinery division of the United States Navy Yard at Boston, Mass.

Somerville, Mass. N. I. Mosher

PLANING A BLOCK SQUARE

After carefully reading the article of this title which appeared in the October number of Machinery, it seemed to me that the method described was correct in some respects and wrong in others. One point on which the writer of this article is certainly wrong is in recommending the planing of any piece of work with the work overhanging the vise, while feeding the tool down on the work. There are certain cases in which this is unavoidable, an example being the planing of the ends of long work but it is a practice which should be avoided wherever possible. The reason for this is that the movable jaw of most vises is not rigid but will lift up to a certain extent. The magnitude of this lost motion depends upon the amount of abuse which the vise has undergone in the past. As a result, when it is attempted to plane a piece of work which overhangs the vise and feed the tool down in the manner described by the writer of the article referred to, the movable jaw has a tendency to tip, thus throwing the work out of square.



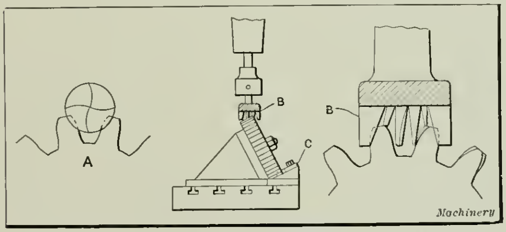
Block to be planed and Set-up for First Four of the Six Sides

What the writer has found to be the best method of planing up an accurate square block, and one which is used by many diemakers of experience, is shown in the accompanying illustration. The first step is to remove the scale from all sides of the block, this also being the means of removing a certain amount of strain in the metal. In performing this operation, it is good practice to leave not more than 1/16 inch of the metal for the finished cuts which are taken as follows: By resting one side of the work on the bottom of the vise, and one side against the solid jaw, the vise is closed up, but instead of bringing the movable jaw against the block, a round pin is inserted between the jaw and the block. This pin not only clamps the work, but owing to the small bearing surface which it presents to the block, it compensates for whatever slight amount of inaccuracy was left from the first operation. Repeating this operation on every side of the block will result in the production of an accurately planed block and by this method the work can be set in the center of the vise for all operations, the only exception being in the case of unusually long work, a contingency which has already been referred to. The illustration shows the set up for planing the first four of the six sides of the work. In preparing to machine the fifth side of the block, a square is used in setting the work in the vise. This method assumes that the face of the fixed jaw of the vise is exactly perpendicular and forms an angle of just 90 degrees with the base.

Pawtucket, R. I. H. Murphy

METHODS OF CHAMFERING GEAR TEETH

There is a well-known type of machine for chamfering the teeth of the gears for automobile transmissions, electric starter gear trains, etc., but few shops have enough work to warrant purchasing one of these special machines. In such shops, many makeshifts have been devised for the purpose of chamfering gear teeth, and two particularly good examples of this kind recently came to the writer's attention. In one case, the gear which is to have its teeth chamfered is mounted on a mandrel which is held in a fixture set up on the table of a drill press. This fixture locates the gear in the proper position to enable the chamfering operation to be performed by a rather blunt twist drill, the correct size of which for any given gear can be quickly ascertained by experiment. This drill is fed down between the gear teeth as shown at *A* in the accompanying illustration, and cuts off the corners of two adjacent teeth at each operation. The results obtained in this way are fairly good, although the finish is not equal to that secured with the milling fixture which is shown at *B* in the same illustration.

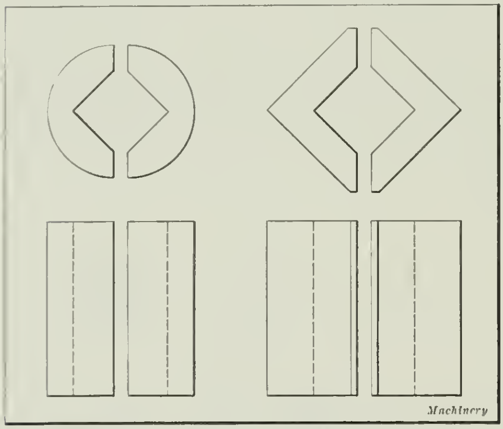


Methods of chamfering Gear Teeth on Drill Press and Milling Machine

The milling fixture referred to consists of a hollow milling cutter which chamfers the outside corners of two adjacent teeth simultaneously, and a fixture for supporting the gear at the proper angle for performing the chamfering operation. The design of the fixture naturally depends upon whether a vertical or horizontal milling machine is to be used. The gear is mounted in such a way that it can rotate but is prevented from doing so by a stop *C* which is inserted between two gear teeth while a cutter is working. It will be seen from the illustration that the gear is set up at such an angle that the cutter only works on the corners of the teeth at one edge of the gear, the cutter being made large enough to straddle two teeth and cut the outside corners from both of them. When the proper care is taken in handling the work, the finish obtained with this fixture is said to be equal to that produced by the best forms of gear chamfering machines. C. S. R.

BUSHINGS FOR PUNCH PRESS RAMS

In making dies—especially in jobbing shops—it often happens that the diemaker is required to set up punches with different sized shanks in the punch press. As there is often no bushing of a size to fit both the hole in the ram of the press and the shank of the punch, the practice is to turn up a round bushing, bore a hole of the required size in it and then split the bushing in half. Where this is done one needs a separate bushing for each size of shank. To overcome this difficulty I recently made two or three bushings of the forms illustrated herewith. A glance at the illustrations will make it evident that these two bushings can be used for a number of different sizes of punch shanks. It will be seen that one bushing is provided for fitting a punch press which has a round hole in the ram, while the other fits a machine which has a square hole in the ram. By having a square hole in the bushing instead of a round hole, the same bushing will fit various sizes of round punch shanks, and as a four point bearing is obtained a secure grip is assured. As these bushings cost no more than the bushings with a round hole, and as they are more or less universal, while the round-hole bushing will only fit one size of shank, no further argument should be required in pointing out the obvious advantages of this design.

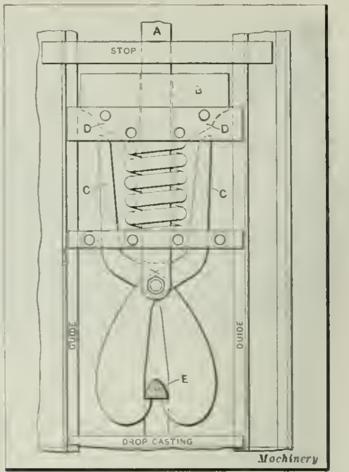


Bushings for Punch Press Rams with Square and Round Holes

West Orange, N. J. DONALD BAKER

IMPROVED DROP RELEASE FOR FOUNDRY SCRAP BREAKER

For use in breaking up scrap car wheels ready to be melted in the cupola, we make use of a 3000-pound drop which is equipped with a release mechanism shown in the accompanying illustration. The hammer slides between guides as shown, and is raised by compressed air to a sufficient height to break the class of scrap which is placed on the anvil. Until we installed this arrangement for releasing the drop, we found it very difficult to release the hammer without causing an impact in the cylinder and drop frame, which did considerable damage. The design of the release mechanism and the way in which it operates are clearly shown so that little description is necessary. The main bar *A* to which the piston rod or cable is attached, slides in the top casting *B*. The spring should be of about the same size and strength as the weight of the hammer and should be almost closed at the time the hammer is released. It will be evident that when the hammer has been raised to the point of release, the arms *C* engage the inclined surfaces *D* on the top casting, thus causing the arms *C* to be spread apart so that their hold on the support *E* of the drop hammer is released. The top surface of the arms *C* and also the under side of the inclined surfaces *D* should be casehardened to prevent them from wearing.



Improved Release for Use on a Foundry Drop for breaking Scrap

The drop hammer remains in the guides at the time of impact, the lower end of the guides being about two feet above the anvil on which the scrap is placed. The drop hammer is about 4 feet 6 inches high so that there is always 2 feet 10 inches of it in the guides, when the thickness of the casting under the hammer is taken into consideration. The guides are subjected to considerable strain but as the point of greatest strain is near the base, we have found very little trouble from this source. The principal reason for designing this release mechanism was to take up as much of the impact in the cylinder as possible. The stop can be adjusted in order to change the position at which the hammer is released. This equipment has been in constant use for over three years, during which time the cost of up-keep was practically nil.

Lenoir City, Tenn. JOHN V. PIERCE

METHOD OF DRAWING AN ELLIPSE

A method of drawing an ellipse which the writer has not yet seen in print, although it is simple and accurate enough to commend itself to the attention of the most critical, is described in the following. In using this method, it is necessary to know the major and minor axes of the ellipse which is to be drawn and with this knowledge, a piece is made of the form shown in Fig. 1. Thin wood is satisfactory for this purpose, a piece of an old cigar box being as good as anything. Referring again to Fig. 1, the distance *CD* is one-half the minor axis of the ellipse while the distance *DE* is one-half the major axis. It will be evident that the point *D* consists of the pencil holder of an ordinary draftsman's compass, which is secured to the end of the tracing arm in the manner shown.

From another piece of the same wood, a piece is made of

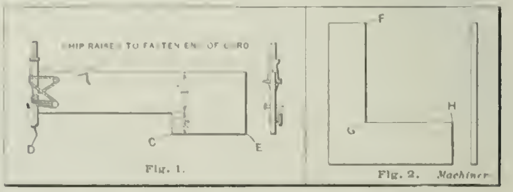


Fig. 1. Fig. 2.

Figs. 1 and 2. Two Parts of Ellipse Drawing Instrument the form shown in Fig. 2, the distances *FG* and *GH* being just a little longer than the distance *CE*, Fig. 1. In starting to draw the ellipse, the first step is to lay out two lines which intersect each other at right angles, as shown in Fig. 3. The square illustrated in Fig. 2 is then held with the fingers of the left hand so that its inner edges coincide with the center lines which have been laid out. The tracing arm is then held vertically with its corner *E* in close contact with the corner *G* of the square, and the side *CE* flush against the side *FG* of the square. Then by drawing the corner *E* along the side *GH* of the square while the corner *C* is kept in contact with the side *FG*, the pencil point will trace one-quarter of the required ellipse, as shown in Fig. 3. The remaining three-quarters of the ellipse is formed by simply turning over the square and repeating the operation three times.

Reference to Fig. 3 will doubtless make this method quite clear to the reader. If, for instance, an ellipse with a major axis of 10 inches and a minor axis of 4 inches is required, the distance *DE*, Fig. 1, will have to be 5 inches and the distance *DC* 2 inches, while the length of the legs *FG* and *GH* of the square (Fig. 2) will have to be about 2¼ inches. The description may sound a trifle complicated, but after trying this method, the reader will be convinced that it is in reality quite simple. In order to get satisfactory results the sides *FG* and *GH* of the square must be as smooth and straight as possible, and the corners *C* and *E* of the tracing arm should be sharp and clean so that they will slide smoothly on contact with the square. Those requiring a more permanent form of instrument will easily be able to devise a more stable method of holding the tracing point, and also means for varying the distance *CE* by making the tracing arm shown in Fig. 1 of two adjustable pieces which can be locked together in the required position. Where it is required to lay out an ellipse on a metal surface, it will be evident that the pencil point must be replaced by a scriber of suitable form.

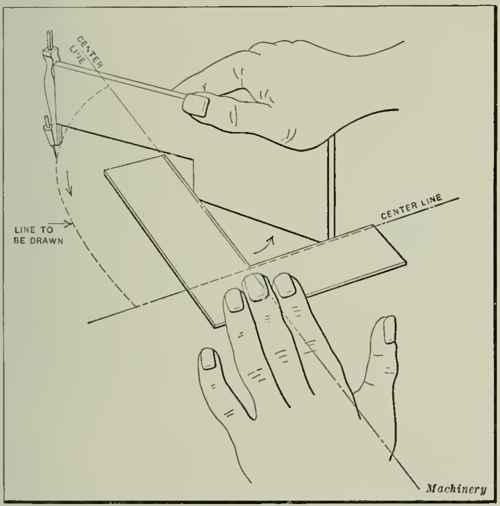
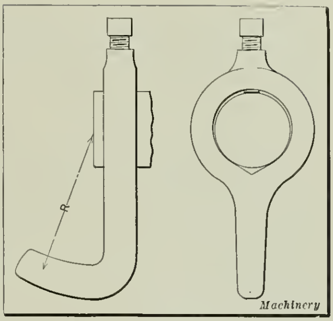


Fig. 3. Method of drawing an Ellipse with Instruments shown in Figs. 1 and 2

Greenfield, Mass. A. W. SCHOOF

EQUALIZING DOG FOR TAPERED WORK

The accompanying illustration shows a driving dog with a curved tail which is especially intended for driving tapered work, the form of this dog being such that a more nearly uniform speed is obtained than in cases where an ordinary dog is used. The center of the arbor—or the center in the work, if an arbor is not used—should extend the proper distance through the opening in the dog so that the center in the end of the work will correspond with the center of the curved tail, as shown in the illustration. The edge of the driving plate should be well rounded over. When these conditions are complied with, the work will rotate at a more nearly uniform speed than it would if driven by an ordinary dog with a tail at right angles to the body. Where an ordinary dog is used, the variation in the distance of the contact point between the driving plate and dog from the center, during each revolution, is responsible for the variation in the speed of rotation. As the driving plate rotates at uniform speed, the work will naturally be driven faster when the driving plate and dog contact at a greater distance from the center than it would when this distance is reduced.



Equalizing Dog for driving Tapered Work

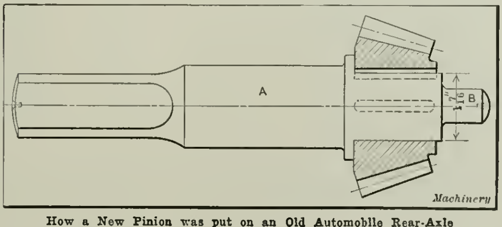
In addition to the attainment of a more nearly uniform speed, the use of this curved tailed dog causes the work to be driven more smoothly and without danger of the tail of the dog sliding to the end of the slot in the driving plate and being prevented from going as far in that direction as would be required for the work to turn freely—a condition which must be carefully determined when using an ordinary dog. A comparative test made in threading a piece of work with a taper of 3 inches per foot and a thread lead of ½ inch, showed the following results: with a straight tailed dog, the error in the lead of the helix was 0.016 inch; while with the curved tailed dog, this error was reduced to 0.008 inch which represents an increase in accuracy of 50 per cent.

Watervliet, N. Y. MARTIN H. BALL

AUTOMOBILE REAR-AXLE REPAIR JOB

Thinking that this repair job, which was done in the shop of the Hamilton Gear & Machine Co., Toronto, Canada, might interest some of my fellow readers of MACHINERY, I am sending it in for publication. As can be seen from the illustration, the job was an automobile rear-axle driving pinion, solid with the shaft, which had three or four teeth stripped off. It was brought in by a customer who wanted a cheap rush job and suggested that we might use the old shaft and put on a new pinion. A drawing with all dimensions was made of the old piece, which of course, was made of casehardened steel; and it was decided to put a new pinion on the old shaft, as it was possible for the bore in the pinion to be 1 7/16 inch in diameter and still have plenty of metal between the keyseats and the root of the teeth.

The next question was turning off the old pinion. The shaft was ground at *A* and *B*, so it could not be annealed and rehardened, as the heat would tend to warp it, which would necessitate regrinding; so the hardened teeth were ground off on an emery wheel. The work was then put in the lathe and turned down. In doing this, the cut was started in the soft center, the tool worked up to the flange and then back again to the end. The finishing cut through the hard case at the end was taken at a very slow speed. The two ¼-inch keys at 90 degrees apart, only came to within ⅛ inch of the end of the shaft because of the difficulty in cutting keyseats through

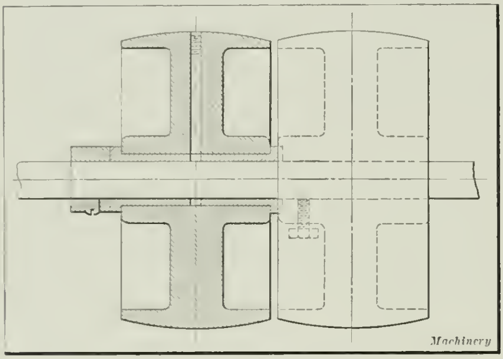


How a New Pinion was put on an Old Automobile Rear-Axle the hard case. The chrome-nickel steel pinion was heat-treated and hardened, and the bore ground for a press fit on the shaft. The customer was pleased with the job and now if the teeth strip again, he only has to have another pinion made.

Toronto, Canada. S. G. Clarke

RE-BUSHING A LOOSE PULLEY

On one of our high-speed drill presses, the loose pulley gave a lot of trouble owing to the necessity of re-bushing or re-babbitting its bearing every three or four months. To overcome this difficulty I bored the hole in the pulley ⅛ inch over size and made two cast-iron shoulder bushings which were a running fit on the shaft and in the pulley. A space ¼ inch in width was left between the bushings at the center of the pulley bearing, as shown in the cross-sectional view; this formed an oil pocket, and an oil hole was drilled through from the face of the pulley to provide for replenishing the oil when necessary. A screw in the top of the oil hole prevented the oil from leaking out. Equipped in this way the pulley has run for 2½ years without giving any further trouble.



Method of re-bushing a Loose Pulley

Milwaukee, Wis. August Brodde

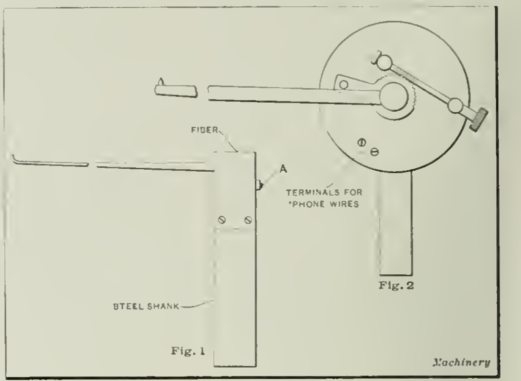
DIEMAKER'S CLAMPS

In the August number of Machinery I noticed a short article by H. Groves entitled "Diemaker's Clamp" and this recalled several useful forms of clamps which I have seen in my travels. It will be seen that the clamps shown at *A* and *B* are provided with legs which may be adjusted on the cross beam for holding different widths of die blocks, while the legs of the clamp shown at *B* may also be adjusted vertically for different thicknesses of die blocks. In the clamp shown at *C*, provision for holding different thicknesses of blocks is obtained by having auxiliary legs which may be held in different slots on the main legs of the clamp. The vertical adjustment provided in clamps *B* and *C* enables the setting to be made more quickly than it could be by adjusting the screw.

Bridgeport, Conn. E. P. Davis

BILL'S TELEPHONIC INDICATOR

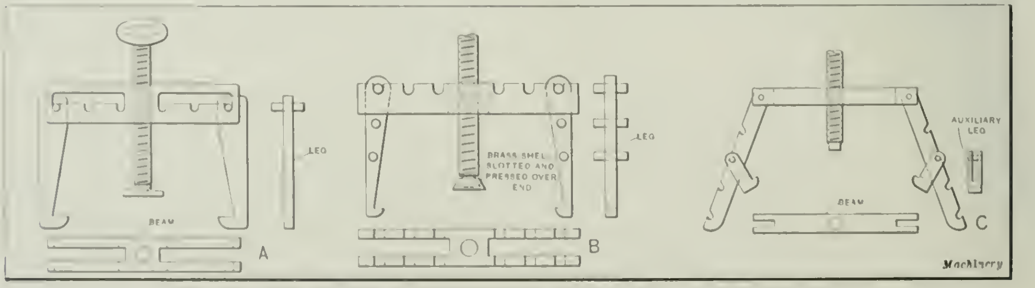
Jack and Bill were toolmakers, working in the same shop. One day, when Jack had to center a job on his lathe face-plate to grind out a hole, it was observed that he used a queer looking tool, like the one shown in Fig. 1, which he assured inquiring neighbors was a "telephonic indicator." It had a steel shank, to go into the toolpost, and on its forward end an extension of vulcanized fiber, which carried a steel needle and an electric terminal *A*. From *A* a flexible covered wire ran to a tin box, which was laid on the lathe carriage, and was said to contain a battery. From this box issued the "cord" of a small 'phone receiver. When the indicator was in use a sharp click was heard in the receiver at every contact of the needle with the work.



Figs. 1 and 2. Two Designs of Electrically-operated Test Indicators

Everyone in the room either came to Jack's lathe and tried the thing, or borrowed it to use on his own work. Bill resolved to make one for himself, but one that would be far superior to Jack's, which, though it undeniably worked well, failed to satisfy Bill's esthetic sense. After devoting a suitable time to meditation, he evolved a sketch, embodying his ideas of how it ought to be built, which he exhibited to his shopmates, several of whom expressed a desire to possess one of the improved variety. This put an idea into Bill's head, and when his summer vacation came, a few days later, instead of taking his long-anticipated trip to the country, he went to a shop a few miles away, where he had bargained for the privilege of doing a "government job," and proceeded to construct a considerable number of the indicators.

Fig. 2 shows a top view of his design. For the tin box he substituted a neat cylindrical box, made of seamless brass tubing, which was mounted on a shank to go into the toolpost. This box contained a small two-cell battery, like those in some pocket "flashlights," and on its vulcanized fiber cover were the parts shown in the illustration. The adjusting "worm" was threaded with a machine screw die, and the worm-gear segment hobbed with the corresponding tap. The long arm for the contact point was of T-section. As a spring held it lightly against the pin in the segment arm, it was susceptible of easy adjustment. Two terminals on the cover



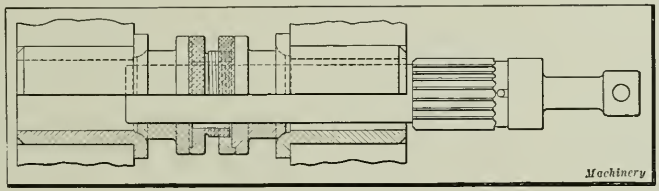
Three Useful Types of Diemaker's Clamps provided with Different Methods of Quick Adjustment provided attachment for the receiver cord, and the whole affair, being well made, certainly presented a more workmanlike appearance than did Jack's rough arrangement.

Bill was confident that as soon as he returned to work and exhibited his new indicator, orders would flow in for a goodly number, but one day, near the end of his vacation, it occurred to him that it might be well to try one, just to see how much better it worked than Jack's. To his consternation, it was a flat failure, giving forth, when its point touched the work, not a clear, sharp click, but a buzzing sound which, once started, continued until work and contact point were separated by several thousandths inch. In vain he "tinkered" with it but it refused to click.

A friend, visiting Bill's room, found all the new indicators stacked on the table, and was told by their maker, who sat gloomily contemplating the fruit of his labors, that they were to be taken down the harbor and dumped overboard. Fortunately, the friend possessed the knowledge of the rudiments of electricity that Bill lacked, and readily saw where the trouble lay. He purchased some cotton-covered German silver wire, about No. 35, six or eight feet of which, rolled into a coil, was put into the box part of each indicator, its ends being connected to the screws which hold the receiver wires. Subsequent inquiry brought out the fact that Jack's had a similar "shunt" tucked away in the tin box, he having found that if the shunt were omitted the "extra current" flowing from the receiver magnet at each breaking of the circuit caused a rapid vibration of the contact-point and its arm, and the consequent buzzing in the receiver that had so troubled poor Bill.

The electrical connections of Bill's indicator are very simple. One wire from the battery connects to the brass box, the other to one of the receiver terminals. The other terminal is connected, by a wire under the fiber cover, to the stud that carries the arm and worm-gear segment.

Guy H. Gardner
New London, N. H.



Lining Reamer for Use in Finishing Gas Engine Bearings

USE OF COPPER ELECTROPLATE IN LOCALIZED CASEHARDENING

We were required to make a pipe roll 30 inches long by 3 inches in diameter, of the form shown in Fig. 1, with hollow casehardened trunnions upon which it was to turn screwed into the ends. Through these trunnions a soft steel arbor, one inch in diameter, was required to pass with an easy sliding fit. To obtain this result the bore through the trunnions had to be 0.002 inch larger than the arbor, the arbor being ground as close as possible to one inch in diameter. We proceeded by cutting the pipe to the proper length and tapping the ends to receive the trunnion sleeves, one of which is shown in detail in Fig. 2. These sleeves, before being screwed into the pipe, were casehardened, after which the holes were lapped out 0.002 inch over size, as previously mentioned. The trunnions were then screwed into the ends of the pipe, after which the roll was placed in a lathe where the outside diameter was ground to the required size.

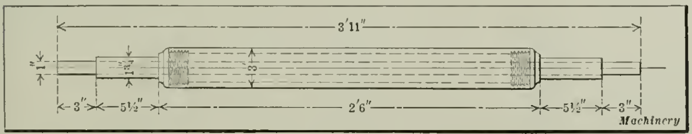


Fig. 1. Design of Roll for which Casehardened Trunnions were required

Everything progressed satisfactorily until the attempt was made to insert the steel arbor, and then the trouble began. It was found that while the arbor would pass through either one of the trunnions separately, a slight deformation of the trunnions in hardening or in screwing them into the ends of the roll, had sprung the holes sufficiently out of alignment so that it was impossible to pass the arbor through both trunnions at one time and still obtain the required free sliding fit. This fault had to be corrected before the roll could be used, and the obvious remedy was to correct the error in alignment with a reamer long enough to pass through both trunnions after they were screwed into place. This, however, was impossible, for when the outside of the trunnions was casehardened the inside had also been hardened so a reamer could not cut it.

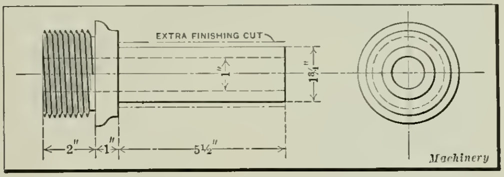


Fig. 2. Detail of one of the Casehardened Trunnions

It was at this point that someone hit upon the happy thought that saved the day. A new pair of trunnions was roughed out and bored to size but not reamed. The thread was cut on the head end and the work completed as before, except that an extra finishing chip—shown by the dot and dash lines in Fig. 2—was left on the outside of the trunnion sleeve. Then before proceeding further with the machining operation, the trunnions were given a heavy coat of copper electroplate which completely covered the surface of the metal. After this they were again put in the lathe and a cut taken to remove the metal shown on the outside by the dot and dash lines. It will be evident that in so doing the copperplate was also removed, thus exposing the steel surface of that part of the trunnions which it was required to caseharden. The trunnions were then casehardened in the usual way, and after this operation had been performed it was found that the metal under the copperplate was quite soft. The trunnions were then screwed into the ends of the roll and the bearings line-reamed to obtain the required fit for the arbor. This method of local casehardening will doubtless be found useful in handling various other classes of work. Copper electroplate is recommended for the above process, but if this is unavailable, nickel-plate will be found to be equally satisfactory.

Waldo Paxton

LINING REAMER FOR GAS ENGINE BEARINGS

The lining reamer shown in the accompanying illustration is used for reaming the main bearings of gas engines. These bearings are lined with anti-friction metal which is cast into brass shells and they are finished all over with the exception of the hole which is left 0.010 inch under size. Shims are placed between the two halves of the bearing, the cap being held in place by bolts in the usual manner. The guide bushings for the pilot of the reamer are then put in place, these bushings being located by the fillet of the bearing as shown in the illustration. Particular care is taken in machining the main bearing brasses; they are held in a special fixture fastened to the lathe faceplate, on which they are bored, have the shoulder turned and squared up on both sides and the fillets formed. Owing to this care in machining no difficulty has been experienced in using the fillets for locating the guide bushings for the reamer. The bearings are reamed from both sides of the bed and scraped.

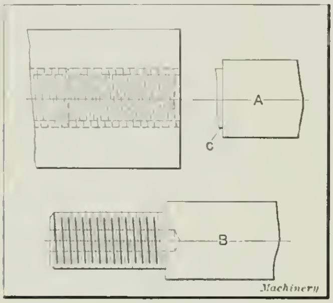
Pasadena, Cal. E. B. Wuest

SHOP AND DRAFTING-ROOM KINKS

INGENIOUS MEANS AND SHORT CUTS FOR SAVING LABOR AND MATERIALS

A REPAIR KINK

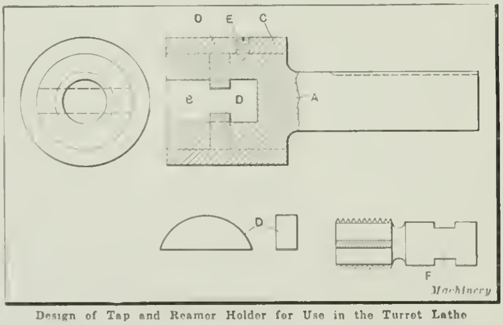
The shoulder screw shown at *A* in the accompanying illustration has been broken off at the shoulder *C*, leaving the screw in the tapped hole. It is a difficult job to take out a screw that is broken in this way if it is a tight fit, and very often the screw has to be drilled out. A shoulder screw is shown at *B*, which has a hole drilled in it just past the shoulder so that if it should break off at the shoulder, the screw could be easily taken out by driving a drift or square piece of pointed steel into the center hole. The screw *B* is still of ample strength and it takes but a very short time to drill the hole when the work can be put under a drill press. But if the same hole has to be drilled by hand after the screw is broken—as shown at *A*—a considerable amount of time will be required. G.



Provision for removing a Screw if it should break

TAP AND REAMER HOLDER

The tap and reamer holder described in the following has been found very useful on turret lathe work, as it is of simple though rigid construction and there is practically nothing to get out of order. It will be seen that there are no set-screws or other projecting parts on the holder which can injure the operator's hands or cause accidents through catching loose sleeves or other parts of his clothing. The body and shank of the holder are made of a single piece of soft steel, the shank being turned to fit the turret hole and milled flat on one side to form a bearing for the set-screw in the turret. The socket *B* is bored out about 0.008 inch larger than the shank of the tap to provide the necessary float.



Design of Tap and Reamer Holder for Use in the Turret Lathe

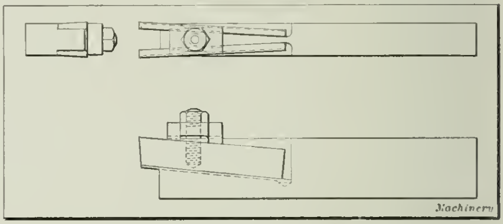
As taps used in turret lathes are frequently made special, their shanks can be made to suit the holder. The taps for this holder have two flats milled across their shanks as shown at *F*; this allows the shanks to be made short and effects an economy in tool steel. It will be seen that two slots are milled in the holder to receive two steel blocks *D*. In assembling the tool, the shank of the tap is inserted in the socket *B*, after which the blocks *D* are dropped into place, and the collar *C* is then slipped on and held by a headless set-screw. If so desired, the holder can be made with only one block *D* and one flat on the shank of the tap, but by having two flats and two retaining blocks the strain will be more evenly distributed.

Pittsburg, Pa. F. Boehmer

SHAPER TOOL FOR FINISHING T-SLOTS

A very simple solution of a little problem that recently came up in our shop may be of interest to some readers of Machinery. The shaper that we manufacture has a table with the usual form of T-slots which are required to be finished 11/16 inch in width. These slots are 21/32 inch wide as the tables are received from the planing department and they are finished to the exact width after the table is fitted to the machine. This is accomplished by means of a tool in the shaper toolpost, which insures having the slots exactly in line with the stroke of the ram. Forged tools were formerly used for this purpose but they were very unsatisfactory, as a few grindings or a burned corner at the cutting edge of the tool made it necessary to re-dress the tool and re-grind it to size, a considerable amount of time being required for forging, hardening, etc.

The tool illustrated herewith was finally developed and has been found a very satisfactory solution of the problem. The machine steel shank is slotted on both sides to receive two high-speed steel blades to give a rake of 5 degrees and a side clearance of 3 degrees, the blades being ground to give a front clearance of about 3 degrees. These blades were clamped in place as shown in the illustration, a 5-degree chamfer on the bottom of the blades and slots serving to hold the blades in place against the shank. By simply grinding the ends and moving the blades out, it is possible to keep an accurate width at the cutting edge of the tool.



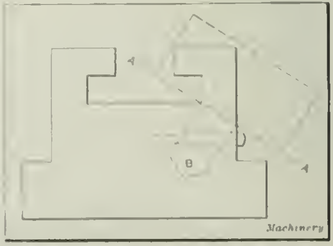
Tool for finishing T-slots in Shaper Table

Central Falls, R. I. Norman R. Earle

REPAIRING A BROKEN T-SLOT

The accompanying illustration shows an end view of the tool-slide on a pulley crowning fixture which we use in our shop. Recently we were using this fixture and taking an unusually heavy chip with the result that the T-slot broke out on one side. We attempted to repair this damage in two different ways, but neither proved able to stand up under the strain when the fixture was in use. After giving the matter some thought, we finally managed to make a satisfactory repair as shown in the accompanying illustration, and since that time no further trouble has been experienced.

We first planed the broken part to an angle as shown by the line *A*—*A*, the amount of metal planed off being just sufficient to enable two pieces of flat stock to be put in place as shown by the dotted lines. Two holes were next drilled as shown at *B*, after which the two pieces of flat stock were turned down to form studs, which were a driving fit in the holes *B*. These studs were next fastened in place by tapered pins, after which the blocks were planed down and



Method employed in repairing Broken T-slot the T-slot finished. As previously stated, this method has proved very satisfactory, no further trouble being experienced through failure of the T-slot.

Moore, Pa. A. O. Webster

A GAGE-MAKING KINK FOR TESTING STRAIGHTEDGES

We can learn something from nearly everybody, and as this kink was shown me by a good gage-maker I will pass it along for others. In making a gage where it is necessary to file the edges of two parts to fit perfectly straight, or to make one surface straight with a master straightedge, it is necessary to hold them up to the light to see whether they are accurate or not. It is difficult to hold them exactly parallel if one holds them free at arm's length. If held as shown, that is, with the two metal pieces flat against a piece of heavy plate glass with the edges to be tested together, they can be held perfectly parallel, and any light that may show between the two edges will be plainly seen through the glass.

A piece of plate glass about 3 inches by 4½ inches is a handy size. It should be cut as smoothly as possible, then the edges should be smoothed and rounded a little. It will fit snugly into some little nook in the tool-chest and prove a valuable acquisition.

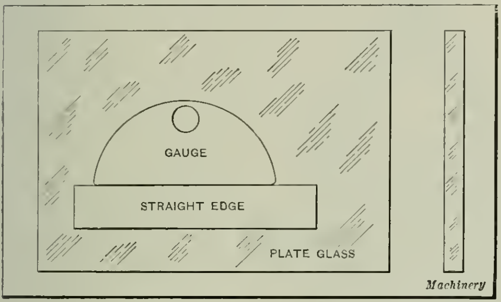


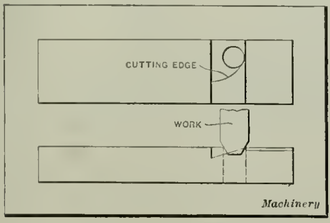
Plate Glass for holding Parts Parallel when testing their Edges

Hartford, Conn. S. Victor Brook

MILLING CUTTER FOR REDUCING THE DIAMETER OF SMALL STOCK

The other day I was given the job of reducing the diameter at one end of a number of pieces of ¼-inch round cold-rolled steel to ⅛ inch. For this purpose, I made a special cutter of the form shown in the illustration. This cutter was held in the toolpost of the lathe while the work was held in a collet chuck. By feeding the cutter over the end of the bar, the diameter was reduced to the required size, a very satisfactory rate of production and finish on the work being secured in this way. The hole in the cutter was drilled 0.005 inch over size to leave the necessary amount of metal for polishing the small end of the bars. The tool was made of tool steel and hardened in the usual way. It will be seen that there is a spiral cutting edge provided by machining an angular slot in the side of the tool which is fed up to the work. No further description should be required to make the design and operation of this tool quite clear to any mechanic. By way of conclusion, it may be well to call attention to the fact that the ends of the bars are slightly beveled as shown in the illustration, to enable them to enter the hole in the tool readily.

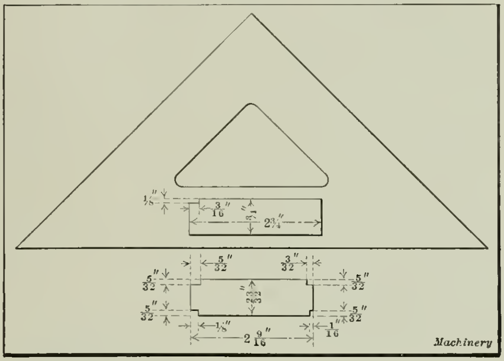
B. E.



Front and Side Views of Milling Cutter

METHOD OF DRAWING SECTION LINES

The following describes a method by which draftsmen can draw section lines without the use of dividers or a scale and still have the lines equally spaced and of a neat appearance. By this method either of four different spaces may be made between the lines according to the requirements of different drawings. Referring to the illustration, it will be seen that an ordinary 45-degree triangle has a rectangular hole cut in it, with a small rectangle of the celluloid left in the upper left-hand corner. A block of wood or fiber is then cut to the form shown, care being taken to have the dimensions of the hole in the triangle, and the block which fits into this hole, of exactly the specified dimensions, so that the block will slide freely in the hole. By placing the proper corner of the block adjacent to the corner of the hole in which the small rectangle is left, a space of either 1/16, 3/32, 1/8 or 5/32 inch may be made between the section lines. Operating the loose block with the left hand and the pen and triangle with the right hand, this device will be found not only a time-saver but the means of greatly improving the appearance of cross-sections, with a little practice.



Triangle provided with Device for drawing Evenly Spaced Section Lines

Brooklyn, N. Y. Harry A. Schreiber

VALVE GRINDING COMPOUND

The following will be found an excellent compound for grinding in valves of the form used on gasoline engines, etc. In doing this work great care must be taken to prevent particles of emery from being carried into the valve passages by the oil. If this occurs it will be found very difficult to remove the particles of emery, so that there is considerable danger of their being drawn on into the engine when it is once more placed in operation. A satisfactory substitute for oil and emery can be made by taking a cake of yellow laundry soap and mixing it with ½ pound of white lead. These constituents are mixed to a thick paste and then equal parts of Nos. 80 and 100 carborundum are added until the required consistency is obtained. This compound should be used in the form of a thick paste, and in place of oil a drop or two of water is applied to the seat of the valve when grinding. The consistency of this compound is such that there is no tendency for it to run—as in the case of oil—and as a result the particles of abrasive remain on the valve seat being ground.

Charles City, Iowa G. U. Kaiser

A TOOLMAKING KINK

Experience has shown that the end of a bar of steel that has been broken off should never be used for the working or cutting end of a die or punch. The fibers in the end of such a bar have been so severely strained in breaking that the steel is unsuitable for performing the work done by a punch or die. The broken end should be made the shank of the punch, while the end of the bar that was cut off should be used for the cutting end of the tool.

Waterbury, Conn. Charles Doescher

SOUTH AMERICAN TRADE CONDITIONS

BY R. G. BETTS*

Those "South American opportunities," born of the war in Europe, are not all that they seemed. Although it appeared logical that the time was ripe for United States manufacturers to capture the trade of the warring nations, the glowing reports to that effect should be somewhat modified by advices from South American importers themselves.

They indicate that the South American countries were so hard hit by the war that "trade is paralyzed," to use the language of an Argentine firm, the financial distress being acute almost to the breaking point, while even were conditions more favorable, the handicaps under which the U. S. A. has so long operated—lack of ships and of facilities for exchange and extended credit—are still of such potent influence that they must be reckoned with if the United States is ever to become a truly serious competitor for trade in the Southern countries.

Pratt & Co., of Buenos Aires and Carlisle Crocker & Co., of Montevideo, both old and reputable firms who have handled many lines of goods "made in U. S. A.," join in sounding this warning to manufacturers and in making clear the conditions that exist. The former writes:

> The immediate idea of many people on the breaking out of the European war was that business between the South American countries and the States would naturally jump into great importance, and there are undoubtedly large and varied lines of staples that must be provided for through the United States which formerly were received from Europe. This undoubtedly is true whether the conditions here improve or grow worse. There are also special lines which have been established here and on which a fair demand has been created where the importer finds it expedient to continue to supply that certain demand through the United States, provided he is able to do so.
>
> In regard to any special increase in trade between the Argentine, for instance, and the United States, we must consider for the moment conditions here and financial conditions in general throughout the world. We were in a financial crisis of some months duration when the war broke out. The immediate effect was to render conditions worse instead of better—the crisis has become more acute because people are discovering that the business of the world is done on credit, and when European credit is retired from this country, practically all the foreign credit they had was retired.
>
> When credits are retired, money counts, and people who were considered wealthy and beyond the reach of want found themselves suddenly in a market without easy money circulating and no cash value for anything that they owned. People cannot buy who cannot pay and even if some people are willing to give orders it is a bad time to take them at the New York end. We are speaking of general conditions only.
>
> Trade never was so paralyzed in the history of the country as it is at this moment. We hope that it will get better after the wheat crops, which should be settled within the next two or three months.
>
> Up to the present, the exchange proposition between Buenos Aires and New York and London has been against doing business, for a time at least. New York banks would not discount anything on Buenos Aires and would not even take drafts for collection. The Buenos Aires banks could not send them the money when collected and New York had to take drafts on London, which in many cases the New York banks would not cash. Our government conversion house has remained closed since the beginning of this war; therefore, although the legal rate between paper money and gold has remained fixed, the banks do not recognize this rate in fixing the rates of exchange, which is an abnormal condition, and this contributes to the confusion, inasmuch as we buy in gold and we sell here in paper money.
>
> The hard times here, together with the overstocks and the necessity of raising the money to meet unexpected calls on account of the retiring of credit, have forced liquidations and auctions and cut prices on every hand, and prices in many cases are far below cost.
>
> These conditions will probably last until this liquidation is to a great extent effected and until times improve. We have had several inquiries from the United States regarding the opportunity at present for pushing American business and we have advised the inquirers to postpone any action.

It goes almost without saying that the conditions which make for such far-reaching commercial distress in the great Republics of Brazil and Argentine are felt keenly in the smaller countries, Uruguay, for example. How keenly is vividly portrayed by Carlisle Crocker & Co., of Montevideo, who in emphasizing that no present opportunity exists for increased trade with the United States, point out specifically the causes that have handicapped it in times of prosperity, and that, unless Uncle Sam changes some of his ways and means, will continue to handicap it forevermore. The Uruguay importers say:

> However bad the situation is here, it is not nearly as serious as the one in the Argentine Republic and Brazil, where enormous failures are reported every day. Our market here has always maintained a reputation for conservatism and solidity, of which it is giving ample proof at the present time.
>
> Beginning at the time of the Balkan war the country experienced a tremendous slump in business in general. Apparently there was a great scarcity of money. Collections became more and more difficult, the banks called in the overdrafts they had conceded to their customers, and the merchants naturally followed their lead, and restricted their credits. With the result that in a little while business came to a standstill.
>
> An absolute paralyzation is felt since the outbreak of the European war. As an illustration: During August only two automobiles were sold in this city—both Fords. This was August 7. Since then, not a single automobile has been sold in the country. Most dealers have stock left over from last summer, when business was not nearly as good as the summer previous. The dealers in Benz autos have failed, the Renault people have moved to smaller premises, the Delhaye ditto, the Delauney-Belville ditto. We also have given up our large salesroom and moved to our general depot and others have done the same, the list being longer than we care to mention in these lines.
>
> To give you another illustration of the conditions of business in general, our own general sales have dropped more than 50 per cent, and we know for a fact that other business houses on our street (where all the big houses are established) are only selling from 20 per cent to 25 per cent of their customary monthly amounts.
>
> To add to this, it is nearly impossible to buy exchange either on New York or London. There being no direct banking facilities between this market and New York, we are dependent on London banks for exchange, with the corresponding results at the present moment. We have had great difficulty in this regard, and to meet our obligations have had to use all our influence, not only in commercial, but also in official circles. We are paying something like 8 per cent more for exchange than in normal times.
>
> As you know, freights have gone up from 25 per cent to 50 per cent, and there is an additional tax for war risk, amounting to from 2 per cent to 4 per cent.
>
> Our importations from England have not suffered as great changes as those from the United States, which clearly shows that commercially, the United States is tributary to Great Britain. Conditions make freights from England higher, and as a result they raise the freights from the United States. This prevents your country from reaping the benefits of ruling conditions in Europe. You have no banks, and depend on London, with the result that the charge for exchange prevents your gaining any advantage by being at peace while England is at war. Your merchants think this is a fine time to make a larger profit on their goods, so that we can buy just as cheaply in England as we can in the United States and even cheaper. How, then, are American exporters going to capture the market, and start a current of business in their direction, and take it away from England?
>
> It is true that German exportations are at a standstill, but at the present moment everyone is overstocked and does not have to buy fresh stock. It has been the German policy here for a long time to push their sales, to increase their output, giving any terms for payment, as long as this could be accomplished.
>
> Until financial conditions improve here, direct banking facilities are established, the United States gets its own merchant marine, and the exporters learn to open reasonable credits and do business direct, displacing the commission houses (who only thrive because we do not get the full discounts obtainable on the goods we buy) America will not capture the South American market.
>
> Our opinion is that all the talk and enthusiasm being worked up at present in this regard is hot air, and that it will be necessary to dig very deep in order to build the foundations of a trade in South America equal to that of England, Germany or France.

[The opportunities for future trade in South America are attractive, but it is best for our manufacturers to labor under no delusions as to immediate prospects. These extracts from letters present a discouraging situation, but no American manufacturer who has determined to capture some part of the South American trade should let them upset his plans. He must lay them for the future rather than for the present, and the preparation may take years before satisfactory results are achieved.—EDITOR.]

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* Address: 408 West 146th St., New York City

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

GLEASON 30-FOOT HERRINGBONE AND SPUR GEAR PLANER

This machine is adapted for cutting both herringbone and spur gears. A taper attachment is provided for use in planing herringbone gears. As the tool-slide moves forward, this taper attachment actuates a mechanism which rolls the gear blank to obtain the required relation between the work and the tool, as the tool moves forward. The indexing is effected by a positive mechanism which is driven and locked by power. The indexing motion is accelerated at the start and retarded toward the end in order to avoid shock. The capacity is for gears ranging from 15 inches to 30 feet in diameter. Herringbone gears from 6 to 48 inches face width, and spur gears from 3 to 36 inches face width, can be cut. The pitch is unlimited.

The Gleason Works, Rochester, N. Y., have recently completed a herringbone and spur gear planer for the R. D. Nuttall Co., which is particularly noteworthy on account of the wide range of gears that can be cut. This machine is of the single tool planer type and is adapted for either planing teeth from solid metal or for finishing cored teeth. The teeth are formed by templets which are of the same type for both spur and herringbone gears. Cutting speeds ranging from 15 to 60 feet per minute are available. The weight of the machine is 92,000 pounds, and it will be mounted on a concrete foundation provided with a pit to receive the under side of large diameter gear blanks while the teeth are being cut.

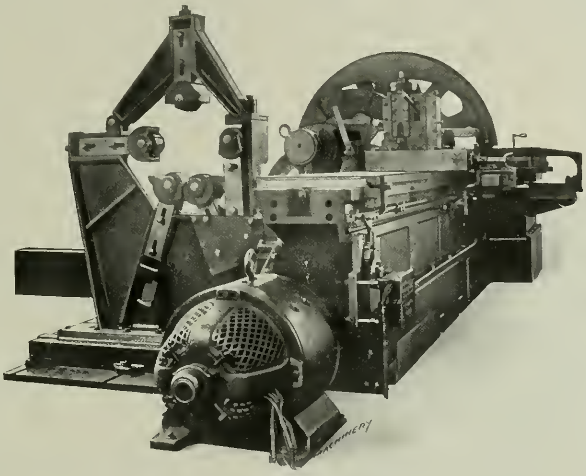


Fig. 1. End View of Gleason 30-foot Herringbone and Spur Gear Planer, showing Tool-slide, Master Switch and Tripping Device, Taper Attachment and Driving Motor

The Drive

The machine is driven by a 20-horsepower Westinghouse reversing type direct-connected motor, from which the power is transmitted through an oil-tight gear-case in which all of the gears and bearings are amply lubricated. This case is located inside the frame but can be readily removed for making repairs or adjustments. The last gear of the train meshes with a rack attached to the under side of the tool-slide in the same manner as on a regular planer. The tool-slide is 9 feet, 6 inches long and the toolpost can be moved to various positions on the slide. This is for the purpose of providing means for planing rolling mill pinions which are usually cut from forgings in which the pinion is an integral part of the shaft. This brings the pinion blank some distance from the faceplate, and it is necessary to adjust the tool along the tool-slide in order to bring it into the desired position for planing the teeth. The maximum adjustment of the tool along the slide enables the tool to be set 126 inches back from the faceplate. For planing the teeth of pinions of this construction, a large roller steadyrest is provided for supporting the outer end of the work; this steadyrest is clearly shown in Figs. 1 and 2, and a good idea of the arrangement of the tool-slide will be obtained by referring to Fig. 1.

The Toolpost, Tool-feed and Reversing Mechanism

The toolpost is of the clapper box type, and is so designed that it may be swiveled for various spiral angles. It is mounted on a cross-slide which is adjustable on the tool-slide, as previously mentioned. The design is such that it is possible to finish all herringbone gears without requiring the blank to be reversed on the arbor. The tool is fed by means of a screw and ratchet which are actuated by adjustable dogs located on the side of the frame. The electrical apparatus for the reversing mechanism was furnished by the Westinghouse Electric & Mfg. Co. The master switch and the mechanical tripping device for regulating the length of the

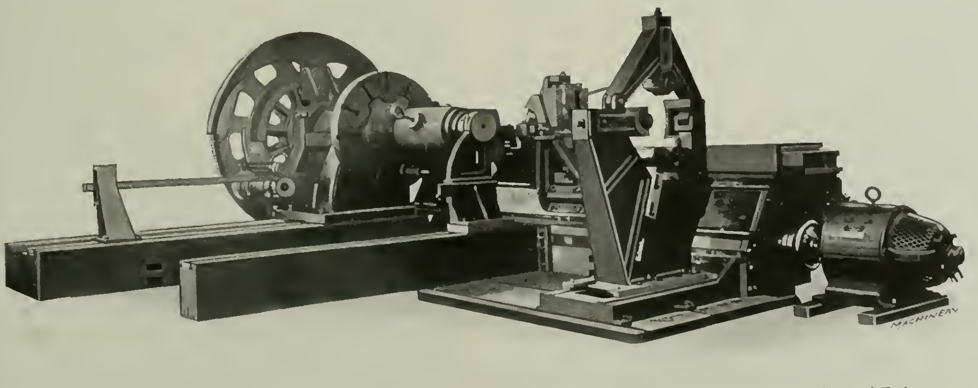


Fig. 2. General View of Gleason 30-foot Herringbone and Spur Gear Planer, showing Work-head, Means of setting for Gears of Various Diameters and Outboard Support for Pinion Shafts

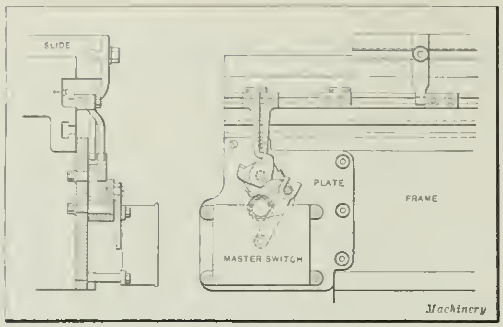


Fig. 3. Arrangement of Master Switch and Tripping Device for regulating Length of Stroke

stroke and reversing the direction of travel are bolted to a plate fastened to the end of the frame. There is also a pendant switch by which the slide can be inched along.

Rolling the Gear Blank

In planing herringbone gears it is necessary to roll the gear blank, in order to bring the work into the proper position to plane the teeth on the required helix angle as the tool moves forward in a straight horizontal line. This is accomplished by means of a taper attachment which is set to the required angle and works in conjunction with the tool-slide to actuate the mechanism which rolls the gear blank. The rolling of the blank may be done in either of two ways. On gears up to approximately 12 feet in diameter, the blank is rolled in the following manner: A rigid bar which is adjustable in its bracket on the tool-slide forms the connection between the tool-slide and the taper attachment. The adjustment is necessary in order to allow for setting the tool and the taper attachment in the proper relation to each other. The taper attachment, which is shown in Fig. 4, may be set to any angle up to 30 degrees either way from the center. Figs. 5 and 6 show the arrangement of the mechanism which provides for rolling the gear blank in cutting herringbone gears.

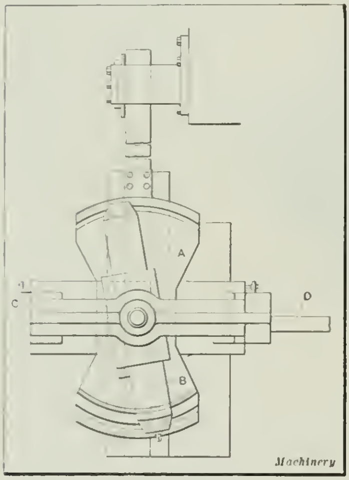


Fig. 4. Taper Attachment for rolling Herringbone Gears

Obviously, the first step is to set the taper attachment to the required angle and make other necessary adjustments. As the tool-slide moves forward, the shoe *A* which runs over the slide *B* is given a transverse movement by the forward movement of the bar which connects the tool-slide with the taper attachment. This transverse movement of the shoe is, of course, due to the angular setting of the slide *B* of the taper attachment. It will be seen that the shoe *A* is connected to yoke *C*, and the transverse motion which is transmitted to this yoke by the shoe is, in turn, passed on to the rack *D*. The transverse motion of the rack *D* results in turning a pinion that is integral with a shaft, the other end of which carries a second pinion which meshes into a 72-inch gear segment *E*. This segment is part of a fan tail which carries the index bracket. By means of the index wheel and worm, this bracket is connected with the spindle on which the gear is carried; and by the proper setting of the taper attachment, each stroke of the tool-slide rolls the gear blank accurately in time with the tool without requiring any change of gearing. Reference to the illustrations will make the arrangement of the mechanism for rolling the gear blank quite clear.

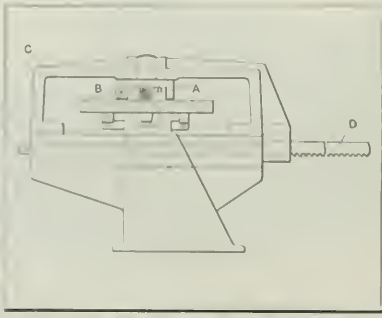


Fig. 5. Connection between Taper Attachment and Rack D

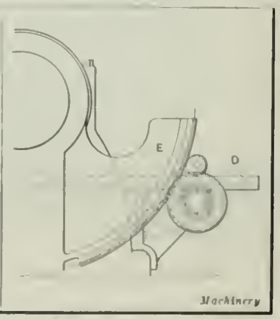


Fig. 6. Gearing connecting Rack D to Gear Segment E

In cutting gears over 12 feet in diameter, the method is the same except that instead of driving into the fan-tail segment *E*, a separate bracket is furnished which carries a pinion meshing directly with a 12-foot segment on the faceplate. This arrangement is found to give better control in cutting gears of large diameter. The pinion meshing into the 72-inch segment is removable, so that the head can be moved on the frame for gears of various diameters, without operating the rolling mechanism.

The Indexing Mechanism

The indexing is accomplished by a positive mechanism which is driven and automatically locked by power. A ¾-horsepower motor is provided for this purpose which is geared to give eight seconds per index. In order to avoid shock, the indexing is accelerated at the beginning and retarded at the end of the motion. Figs. 7 and 8 show detailed views of the indexing mechanism and the mechanism for accelerating and retarding the indexing motion. These illustrations will be better understood by referring to them in connection with Fig. 9, which shows the general arrangement of the indexing mechanism. The motor is mounted on top of the index bracket, this bracket being located below and in front of the index wheel. The motor is not shown in the detailed view of the indexing mechanism, Fig. 7, but it drives through a train of gears to a pinion meshing with the gear *G*, to which the ratchet *F* is fastened. This part of the mechanism runs continuously. The index is tripped by hand, the method of operation being as follows: By raising the lever *A*, the trip *B* is lifted, thus causing the latch *C* which is keyed to it to be thrown down. The depression of the latch *C* releases the pawl *E* which is mounted on the stop-plate *D*; when the pawl is released in this way, the action of a coiled spring causes it to engage the ratchet *F*, thus locking together the gear *G* and the stop-plate *D* which is keyed to the shaft *O*.

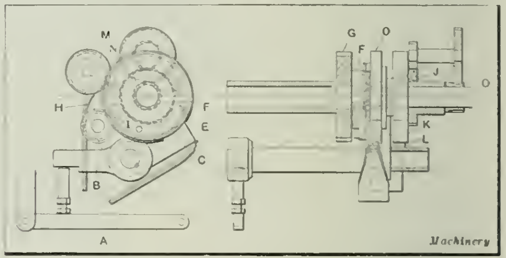


Fig. 7. Arrangement of Indexing Gears and Locking Device

On the end of the shaft *O* there is a set of timing gears *J* which give a four to one reduction on the secondary stop-plate *K*. This plate *K* has a flat spot on its periphery, and the rider *L* which is a part of the latch *C* lies on this flat when the mechanism is not in action. When the latch *C* is tripped as previously described, the stop-plate *K* is put in motion with the result that the rider *L* and latch *C* of which it is an integral part are held out by the running of the rider over the circumference of the plate *K*. After the plate *K* has made one complete revolution—corresponding to four revolutions of the gear *G*—the rider *L* again falls into the flat on the plate *K*, thus allowing the latch *C* to engage the pawl *E* and disengage the pawl from the ratchet *F*. As a result of this disengagement of the ratchet, that part of the mechanism beyond the gear *G* comes to rest. As there must be a slight time interval between the release of the pawl *E* and the locking of the latch *C*—due to the retarding of the index motion toward the end—the plate *F* does not immediately come up snug against the latch *C*. To effect this, the plate *F* is driven by means of the cam *M* striking the dog *N*. When the dog *N* is in its proper position, the cam *M* can rotate freely, being geared in time with the dog directly from the gear *G*.

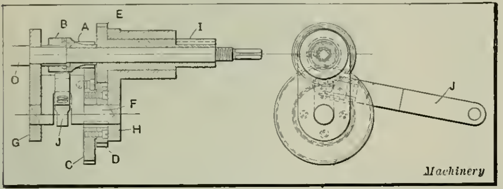


Fig. 8. Arrangement of Variable Speed Gearing for accelerating and retarding Indexing Motion

Accelerating and Retarding Index Motion

For the design of this mechanism, acknowledgment is made to the Bullard Machine Tool Co., Bridgeport, Conn. This accelerating and retarding mechanism may be considered part of the index mechanism, its purpose being to overcome the shock of starting and stopping the moving parts. Referring to Fig. 8, the method of operation is as follows: The shaft *O* is a continuation of that shaft in Fig. 7, and runs at a constant speed while the indexing operation is taking place. At other times the shaft *O* is at rest. The pinion *A* is locked to the shaft *O* by a clutch *B* which is employed for the purpose of setting the indexing mechanism in the proper relation to the accelerating and retarding device. It will be seen that the pinion *A* drives gear *C* to which the gear *D* is securely fastened. The gear *D* meshes with gear *E*, the gears *D* and *E* being of the same diameter, while a four to one reduction is obtained between pinion *A* and gear *C*, thus keeping them in step with the timing gears of the index mechanism. The gears *C* and *D* are keyed to the crankshaft *F*, the fulcrum of which is located on the pitch line of the gear *D*. This crank is carried in brackets *H* and *G* which are free to swing about the shaft *O*.

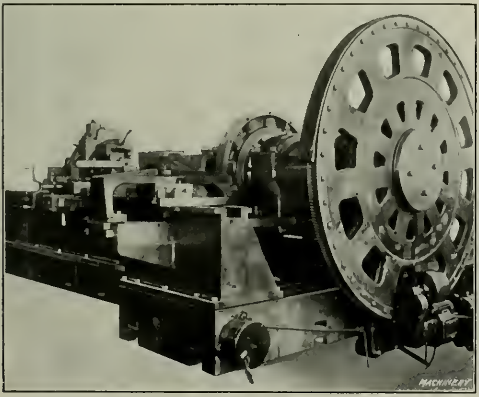
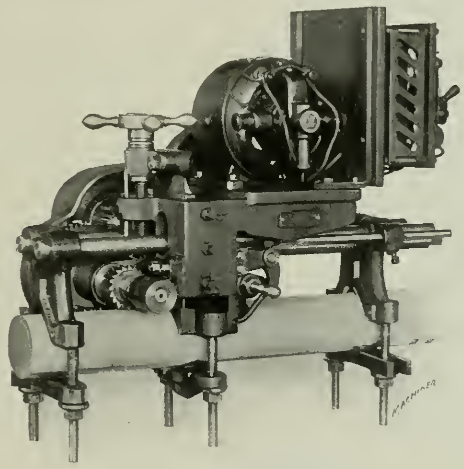


Fig. 9. End View of Machine showing Indexing Mechanism and Index Wheel

The connecting-rod *J* is secured to the crank, the opposite end of this rod being secured to a fixed center. As the pinion *A* rotates at a constant speed, it causes the gears *C* and *D*, and consequently the brackets *G* and *H*, to swing up due to the end of the connecting-rod *J* being fixed. The result is that the gear *D* is rolled around the gear *E* at a variable speed, due to the crank motion; and as a result the motion of the gear *E* is first accelerated and then retarded. It will be seen that the bearing of the gear *E* is extended, and at *I* the first of a train of change gears is mounted, which transmit the drive to the worm that meshes with the 92-inch index worm-wheel. By means of this variable speed motion, the indexing is accelerated at the beginning and retarded at the end of the motion, so that shock and vibration are entirely overcome.

BURR PORTABLE SHAFT KEYSEATER

The value of a portable shaft keyseater for use in any plant where there is a considerable amount of transmission equipment will be readily apparent, as a tool of this kind greatly simplifies the performance of repair, alteration and erection work. With one of these tools it is possible to cut keyseats in the shafting without requiring it to be taken down, and as a result a saving is effected both in the cost of doing the actual work and the avoidance of shutting down the machinery for an extended period. For some years John T. Burr & Son, 429 Kent Ave., Brooklyn, N. Y., have been making a portable keyseating machine for handling the class of work referred to. The accompanying illustration shows a recent development of this company's which, it will be seen, consists of a motor-driven portable keyseating machine. The application of the electric drive adds materially to the efficiency with which the tool operates, and the design and construction have also been materially improved to meet the requirements of the most modern tools and working conditions.



Burr Motor-driven Portable Shaft Keyseater

This machine is known as the No. 11 Burr portable shaft keyseater, and has a capacity for milling keyseats in the ends or middle of shafting up to 5 inches in diameter. Reference to the illustration will make it evident that the machine can be easily attached to the shafting without requiring it to be taken down for milling the keyseat. However, the machine is equally useful for performing keyseating operations on new shafting or spindles before erection. Keyseats up to 12 inches in length can be cut without requiring the machine to be reset. The machine is provided with an automatic feed and automatic release which disengages the feed at any predetermined point. To trip the feed, the steel worm is dropped out of mesh with the worm-wheel; and the feed is reengaged by simply lifting the handle at the end of the worm spindle. In resetting the machine after a cut has been completed, the feed is tripped and the feed-screw turned by hand. The feed nut is made of bronze and may be replaced from stock.

The two clamp-heads are firmly fastened to the shaft which is being keyseated, by means of bolts and cross-bars. The rear clamp carries the feed nut, and the cutter-head is fed along the shaft as the cut progresses, its roller binder being tightened just enough to take up the vibration. It will be seen that the cutter arbor is provided with an outboard bearing and the cutter is set central by means of an expansion collar placed between the main arbor collar and the cutter. The regular equipment of the machine includes a set of milling cutters which can be used singly or in combination to provide for cutting keyseats ranging from 1/4 to 1 1/4 inch in width, and varying by 1/16 inch intervals. The cutter-slide is provided with an adjustable gage showing the depth to which the keyseat is being milled. It will be seen that the motor is mounted on a platform, bolted to the cutter-slide and drives through a train of gears, the first pinion being of rawhide. Motors may be furnished to run on almost any standard direct or alternating current. The motor is connected to the electric circuit by means of a flexible cord and plug. The net weight of the machine is 175 pounds.

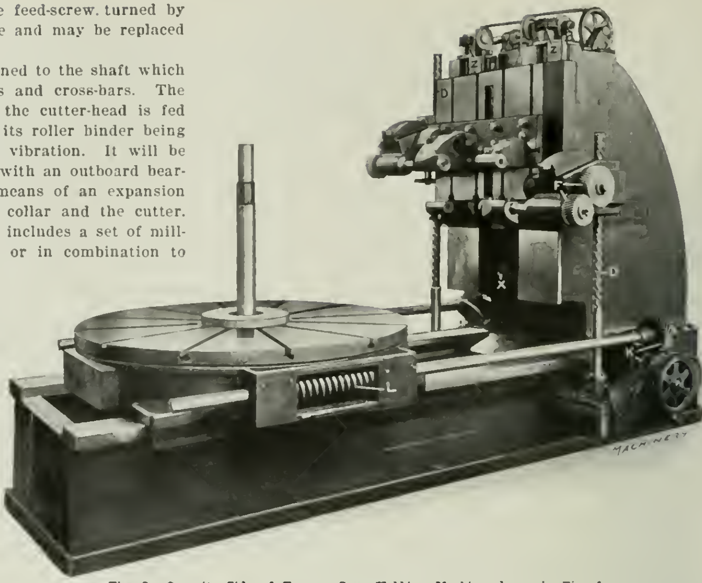


Fig. 2. Opposite Side of Fawcus Gear Hobbing Machine shown in Fig. 1

FAWCUS HERRINGBONE GEAR HOBBING MACHINE

The most important feature of this machine is the fact that it is provided with two hobs which work simultaneously to generate the two sides of each herringbone tooth. The two hobs are driven by a differential speed mechanism which increases the speed of one hob and decreases that of the other, so that the two hobs generate the two sides of the teeth at the required helix angles. The index worm-wheel is driven by two worms, one of which engages each side of the wheel, providing a very smooth drive and means of taking up lost motion.

The theoretical advantages of herringbone gears are generally conceded, but until recent years the wide application of this system of gearing was prevented by the practical difficulties which were encountered in cutting the double helical teeth. Where it has been attempted to use a single gear hobbing machine for the purpose, the method has been to make the gear in halves, each of which has a set of single helical teeth generated on it; and these two parts are then bolted together to form the herringbone gear. The objectionable feature of this method of procedure is that it is a difficult matter to produce a herringbone gear in this way which has the two sets of helical teeth in proper alignment; and where the two halves of the gear are not bearing together exactly as they should, it will be evident that the advantages of the herringbone gear are largely missing. The same difficulty is encountered when it is attempted to use a single hobbing machine to generate two sets of helical teeth in a solid blank in two operations.

The practical advantages accruing from the use of herringbone gears are quite generally known, but it may not be out of place to refer very briefly to them. The double helical teeth in this type of gear practically eliminate shock and vibration. These features mean that the efficiency is very high and noise is reduced to a minimum; and for these reasons herringbone gears have found wide application. With the introduction of practical methods of cutting gears of this type and the resulting stimulus which has been given to their application, the desirable features of herringbone gears have become more widely known, and as a result they are replacing other types of gears on many classes of machines.

Purpose of the Fawcus Herringbone Gear Hobbing Machine

With the view of taking advantage of the features of the hobbing machines for cutting herringbone gears, and at the same time to overcome the difficulty experienced in cutting gears of this type on the ordinary hobbing machine, the Fawcus Machine Co., Pittsburg, Pa., has recently perfected a duplex machine which is equipped with two hobs that work simultaneously, each hob generating one of the sets of helical teeth of the gear. The machine has a capacity for cutting gears ranging from 6 inches to 15 feet in diameter. The feature of greatest mechanical novelty is the differential speed mechanism by which the two hobs are driven, to provide for cutting the teeth with helix angles of opposite inclination. The face of the gear blank is turned with a groove at the center, the width of which is about equal to the circular

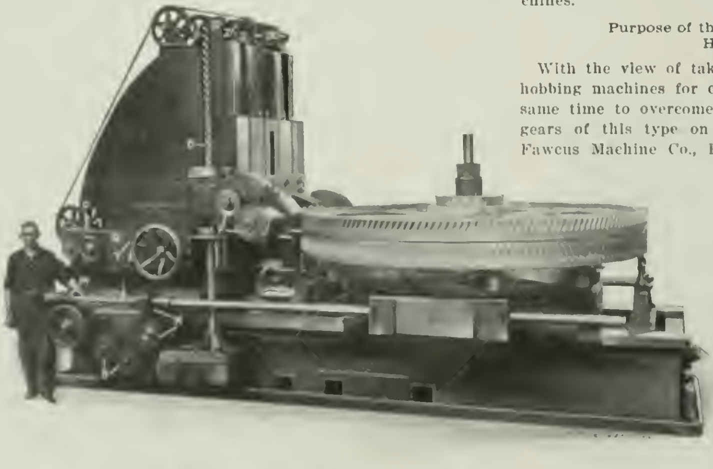


Fig. 1. Fawcus Double Herringbone Gear Hobbing Machine

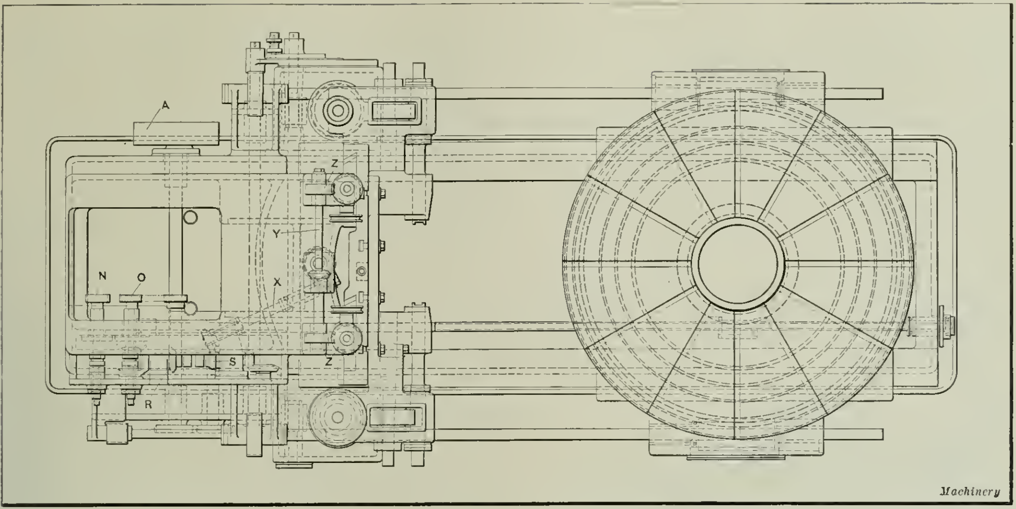


Fig. 3. Plan View of Fawcus Double Gear Hobbing Machine

pitch of the gear which is to be cut. One hob starts work at the top of the blank and works down to the groove, while the second hob starts at the groove and works down to the bottom of the blank. In order to obtain the required helix angles, the speed of the upper hob is retarded, while the speed of the lower hob is increased, the differentiation of the speed being such that the required helix angles are obtained. A detailed description of the entire mechanism of the machine will be given in subsequent paragraphs, and in this connection the differential speed mechanism for driving the hobs will be fully described.

In operating the machine, the first step is to set the hobs, after which the work is brought into contact with them and the horizontal feed engaged to feed the work up to the hobs until they have cut into the gear blank to the required depth. When this result has been obtained, the horizontal feed is disengaged and the vertical feed engaged to feed the hobs down over the face of the gear blank. The mechanism provided in the machine must serve five fundamental purposes: first, means must be provided for driving the hobs; second, for securing the differential speed between the two hobs; third, for rotating the work; fourth, for the horizontal feed of the work; and fifth, for the vertical power feed for feeding the hobs across the face of the gear blank. The mechanism by which these results are obtained, together with the means for securing the various adjustments necessary, are described in the following.

The Differential Speed Mechanism for Driving the Hobs

Referring to Figs. 3 and 4 which show a plan and side elevation of the mechanism, power to drive the machine is applied at *A*, which may be either a gear or pulley according to whether the machine is arranged for individual motor drive or belt drive from the countershaft. The shaft on which the driving gear or pulley is mounted is carried through to the

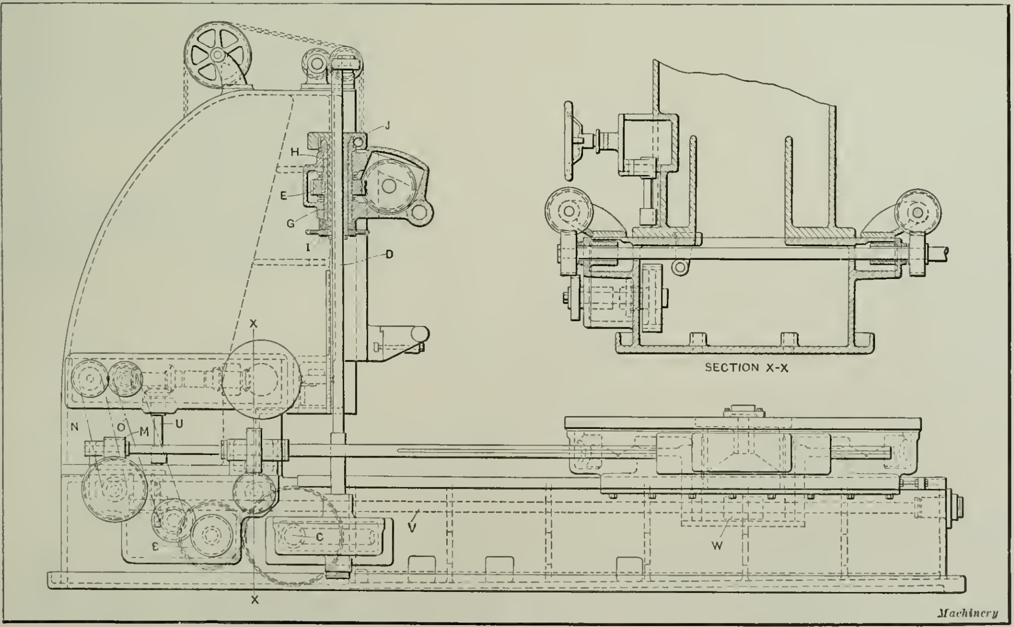


Fig. 4. Side Elevation and Partial Cross-sectional View on Line X-X

opposite side of the machine, and has the first of a pair of gears *B* mounted on it. Variations of speed are obtained by employing different change gears at *B*. The shaft on which the second gear *B* is mounted extends back inside the bed of the machine and transmits power through a pair of double helical gears to the shaft *C*. From this shaft the power is transmitted through a worm and worm-wheel to the spiral splined shaft *D*. The shaft *C* extends through to the opposite side of the machine where there are a second worm and worm-wheel for driving a similar spiral shaft *D* on that side of the machine. These two spiral shafts serve the double purpose of driving the hobs and providing the differential speed effect which is required to secure the necessary helix angles. Referring to Fig. 2, it will be seen that these spiral shafts are of the same hand, but they are driven in opposite directions. Each shaft runs through a gear-box in which there is a spiral gear *E* which is splined onto the shaft *D*. From the gear meshing with the gear *E*, the motion is transmitted through a second pair of spiral gears shown at *F* in Figs. 1 and 2, to the shafts on which the hobs are carried. The head in which the hobs are carried, is integral with the gear-boxes in which the spiral gears *E* are contained; and when the vertical power feed is brought into action, each gear-box is fed down with the head. The result is that the speed of one hob is accelerated, its final speed being the number of revolutions per minute obtained through the gearing plus the part of a revolution per minute secured through the vertical movement of the gear *E* on the spiral shaft *D*. The gear-box at the opposite side of the machine is fed down in a similar manner, but the spiral shaft at this side of the machine is rotating in the opposite direction. As a result, the ultimate speed of the other hob is the number of revolutions per minute obtained by the vertical movement of the gear on the spiral shaft. The differential speed obtained in this way from the two spiral shafts is regulated to obtain the required helix angle for the gear that is being hobbed.

Method of Setting Up and Adjusting the Hobs

In setting up the machine ready for working on a given operation, the two hobs must be set in the proper relation to each other, and means for securing this result are provided in the gear-box on the splined shaft at the left-hand side of the machine, shown in Fig. 1. In setting, the position of the hob at the right-hand side of the machine is arbitrarily fixed because no means of adjustment is provided at that side. After the right-hand hob has been mounted on its arbor, the left-hand hob is set up and it is then necessary to adjust the position of this hob. Referring to Fig. 4, it will be seen that the gear *E* is mounted on a sleeve *G* which, in turn, surrounds a sleeve *H* which is splined to the spiral shaft *D*. At the bottom of the gear-box there is a handwheel *I* which is threaded onto the lower end of the sleeve *H* to provide for locking the mechanism when the required adjustment of the hob has been made. At its upper end the sleeve *H* is extended to form an annular cap in which a worm *J* is mounted that meshes with a worm-wheel cut in the top of the bushing *G* on which the spiral gear *E* is mounted. In order to adjust the position of the hob, a wrench is placed on the squared end of the shaft *J*, by which means the worm and worm-wheel connecting the sleeves *G* and *H* are turned. The movement of sleeve *G* results in rotating the gear *E* which transmits the motion through the regular train of driving gears to the hob. When the hob has been adjusted in this way to bring it into the required position, the handwheel *I* is turned, thus locking the sleeves *G* and *H* together and holding the hob in its required position relative to the hob on the opposite side of the machine.

Means for Rotating the Work

It has already been mentioned that the shaft *C* runs through the bed of the machine and drives the splined shafts *D* at each side through worm-gearing. At the right-hand side of the machine, shown in Fig. 2, the shaft *C* is extended beyond the worm for the purpose of driving the first of a train of gears which transmits power to the spiral gears *K*. Different index change gears can be employed to transmit the motion to the spiral gears *K*. Referring to the illustration, it will be seen that the driven gear of the pair *K* is carried on the horizontal shaft which has a worm *L* splined to it at the forward end. This worm meshes with an index worm-wheel cut in the periphery of the work-table and provides for rotating the work. The shaft on which the driver of the spiral gear pair *K* is mounted extends through to the left-hand side of the machine, as shown in Fig. 1, where there is a second pair of spiral gears *K* which drive another horizontal shaft. This shaft has a second worm splined to it, which engages the work-table index worm-wheel at the opposite side. This double drive for the work-table is one of the advantages of the machine, as it eliminates torsional strains and vibration, and provides the maximum uniformity of motion.

Arrangement of the Feed Mechanism

The drive for the feed mechanism is taken from the horizontal table driving shaft shown in Fig. 1. Referring to this illustration, it will be seen that the shaft extends back from the spiral gears *K* and has a worm *M* mounted upon it. The shaft on which the worm-wheel meshing with the worm *M* is carried, extends through the machine and transmits motion to the feed-box through a sprocket chain *N*. The drive secured through the chain *N* is for the forward or cutting speed; and to provide for a quick return, a second sprocket chain drive *O* is carried up to the feed-box from the main driving shaft on which the first of the gears *B* is mounted. Change gears on the outside of the gear-box *Q* provide for varying the rate of feed. The lever shown at *P* in Fig. 1 operates an interlocking clutch mechanism which provides for engaging either the forward drive from the chain *N* or the quick return from the chain *O*, but makes it impossible for damage to be done to the machine by engaging both motions at the same time. The motion transmitted from the sprocket chain drive *N* or *O*—according to the position of the interlocking clutch—is transmitted through the gear-box shown at *Q* in Fig. 1, to a shaft on which the bevel gears *R* and *S* (Fig. 3) are mounted. Located between these gears there is a clutch which is operated by the lever shown at *T* in Fig. 1. By engaging the clutch with the gear *R*, the horizontal feed is engaged, while engaging the clutch with the gear *S* places the vertical feed in operation. It will be evident that this makes it impossible for both feed motions to be engaged simultaneously, and it will be remembered that in operating the machine, the horizontal feed is first engaged in order to move the gear blank over until the hobs have cut to the required depth, after which the horizontal feed is disengaged and the vertical feed engaged to feed the hobs across the face of the gear blank.

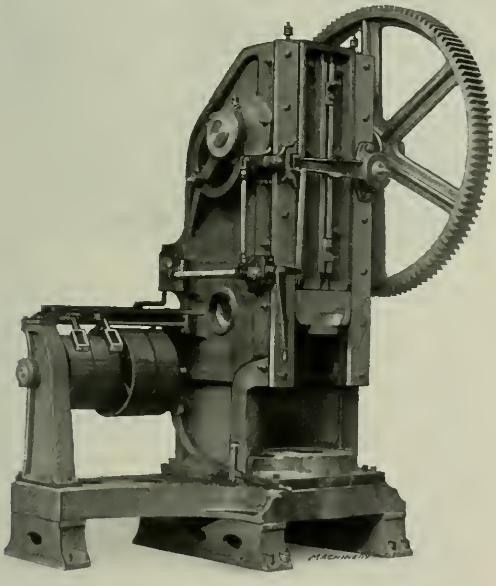
When the clutch is engaged with the gear *R* to operate the horizontal feed, the drive is carried down through the vertical shaft *U* to a worm and worm-wheel which transmits the motion to the horizontal shaft *V*, which is threaded into a nut *W* in the base of the work-table. In this way the horizontal feed of the work is obtained. When the clutch is engaged with the gear *S*, the drive is through the bevel gear pair to the shaft *X*, which transmits the motion through a worm and worm-wheel and pair of bevel gears to the horizontal shaft *Y*. Located at each end of this shaft there are a pair of spiral gears *Z*, which transmit motion to the screws that operate the vertical feed of the cutter-head. It was deemed advisable to use two screws for the vertical feed, owing to the great width of the head of the machine. The head is counterweighted as shown.

General Features of the Machine

A feature in the design of this machine, which is of considerable mechanical interest is that the two hobs rotate in opposite directions. Looking at the machine from the position shown in Fig. 1, the upper hob rotates in a clockwise direction, which is generally accepted as the proper method of rotation for a milling cutter when operating under these conditions. The lower hob rotates counterclockwise, and when the design of this machine was in its early stages, speculation was rife among the designers of the Fawcus Machine Co. as to the probable results obtained with a hob working under such conditions. Since the machine has been placed in operation, however, experience has shown that the work produced by the lower hob is exactly as satisfactory as that done by the upper hob. The features of the machine which tend to give exceptional accuracy are the fact that both halves of each herringbone tooth are hobbed simultaneously so that errors in spacing resulting from cutting the two halves of the tooth independently are overcome. The method of driving the table by means of two worms engaging the index wheel is also an important factor in increasing the accuracy of the work, because it provides for taking up lost motion and dividing any error which may exist in the spacing of the index wheel, the latter being a particularly important point. The rate of production secured with this machine is naturally in excess of any method whereby two separate operations are required to cut the two halves of the gear.

WATERBURY-FARREL LONG-STROKE DRAWING PRESS

To meet the demand for a long-stroke heavy drawing press of exceptionally large capacity, the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn., has developed a press of the rack and pinion type which is equipped with a shifting belt drive. This press has a capacity of 60,000 pounds working pressure, and is applicable for such operations as drawing long shells or brass of the form used in making field gun cartridge cases, thermos bottles, pneumatic tire pumps, plumbers' supplies and various similar products. The noteworthy features of the design are the high speed at which the machine operates, combined with convenience and ease of adjustment.



Waterbury-Farrel Long-stroke Drawing Press

The drive is provided by an arrangement of double belts, which eliminate danger of accidents from over-running the gate should the belts break. The stroke of the gate is adjustable according to requirements, and may be anywhere from 12 to 48 inches. This adjustment is obtained by dogs on the front of the gate, which automatically shift the belts at each end of the stroke by means of the well-known shifting belt principle employed on planer drives. By operating the lever at the left-hand side of the machine, the operator can reverse the travel of the gate or stop it.

High, intermediate or low speeds are obtained by change gearing. At the highest speed the gate has a drawing speed of approximately 20 feet per minute, and a return speed of approximately 25 feet per minute. At the slowest speed, the gate has a drawing speed of 10 feet per minute and a return speed of 12½ feet per minute. At the high speed, the machine will pull 20 tons, and at the intermediate or slow speed it will pull up to 30 tons. The principal dimensions of the press, other than those which have already been given, are as follows: Total height of machine with gate at its highest point, 14 feet, 2 inches; floor space occupied, 7 feet, 6 inches by 8 feet, 9 inches; and total weight of machine, 27,500 pounds.

HILLIARD FRICTION CLUTCH

The Hilliard Clutch & Machinery Co., Elmira, N. Y., has recently introduced a friction clutch which is particularly adapted for use on light punch presses. The operating mechanism of this clutch is similar to that of the standard 8-inch friction clutch made by this company, the chief distinction consisting of the application of a special bushing on the clutch which forms the subject of this article. The bushing, which is shown at the left-hand end in Fig. 2, is styled a "stationary floating bronze bushing"; it is made in two sections with a large reservoir between the two, which can be packed with grease to insure satisfactory lubrication of the bearing. The bushing itself is prevented from rotating by a projecting arm which extends from its outer end and is attached to some fixed support by means of a rod or wire. With this construction the power shaft may be in motion without having any frictional contact with the clutch pulley, the bushing separating the shaft and pulley in a way which makes it impossible for friction to set the clutch pulley in motion. Having the pulley running on a stationary bushing also enables it to stop more quickly, as frictional contact with the running shaft does not tend to keep the pulley rotating after the clutch has been released.

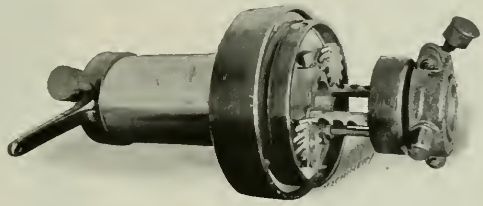


Fig. 1. Hilliard Friction Clutch for Light Power Presses

The mechanism for operating the clutch is the same as that of the standard Hilliard 8-inch clutch. However, it may not be out of place to present a brief description for the benefit of those readers who are not familiar with this mechanism. Referring to Fig. 2, it will be seen that the friction ring *A* is secured to the driven member *B* and that this ring is maintained at a fixed distance from the friction surface of the driving member *C*, this spacing being determined by the length of the hub *D*. The friction plate *E* is splined onto the hub *D*. The friction inserts *F* are pressed into the friction ring *A* but have sufficient freedom of travel through the ring *A* to come into contact with the friction face of the driving member *C* when thrown against this member

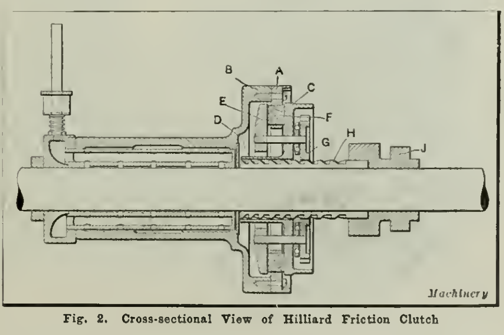


Fig. 2. Cross-sectional View of Hilliard Friction Clutch

by the friction plate *E*. The friction plate *E* is drawn forward to engage the friction inserts *F* with the driving member *C*, by means of worm-threaded studs which are screwed into the plate *E*. Spiral gears *G* are carried on the studs, these gears being turned by racks *H* which are carried by the sliding collar *J*, this collar being operated by the usual form of shifting yoke and lever. The operation of this mechanism gives a very smooth and gradual engagement, and as soon as the clutch has been sufficiently engaged to drive the load, the strain is carried entirely by the threaded studs, relieving the teeth of the spiral gears *G* and racks *H* from all strain.

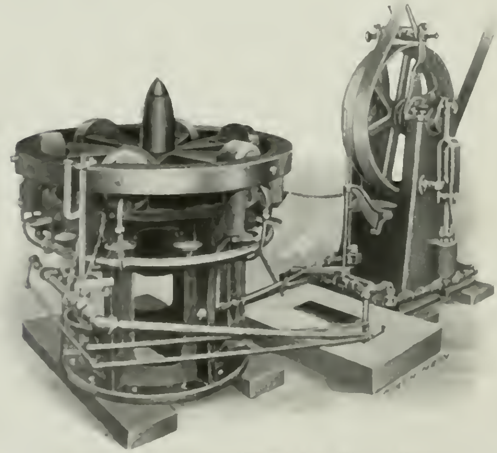
WEST SHELL BANDING MACHINE

The accompanying illustration shows a recent addition to the line of hydraulic compressing machines built by the West Tire Setter Co., 244-245 Cutler Building, Rochester, N. Y.

The present machine is for the purpose of compressing copper bands onto shrapnel shells and other forms of projectiles. The machine consists of a cast-iron base on which a rolled steel ring is mounted. This ring is a single piece made without a weld, and carries six hydraulic rams which are equally spaced around its periphery. These rams work on radial lines and carry dies or pressure blocks which extend in toward the center of the machine and apply the pressure to the bands which are to be compressed onto the shell.

Oil is used in the cylinders of the machine, this medium serving the double purpose of affording the required pressure and at the same time keeping the cylinders lubricated and preventing rusting of the working parts. The pressure is developed by means of a two-plunger belt-driven pump which takes the oil from a tank on the floor and delivers it into a central reservoir located in the base. From this reservoir the oil is distributed to the several rams through individual pipes leading to each ram. In this way a uniform pressure is obtained behind each ram. Under normal operating conditions, the machine has a capacity for compressing two or three bands per minute.

The West Tire Setter Co. is now building a tire setting machine for foreign shipment, which has a capacity for compressing steel tires up to 12 inches wide by 1¾ inch thick, with diameters ranging up to 6 feet. The metal is compressed cold. Machines of this type are also built for handling tires of larger diameters.



West Hydraulically Operated Shrapnel Shell Banding Machine

NILES-BEMENT-POND BORING MILL

A noteworthy feature of this machine is the introduction of a center boring head which is mounted on the rail between the two regular heads. The center head can be traversed to the right or left to allow either of the regular boring heads to be brought to the central position. The way in which the spindle of the middle head is driven will be apparent from Fig. 1. Boring mills of this type are made in 44-, 53-, 62- and 73-inch sizes.

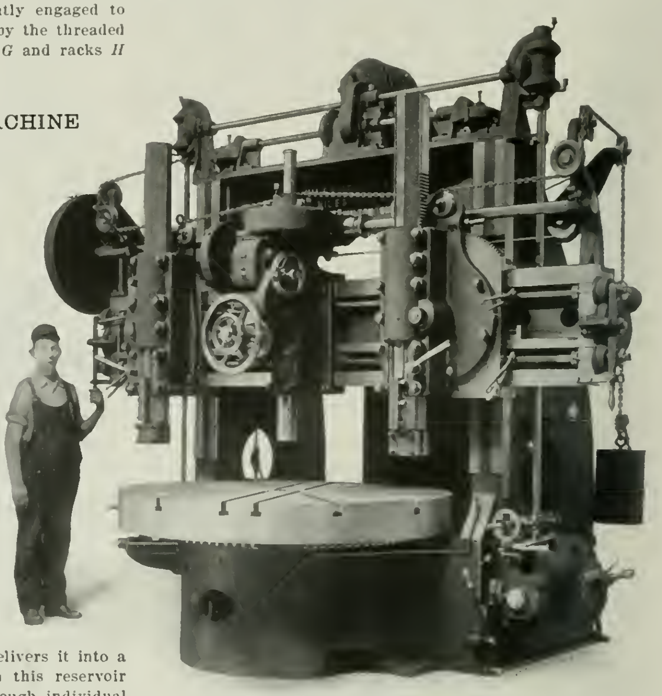


Fig. 1. Front View of Niles-Bement-Pond 73-inch Boring Mill equipped with a Center Head

The accompanying illustrations show front and rear views of a 73-inch Niles boring and turning mill equipped with a center boring head, which was recently built for the Troy Engine & Machine Co., Troy, Pa., by the Niles-Bement-Pond Co., 111 Broadway, New York City. It will be seen that the central boring head is mounted on the rail between the two regular heads, and the central head may be traversed along the rail by means of a rack and pinion. Sufficient adjustment is provided to enable the center boring head to be traversed to the left to enable the regular right-hand head to be brought to the center of the rail. Similarly, the central head may be traversed to the right and the regular left-hand head brought to the central position. The spindle of the center boring head is driven by a motor of three to one speed variation, mounted on the left-hand end of the cross-rail. Three positive feeds are provided, which are controlled by a pull-pin conveniently located on the head. The spindle has rapid traverse by means of a large handwheel. On the horizontal driving shaft there is provided a clutch which disengages the drive from the center boring spindle, when it is desired to feed the spindle without rotating it. This is sometimes desirable when finish-boring is done with the table revolving and the center boring spindle stationary.

All changes of feed and reversal, rapid power traverse or hand adjustment of saddles and bars, and also the cross-rail adjustment and table control, are within reach from the operator's position. One lever disengages the feed, engages the fine and coarse feed, and operates the fast traverse in either direction. Rapid power traverse to the saddles and bars in either direction is provided; and hand adjustment of the saddles and bars is by automatic releasing ratchets located at the sides of the saddles. The machine is self-contained, and as no part extends below the floor line, no special foundation is required. The housings are of box-girder form, double webbed and broad faced, without openings in the front face. The cross-rail elevating screws are located between the housings. They are securely bolted to the bed, and firmly tied together at the top by a heavy brace.

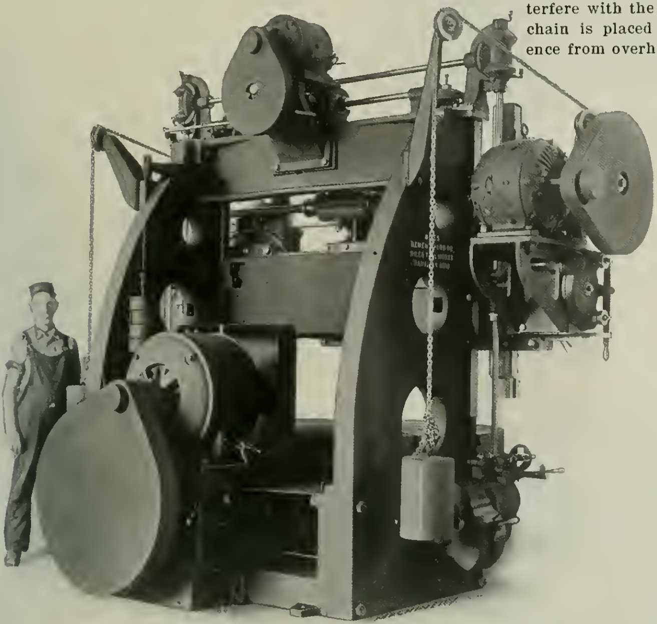


Fig. 2. Opposite Side of Boring Mill shown in Fig. 1.

The table is deep, strongly ribbed and supported by an annular bearing of large diameter running in a bath of oil. The table is driven by an accurately cut coarse pitch bevel gear of maximum diameter and wide face. The surface of the table has four pairs of parallel and eight radial T-slots. The table spindle is long and of large diameter; and it is maintained in strict alignment by an upper and lower bearing. The former is bored out of the solid bed and fitted with an adjustable taper bushing to take up wear. The lower bearing is bronze bushed. On the end of spindle is an adjustable threaded collar to prevent lifting.

The cross-rail is of the three-track type, having a narrow guide at the bottom, with the saddle traversing screw located between the guiding surfaces, thus giving the best possible condition for accurately guiding the saddles. The cross-rail is of the box girder form, broad faced, and of great depth to effectually resist heavy cutting; and it may be readily clamped to the housings. Power adjustment is provided. The saddles have wide bearings on the cross-rail, which are accurately scraped, with provision for taking up wear by means of taper gibs. A clamp bolt is provided for clamping each saddle when the bar is feeding. The swings are accurately graduated, and swivel by means of an arc worm at the top.

The bars are massive steel forgings, octagon in form, which are scraped to a bearing on four sides, thus allowing for taking up wear in all directions. A binder bolt is provided in the bottom of the bar cap for locking the bar when the saddle is feeding. Eight positive, continuous and reversible feeds are provided, which are independent for each head, both in the amount and direction for down, cross and angular feeding. The tool-holders are steel forgings, with provision for readily clamping the tools for boring, turning and facing operations. They have straight shanks and are readily removable for the insertion of special boring-bars. Counterweights for each bar are attached to the same chain; but they act independently and will not pull the swings over, nor interfere with the movement of the saddles. The counterweight chain is placed at the rear of the bars to prevent interference from overhead cranes when placing work on or removing it from the table. Safety friction clutches are located on the vertical spline shafts to insure against accidents, in case the heads or bars meet with some obstruction when either feeding or fast traversing. All gears are guarded.

All shafts are of high-grade steel, and the drive is bushed throughout with bronze. Taper gibs are used to take up wear on sliding surfaces. All driving, feeding, fast traversing and elevating gears are of very liberal diameters, pitches and faces; and steel, bronze, rawhide or semi-steel is used, to give the best conditions of strength, and at the same time, long wear.

Motor drive by direct current is by a motor of 4 to 1 speed variation, carried on a plate located at the rear of the machine between the housings. Power is transmitted through a double run of clutch gears, giving two mechanical changes in speed, which with the usual sixteen or more speeds in the controller, gives thirty-two or more speeds to the table. The motor is fitted with push-button control and a dynamic brake for the table.

Belt drive through a single pulley or alternating current motor drive by a constant speed motor, is through a speed box and back gears located in the rear of the mill, giving twelve changes of speed. All gears in the speed box are of "Cycloid" gear steel, of approximately 200,000 pounds per square inch tensile strength, when heat-treated and hardened. The speed box is fitted with a hand friction clutch for starting and stopping the table. A brake is provided, and controlled by the same lever that operates the clutch.

A separate motor, located on the top brace of the mill, is furnished with alternating current drive for adjusting the cross-rail, and providing rapid power traverse to the bars and saddles. Belt driven machines are built on the convertible plan, and may be readily changed to motor drive. These machines are built in 44-, 53-, 62-, and 73-inch sizes.

WARNER & SWASEY TURRET LATHES

This company is now building the Models 2-A and 3-A turret lathes of its manufacture with single-pulley drive and a geared head, with the gears running in oil. The power and working

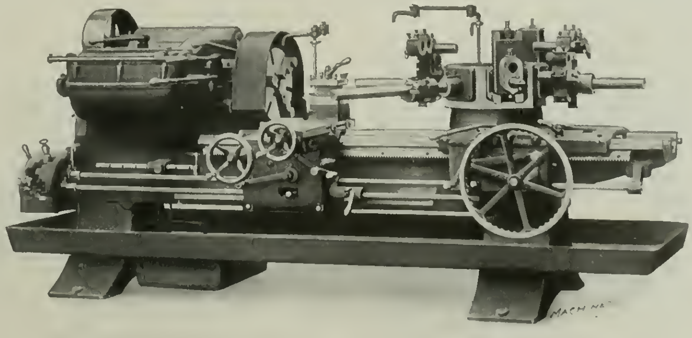


Fig. 1. Front View of Warner & Swasey Universal Hollow Hexagon Turret Lathe

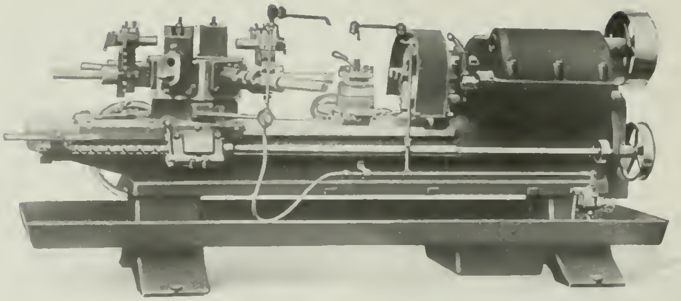


Fig. 2. Opposite Side of Warner & Swasey Turret Lathe shown in Fig. 1

range of the machines have been materially increased. The turret and carriage are operated simultaneously by power, the turret and carriage feeds being independent of each other. As many as eleven tools may be placed in operation with one set-up. Twelve spindle speeds are available, ranging in geometrical progression from 8 to 250 revolutions per minute. Feeds range from 0.010 to 0.212 inch per revolution.

The latest product of the Warner & Swasey Co., Cleveland, Ohio, is an improved model of the universal hollow-hexagon turret lathe. The improvements in this machine apply to both the 2-A and 3-A models; but as the 3-A was the first to be completed, the description will be confined to that machine. The most noticeable change is in the design of head. The former head has been superseded by one entirely new in design, with the gears running in oil. Not so apparent, but perhaps of greater importance, are the increased working range, the greatly increased power of the head, the corresponding increase in the rigidity and strength of the bed, and the two tool carrying units, as well as the larger and more rigid tools. These changes have resulted in greatly increased capacity and efficiency of the machine. The greater capacity has been attained without noticeably increasing the size and operating dimensions of the machine; in fact, the new model is more compact than the former one. The automatic chuck of the No. 3-A machine now takes round stock up to $3\frac{1}{2}$ inches, and the length turned has been increased to approximately 40 inches. The swing over the cross-slide carriage has been increased to $17\frac{1}{4}$ inches, and the maximum swing of the machine to $21\frac{1}{2}$ inches. The capacity of the No. 2-A machine has been correspondingly increased.

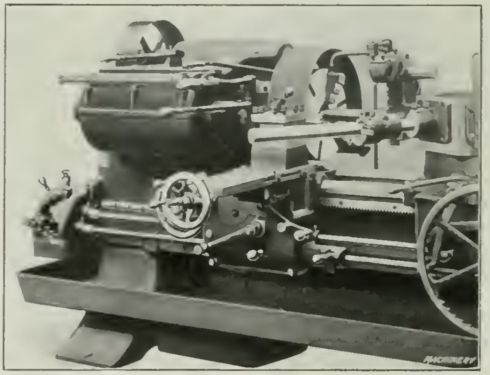


Fig. 3. Close View of Chuck, Carriage and Turret

Although the earlier model was an exceptionally powerful machine, the new machine has power and rigidity greatly in excess of requirements. The new geared head, with the 5-inch belt running on the 16-inch pulley, is capable of delivering 11 horsepower, with a large overload factor. This amount of power will be required only when machining heavy steel castings or forgings, with several cuts being made simultaneously. The rigidity and strength of the bed, the two tool carrying units, and the feeding mechanism for the tools, are well in proportion to the power delivered by the head. The tools have been redesigned to make them in keeping with the increased capacity and more rigid construction of the machine. The splash system of continuous lubrication employed in the head, with the gears running in oil, insures a steady stream of lubricant. This reduces to a minimum the frictional loss of power in the head, and at the same time effects a very decided increase in the life of the machine. The pan has been placed lower, to give increased space for chips and to insure easy accessibility to those parts of the machine directly over the pan. The legs have been redesigned in a semi-box type and with a very wide spread, to insure a solid support and freedom from vibration. The turnstile operating the turret saddle has been superseded by a large handwheel.

The turret and carriage are operated simultaneously by power, with the turret and carriage feeds independent of each other. By this means two distinct operations can be made at the same time—as for example, boring with the turret while the carriage is facing or recessing and cutting off. As many as eleven tools may be placed in operation with one set-up. Through its various combinations, feeds ranging from 0.010 to 0.212 inch per revolution are produced. The machine has twelve spindle speeds, both forward and reverse, with ten feed changes in each direction for both carriage and turret. The feed changes are controlled by the feed box at the head end of the machine. The spindle speeds range in geometrical progression from 8 to 250 revolutions per minute. As in the earlier type, the head is cast solid with the bed, to insure the maximum strength and rigidity. It is of the single-pulley type, and may be belted directly to the line-shaft, or to a constant speed motor. Taper turning and screw chasing attachments are furnished when desired. The taper attachment turns tapers up to $1\frac{1}{2}$ inch to the foot, in lengths of 15 inches. The screw chasing attachment cuts from 2 to 48 threads of any pitch. Each leader will cut 3 pitches that are multiples of 1, 2 and 4 of its own thread.

Notwithstanding the great power and range of the machine, every facility has been provided to make it easy of operation. The power rapid traverse of the turret saddle facilitates quick operation. The independent adjustable stops for both the turret saddle and the carriage reduce setting-up time to the minimum. The hollow hexagon turret permits tools to be bolted from the inside, securing the maximum use of each face of the turret, with full support for the tool in the direct line of thrust and torsional strains. In short, the adaptability is so great that in actual practice this machine has been found economical where but a few pieces of a kind are to be finished—frequently as few as six—as well

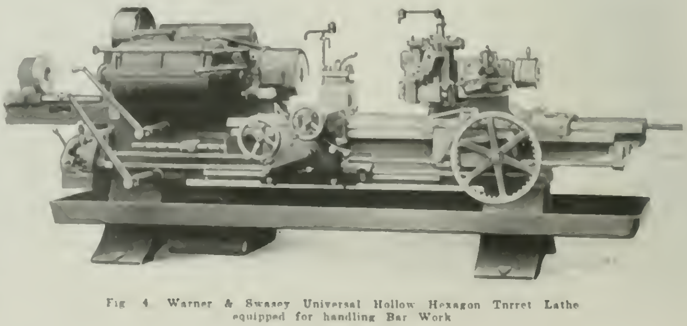


Fig. 4. Warner & Swasey Universal Hollow Hexagon Turret Lathe equipped for handling Bar Work

as for specialized manufacturing work. These features, together with its great power, rigidity, and accuracy, render the machine most highly efficient. Equally adaptable for bar and chucking work, and with standard tools adapted for a large range of everyday needs, this machine will be found most economical for a great variety of work.

J. N. LAPOINTE BROACH GRINDER

The broach grinder which forms the subject of this article was originally developed by the J. N. Lapointe Co., New London, Conn., for use in grinding broaches in its own factory. After the machine had been in use for about two years, it was found to give such satisfactory results that it was decided to place it on the market. Although this machine is styled a broach grinder, it can be used for general tool grinding and a variety of other classes of work. A noteworthy feature is the simplicity of the design and means of controlling all parts of the mechanism. Referring to the illustrations, it will be seen that the machine is equipped with three different heads which are used interchangeably. Any one of the heads can be set up on the machine with little loss of time. Of the three heads referred to, the first is used for grinding the relief on the broach teeth; the second is a plain two-bearing head used for cylindrical grinding; and the third is an electric grinder which can be set up at any angle. The features of these heads will be referred to in detail in subsequent paragraphs.

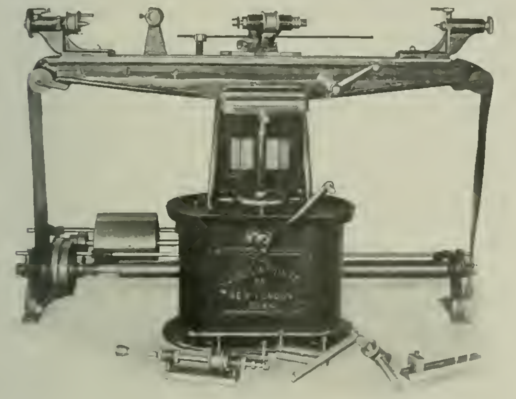


Fig. 1. J. N. Lapointe Broach Grinding Machine

Fig. 1 shows the complete machine, together with all of the attachments and the countershaft. In Fig. 2 a detailed view is shown of the head employed for grinding the relief on the broach teeth. Referring to this illustration, it will be seen that the broach is secured to the table by clamps *A*. and an index finger *B* is used for locating successive teeth in position for grinding. The bracket on which the index finger *B* is supported is fitted with adjusting nuts *C* for regulating the longitudinal position of the finger. The machine is provided with a graduated vertical control wheel which is shown at *D*, and the vertical control handle *E* can be used either at the front or back of the machine as required. Fig. 3 shows a rear view of the machine provided with the same equipment as shown in Fig. 2, and reference to this illustration will make the method of operation more clear. Here it will be seen that the spindle is provided with a knurled knob *F* which is held between the thumb and finger while the wheel is traversed back and forth across the face of the teeth. The spindle is mounted in a swiveling head that can be set to any required angle. The crank *G* which operates the traverse of the work-table can be actuated from either the front or back of the machine, as in the case of the vertical control handle *E*, which is also shown mounted at the back of the machine in Fig. 3.

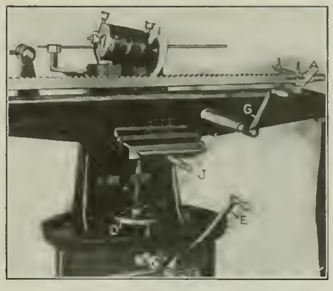


Fig. 5. Electric Grinder Head set up ready for Use

Fig. 4 shows the machine equipped with the head used for cylindrical grinding. Reference to this illustration will show that the centers are set up on the machine and carry a square broach which is mounted in position ready for grinding the faces of the teeth cylindrical. The cross spindle on which the wheel is carried is mounted in a swiveling head that can be set at any angle for "under-cutting." It will be seen that an index plate *H* is provided on the head center, which is used on multiple splined broaches, etc.

In Fig. 5 the machine is shown with the electric grinder set up ready for use. This grinder can be set at any required angle to grind any shape or angle of tooth. This illustration also shows the broach placed in the proper position for under-cutting the faces. When using this equipment, the grinder is given a cross travel by means of a handle on the squared shaft *J* which operates the slide.

ACETYLENE-OIL-GAS GENERATING OUTFIT

The Battery Gas Co., 16th St. and Lowe Ave., Chicago Heights, Ill., is now manufacturing an acetylene gas apparatus in which the gas is made non-explosive by mixing it with oil gas, the acetylene and oil gas being generated simultaneously. The product of this generator is suitable for use in torches employed for welding and cutting metal, in addition to which it may be used for domestic lighting and heating, and for various other purposes for which acetylene gas is employed. In operating this type of generator, the charge is put in a sealed cartridge, and instead of feeding the carbide into the water to produce the acetylene gas. the water is fed to the charge of carbide. Operated under these conditions, the generator is said to be under better control.

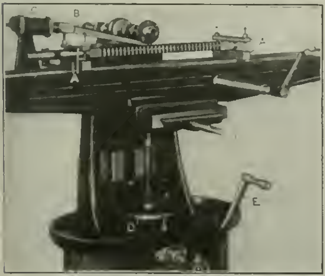


Fig. 2. Front View of Machine equipped with Head for relieving Teeth

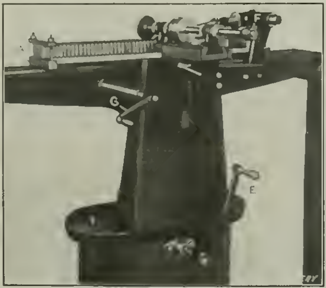


Fig. 3. Opposite Side of Machine equipped as shown in Fig. 2

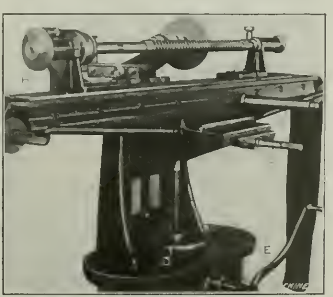


Fig. 4. Cylindrical Grinding Head used for sharpening Teeth

Battery Gas Co.'s Complete Welding and Cutting Outfit using Acetylene-oil-gas

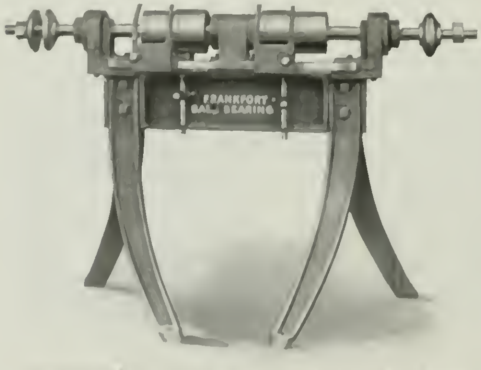
The cartridge containing the carbide has a central tube around which are packed layers of carbide separated by layers of sawdust, sand or other inert material which is saturated with crude oil. When the water is admitted to the central tube, it starts to act on the bottom layer of carbide, and the heat generated by this reaction results in vaporizing the oil contained in the first layer of inert material. As the water is delivered to the central tube, it flows through the bottom and rises into contact with successive layers of carbide contained in the cartridge, with the result that acetylene gas is generated from this carbide and mixed with the oil vapor produced by vaporizing the oil contained in the layers of inert material. It will be evident from this description that the operation of the generator can be accurately regulated by adjusting the flow of water into the central tube, and if this flow of water is stopped, the generation of acetylene gas is also stopped.

The generating apparatus consists essentially of a tank and the cartridge in which the generating charge is contained. When the cartridge is inserted in the chamber it is secured in place by a round plate at the bottom, which is forced tightly against a gasket by means of a hand screw. There is a plug valve in the head of the chamber with radial tubes connecting the port with the water in the tank. When this valve is pushed down by an eccentric lever on top of the generator, water flows through the radial pipes and enters the central opening of the cartridge, causing generation of the mixed acetylene and oil gas to take place as previously described.

A regulator is mounted on top of the generator which is fitted with a metal diaphragm that controls the flow of water to the battery. There is a spring on top of the diaphragm which connects with an eccentric lever fastened on a bar. This bar is threaded into the regulator, and by turning the bar so as to screw it into or out of the regulator, the tension of the spring on the diaphragm is adjusted to regulate the pressure to any required point. The gas produced passes out through a perforated cap at the top of the cartridge and through ports in the head of the chamber into a flue. It then passes down through the water in an annular space outside of the flue and up again through water to a storage space at the head of the tank.

"FRANKFORT" POLISHING LATHE

The "Frankfort" double-spindle ball bearing polishing lathe which is illustrated and described herewith has recently been placed upon the market by the Strong, Carlisle & Hammond Co., 326-344 Frankfort Ave., N. W., Cleveland, Ohio. This machine is equipped with four S. K. F. double-row, self-aligning ball bearings. Each spindle is mounted in two of these bearings which are contained in dust-proof housings provided with oil reservoirs of ample capacity. The bearings do not permit of cramping or wedging the spindles, as they automatically align themselves to overcome the slightest deflection and equally distribute the load. The spindles are made of high-carbon steel, accurately ground to size, and are operated individually or simultaneously.



"Frankfort" Polishing Lathe equipped with S. K. F. Ball Bearings

Each spindle is equipped with tight and loose pulleys, the loose pulley being turned a trifle smaller than the driving pulley in order to relieve the belt tension when the drive is disengaged. Each spindle is arranged with a self-locking brake which acts automatically on the tight pulley and stops the spindle when the belt is shifted to the loose pulley. This automatic brake also locks the belt shifter and protects the operator from the danger of accident due to the belt shifting while he is changing a wheel. It will be seen that the curved design of the legs affords plenty of space on the operating side of the machine.

The principal dimensions are as follows: Diameter of spindle in bearings, 1¾ inch; length of each spindle, 30 inches; distance from floor to center of spindle, 37 inches; floor space occupied, 60 by 26 inches; and net weight of machine, 450 pounds.

KIPNIS AUTOMATIC DRILL AND LATHE CHUCKS

The Kipnis Co., 9-15 Murray St., New York City, is now manufacturing the automatic drill chuck and the automatic lathe collet which form the subjects of this article. Referring to Figs. 1 and 2, which show the drill chuck, the method of operation may be briefly described as follows: The closing of the jaws onto the shank of the drill is controlled by a tapered worm *A*, which engages with teeth machined on the inside of the jaws *B*. When it is required to place a new drill in the chuck, the sleeve *C* is lifted. The rack *D* is carried on the inside of a collar secured to the sleeve; this rack meshes with the pinion *E* which transmits the motion through the bevel gear pair to the worm *A*. When the sleeve *C* is raised, the worm *A* is rotated in the right-hand direction, thus raising and opening the chuck jaws. The drill is then slipped between the jaws and pushed up until the end of its shank abuts against the end of the stud *F* upon which the worm *A* is carried.

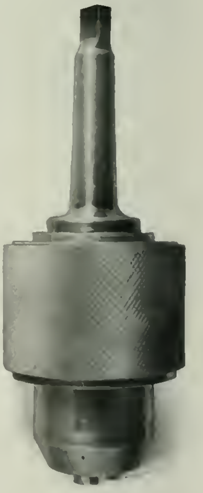


Fig. 1. Kipnis Automatic Drill Chuck

The knurled sleeve *C* which revolves independently of the body of the chuck is then pushed down, causing the worm *A* to rotate in the left-hand direction and tighten the jaws *B* upon the shank of the drill. In this way a sufficiently tight grip is secured to start the drill working, after which the pressure of the cut causes enough friction between the end of the drill shank and the stud *F* to tighten the jaws, the amount of this tightening effect being in direct proportion to the resistance of the cut. There is 1/32 inch play in the coupling that connects the stud on which the pinion *E* is carried with the first bevel gear. This makes the effect of the drill in tightening the chuck independent of the gearing, as only a very slight amount of motion is required. This motion is taken up in the coupling between the bevel gear and spur pinion without requiring the remainder of the gearing to be turned.

It will be seen that the shank of the chuck extends down into the body of the chuck. This extension of the shank is machined out to provide clearance for the first bevel gear,

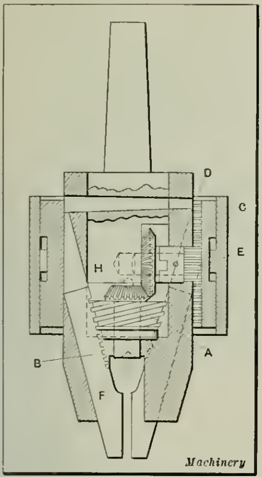


Fig. 2. Cross-sectional View of the Kipnis Automatic Drill Chuck

and the outboard bearing for the stud on which this gear is carried is in the extension of the shank. The lower end of the shank is centered to receive a ball *H* which is carried between this center and a corresponding center on the bevel gear, the thrust of the drill being taken by this ball. It will be seen that there is considerable clearance provided between the annular flange on the inside of the sleeve *C*, which extends into the groove in the collar that carries the rack *D*. The purpose of this clearance is to provide a "hammer" effect which enables the sleeve to acquire momentum enough to release the chuck to remove the drill.

The principle upon which the Kipnis lathe collet works is essentially the same as that of the drill chuck which has already been described. This collet is made in two forms, one of which is threaded as shown in Fig. 3, to be screwed onto the end of a threaded spindle nose; while the other is provided with a hollow tapered shank which fits into the tapered hole of the lathe spindle. In the operation of the collet which is shown in Fig. 3, there are two pins *J* which extend out from the sliding sleeve that actuates a rack and pinion. These pins *J* enter slots in an operating lever which controls the grip of the collet on the work. It will be seen that the worm which operates the chuck jaws is extended to form a bearing for the worm at *K*, the body of the chuck being machined to fit this extension on the worm. The hole through the worm and through the body of the chuck is the same size as the hole in the lathe spindle on which the chuck is to be used. No further description should be necessary to make the design and operation of this chuck quite clear to any mechanic.

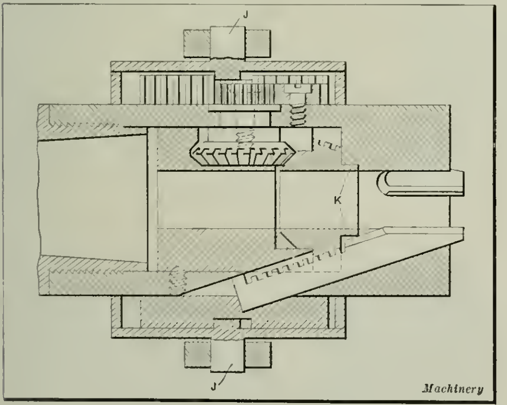
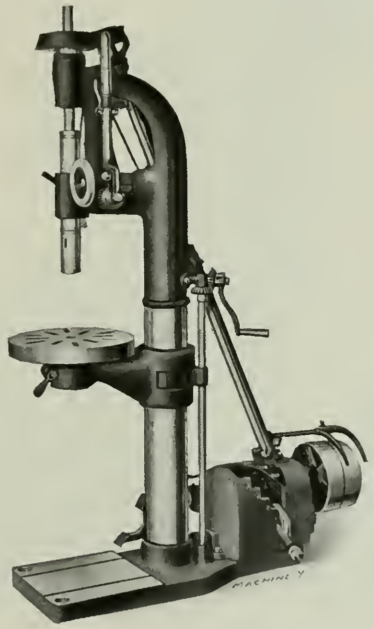


Fig. 3. Cross-sectional View of the Kipnis Automatic Lathe Chuck

LINDGREN HIGH-SPEED DRILL

The Lindgren 20-inch high-speed, all-geared drill which is a recent product of the F. W. Lindgren Co., Rockford, Ill., is particularly adapted for heavy drilling operations. The design has been worked out along lines to provide the necessary power and rigidity to meet the constantly increasing requirements met in the driving of high-speed twist drills. The machine is provided with five geared speed changes which may be instantly made without stopping the drill. The column and base are well ribbed and bolted together with four ⅝-inch cap-screws. All of the bearings in the speed box are provided with ring oilers which insure constant lubrication. The spindle has a ball thrust bearing, and its travel is 9½ inches. The end of the spindle is extended to bring the drift hole below the sleeve, and the sleeve is graduated in inches to make it convenient for the operator to drill a hole of specified depth.

Among the features of this drill, the following may be mentioned: A combination feed lever is provided, which is fitted on a separate sleeve that prevents any binding in the cross spindle. A coiled spring, placed between the column and the lever, causes the lever to drop very gradually, thus preventing accidents by the sudden and unexpected dropping of a heavy lever. The wheel and lever feed are independent of each other. The worm is engaged by pulling the handwheel down and disengaged by pulling a dog to allow a spring to throw it out of action. The feed lever is operated by a ratchet and pawl which automatically disengage when in a vertical position. Another noteworthy feature is the crown gear which is fitted with a thrust bearing at the end of the hub, where there is a fiber washer to prevent the leakage of oil. The oil chamber is filled with felt for the purpose of retaining the oil, this arrangement insuring constant lubrication of the bearing. The principal dimensions of the machine are as follows: Capacity, sufficient to pull a 1¾-inch drill through steel; height of drill, 72 inches; greatest distance from spindle to base, 41½ inches; greatest distance from spindle to table, 28¾ inches; distance from column to center of spindle, 10¼ inches; hole in spindle, No. 3 Morse taper; diameter of table, 15½ inches; floor space occupied, 16 by 50½ inches; net weight of machine, 670 pounds.



Lindgren 20-inch High-speed Drill

"NATIONAL" AUTOMATIC NUT TAPPER

Obviously, the characteristic feature of this machine is the application of the bent tap principle which provides for continuous operation of the machine without reversal. The blanks are fed into the feed chute by vanes contained in a case in the hopper. The vanes are driven from the main shaft by a ratchet and pawl, the ratchet being friction-driven to slip and avoid damage in case the machine becomes blocked. The blanks are transferred from the feed chute to *the tap by a plunger, and means are provided for tapping the hole square with the face of the nut. Either square or hexagon nuts may be tapped, and change gears provided for varying the rate of feed in handling nuts of different sizes. The machines are built in $\frac{1}{4}$-, $\frac{3}{8}$-, $\frac{1}{2}$, and $\frac{3}{4}$-inch sizes.*

Many firms and individuals have endeavored to apply the bent tap principle in the development of a continuous non-reversing nut tapping machine, but although all of the requisite theoretical steps and movements from the introduction of the nut blank to its ejection as a tapped nut were apparently provided for, when placed in operation these machines showed shortcomings that proved them to be of little practical value. The effort to apply this principle has been stimulated by the fact that in theory, at least, the bent tap offered the means of developing a full automatic nut tapper which would operate continuously without reversal, and in which the various movements appeared possible of attainment without the necessity of employing intricate or delicate mechanisms.

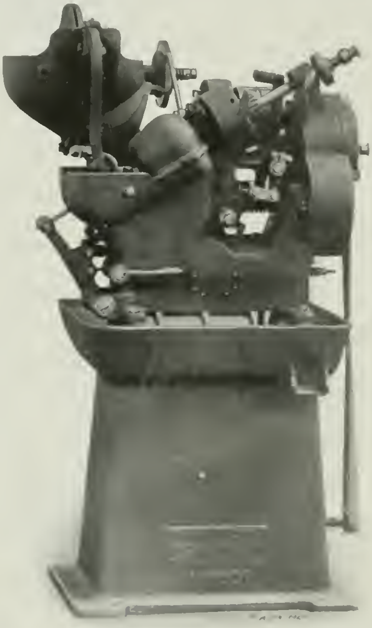


Fig. 1. "National" Automatic Nut Tapping Machine which operates on the Bent-tap Principle

The practical application of the bent tap principle has been made in a new automatic nut tapper which has recently been placed upon the market by the National Machinery Co., Tiffin, Ohio. The simplicity of the design and operation of this machine are features which are secondary only to the unusually high output and the long life of taps that have characterized the trials to which it has been subjected. This machine is at present being built in sizes of $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$ and $\frac{3}{4}$ inch capacity. Fig. 1 shows a general view of the machine, while in Figs. 2 to 5 detail views are given of the more important parts of the operating mechanism. The hopper or container for the blanks, while apparently constructed along standard lines, embodies some improved features. On the small machines the hopper has a capacity for about 80 pounds of blanks, this unusually large size giving one operator sufficient time to enable him to easily attend to a battery of from six to ten machines.

The nut blanks are delivered from the hopper to the feed chute by means of a vane feed, and gravity carries the blanks down into position against the plunger or "starter" which starts them onto the tap. There are four of these feed vanes which are enclosed in a central case, as shown in Fig. 2, so that the pressure or weight of the blanks in the hopper cannot interfere with their operation. These vanes are rotated by the ratchet and pawl shown in this illustration, which derive their motion from the main driving shaft. The ratchet is held between friction flanges so that in case scrap metal or a thin nut blank tends to wedge in the nut groove and retard the progress of the feed vanes, the ratchet merely slips, and damage to the mechanism is avoided.

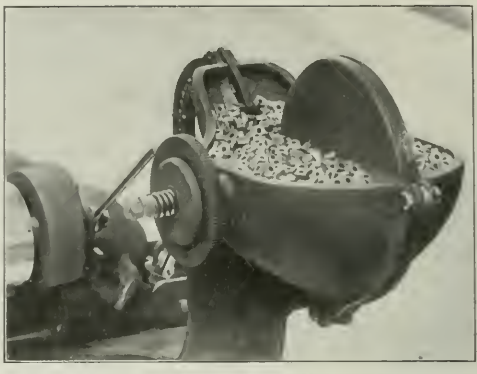


Fig. 2. Feed-hopper, and Ratchet and Pawl which actuate Feed-vanes

The tap spindle and the plunger or starter which transfers the blanks from the bottom of the chute to the tap are inclined at an angle; and the blanks come out of the feed chute at a like angle, thus causing each blank to leave the chute in the proper position to be engaged by the plunger and started onto the tap. The angle of the starter is such that the lubricant keeps its face free from chips so that the nut blanks bear flush against the starter and are tapped square with the bearing face. The tap spindle has a slight lateral travel and is counterbalanced, giving the spindle practically the equivalent of a floating movement; after the starter has fed the blank part way onto the tap, the spindle descends during the completion of the tapping operation, thus keeping the blank stationary while it is being tapped, instead of pulling it through the nut holder or guides, and affording an opportunity of excessive wear on the guides and tap due to the binding of the nut.

It follows, of course, that the better the quality of the blank which is being tapped—*i.e.*, freedom from burrs, having holes of correct size, stock that is free cutting, and blanks of correct dimensions—the higher will be the machine's efficiency. Before being dumped into the hopper, the blanks are sorted from scrap, slugs, etc., but should any scrap accidentally enter the hopper and be passed through the feed chute and fed up against the tap, an automatic relief is provided which shifts the belt and stops the machine before damage can be done.

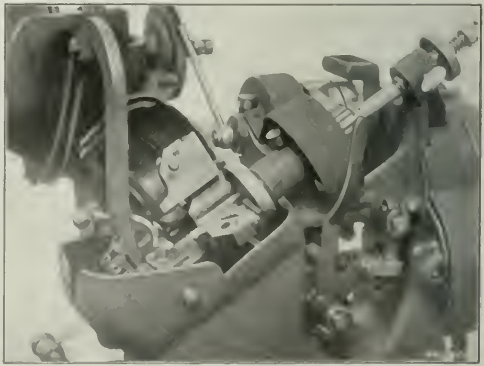


Fig. 3. Head or Tap-holder opened, showing how Nuts pass over Tap and are pushed off by Oncoming Nuts

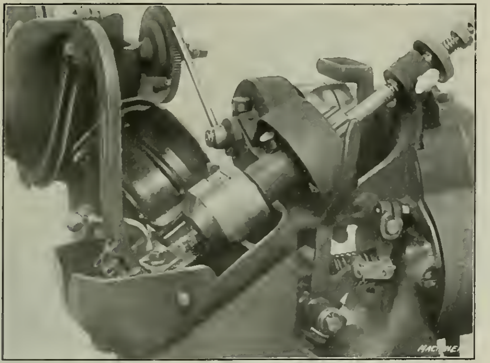


Fig. 4. Head Cover open, showing Nut just leaving Head

This machine is designed primarily for tapping square nuts, but hexagon nut blanks of good quality can be handled. Each size of nut tapper can be tooled for handling both square and hexagon nuts, as well as for several sizes of each style of nut. By making a simple gear change, the rate of feed, *i.e.*, the number of nuts tapped per minute, can be regulated to suit the kind of nuts which are being tapped in the machine. For example, on the ⅜-inch machine, forty nuts of "shop" size can be tapped per minute if the stock is free cutting, the holes of full size, etc.; while U. S. S. nuts which are thicker, require more turns of the tap to each nut, so that the production cannot be more than thirty nuts per minute. A similar reduction must be made when the nut blanks are of tough stock or the holes run smaller than they should. No special tap or grade of taps is necessary as any standard tap that has been successfully employed for similar nut tapping operations will be found equally satisfactory when provided with a bent shank for use in the new "National" automatic nut tapper.

Machines of this type have been installed in a number of large nut plants where they are said to be showing a machine efficiency and tap service that is highly gratifying. This high efficiency is, of course, largely attributable to the simple lines on which the machine is designed. In fact, to accomplish this aim, a battery of these machines was experimented with for several years and subjected to a variety of severe tests while under the supervision of a corps of the National Machinery Co.'s engineers. Each step and movement was analyzed and simplified until the machine was finally brought to its present form.

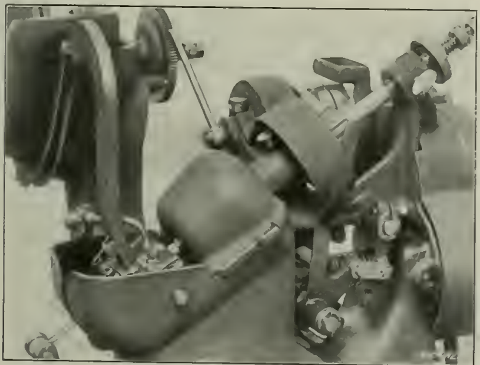


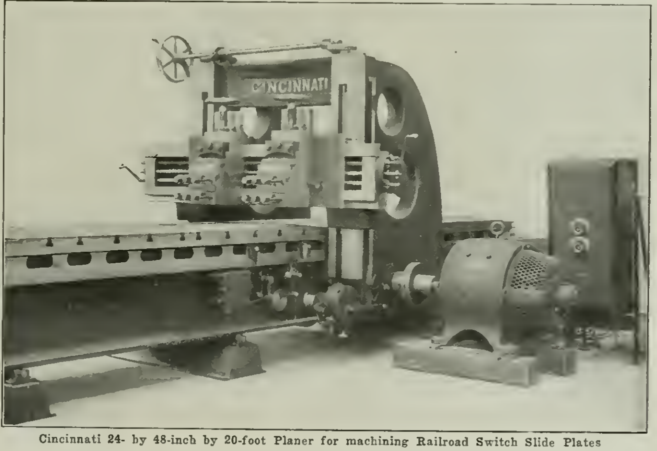
Fig. 5. Same View shown in Figs. 3 and 4, with Head Cover closed to guard all Gears and Revolving Parts

CINCINNATI SLIDE PLATE PLANER

The accompanying illustration shows a planer intended for exceptionally heavy duty, which has recently been completed at the plant of the Cincinnati Planer Co., Cincinnati, Ohio. This machine has a capacity for work 24 inches high by 48 inches wide by 20 feet in length, and was designed for the purpose of planing the ends of steel slide plates of the form used under switch points. These plates are 18 inches long by about 6 inches wide and are planed in for a distance of approximately 6 inches from the end, to a depth of ¼ inch. In machining these parts, the table is loaded with two rows of plates and four tools are employed, two in each head. This reduces the distance that it is necessary to feed the heads to 3 inches instead of 6 inches, as would be the case if one tool were employed in each head. The full depth of cut is taken at one time, the cutting speed being 40 feet per minute.

In order to facilitate rapid chucking and unloading special slots are provided in the top of the table which open at the sides. The table is of the box type and is provided with two inner guides between the vees, and is held down by adjustable gibs at the sides. The driving gears and table rack are of steel. The bed is of the four-wall type, having auxiliary inner walls between the cross girths for the entire length of the bed. The bed is bored to receive the shaft bearings which are internally ground and fitted into place. The housings, which are of a heavy box form, are carried down to the floor line and fastened to the sides of the bed by heavy tongues, bolts and dowel pins.

The rail and heads are of the same type as those employed on the frog and switch planer of this company's manufacture, which was illustrated in the November, 1912, number of MACHINERY. The rail is clamped to the housings by four clamps, two of which are located on the outer and two on the inner sides of the housing faces. The heads are provided with tapered gibs and the dovetails for the down slides are cast solid with the saddles, thereby eliminating one extra joint. The clapper box is of steel and provided with three heavy bolts and clamps which are so arranged that the two tools can be clamped to each head. In the style of clamp used for holding the clapper box at the top, a clamp extending the full width of the slide and equipped with three bolts is provided, in place of the usual cored-slot and two-bolt form of clamp. The machine is driven by a reversible motor coupled directly onto the driving shaft of the planer. This gives a large variation of cutting and return speeds which are independent of each other. All gears are thoroughly covered to provide for the safety of the operator.



Cincinnati 24- by 48-inch by 20-foot Planer for machining Railroad Switch Slide Plates

ROCKFORD AUXILIARY DRILL HEADS

The Rockford Drilling Machine Co., Rockford, Ill., is now manufacturing a line of high-speed auxiliary drill heads, examples of which are shown in the accompanying illustrations. These are made for use in connection with upright or hori-

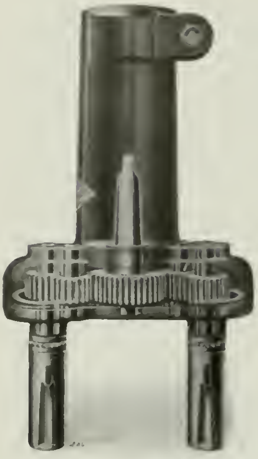


Fig. 1. Phantom View of Rockford Two-spindle Auxiliary Drill Head

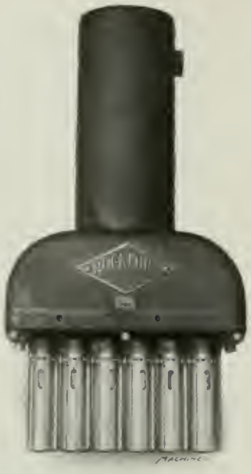


Fig. 2. Six-spindle Drill Head with Spindles in a Straight Line

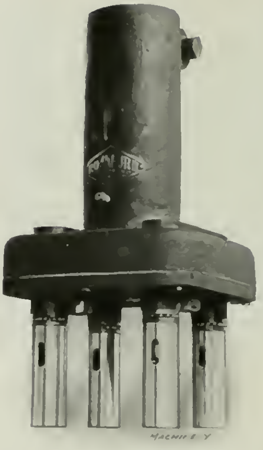


Fig. 3. Four-spindle Auxiliary Drill Head

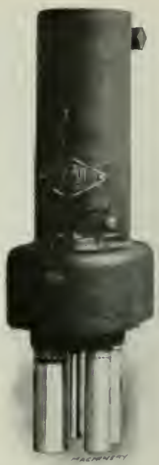


Fig. 4. Head with Spindles spaced close

zontal drilling machines and enable a number of holes to be drilled in the time usually required to drill a single hole. They are made with either stationary or adjustable spindles, and the spindles may be set in a straight line, on the circumference of a circle, or staggered, to suit the requirements of the work which is to be drilled. The length of the spindle sleeve can also be varied to take care of drilling operations on different levels.

All of the gears and spindles in these heads are provided with an upper and a lower bearing, these bearings being bushed with high-grade phosphor bronze, and so arranged that wear due to the thrust of the gears can be easily taken up. The spindles are all provided with ball thrust bearings. The gears are made from either hardened tool steel or bronze, all driving and driven gears being of steel, while the intermediate gears are made of bronze. This affords the maximum of quiet running and smooth transmission properties. The spindles are made of a special grade of steel and may be furnished with tapered holes and drift slots, straight holes and set-screws, or any desired form of chuck. Every bearing is provided with adequate means of lubrication.

Auxiliary drill heads of this type, in which the location of the spindles is fixed, are made oil-tight so that the casing may be filled with grease or oil. On heads where the position of the spindles is adjustable, the casing is made as nearly oil-tight as possible, and it is generally found that the casing of this type of head can be packed with grease. These heads are made to drive high-speed drills at their maximum speed and feed, and heads of this type can be made to meet the requirements of practically any multiple drilling proposition that comes within their range.

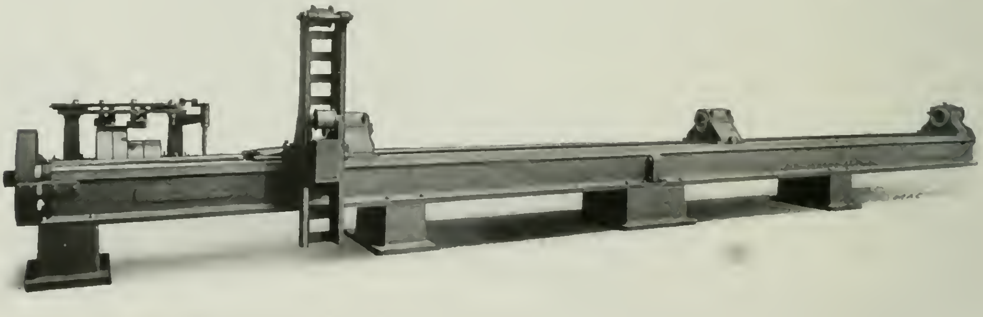


Fig. 1. Head-end of Detrick & Harvey Gun Rifling Machine, showing Drive, Carriage for traversing Bar and Index Head for rotating Bar

DETRICK & HARVEY RIFLING MACHINE

The gun rifling machine which forms the subject of this article is made in two sections, one of which consists of a runway mounted on legs, which carries the traveling carriage and bearings for supporting the rifling bar; and the

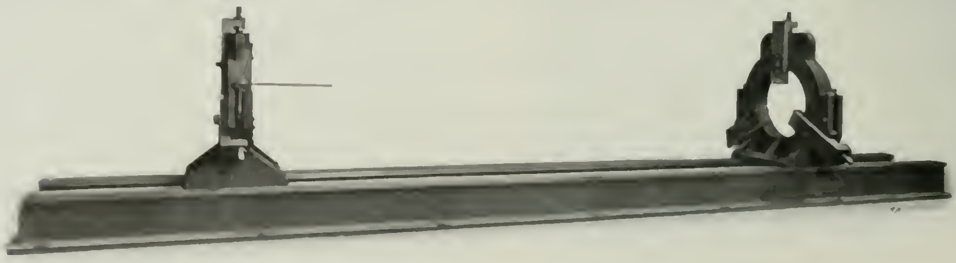
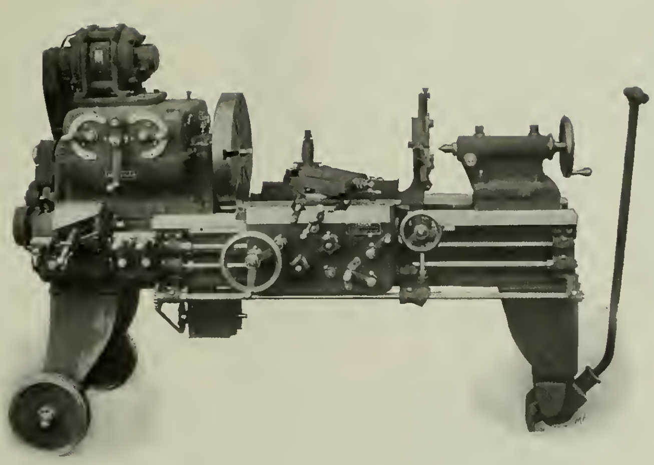


Fig. 2. Work Table or Bed of Detrick & Harvey Gun Rifling Machine with Removable Steadyrests for supporting Gun Barrel to be rifled



"American" 16-inch High-duty Lathe built for Portable Service

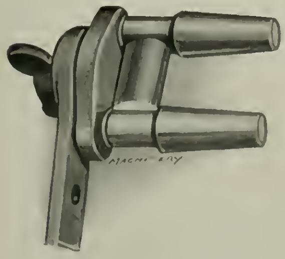
other of a bed with two removable steadyrests to support the gun. Fig. 1 shows the section of the machine for supporting and driving the rifling bar, while the bed on which the work is carried is illustrated in Fig. 2. The large size of the machine made it impracticable to show both parts in a single illustration.

Referring to Fig. 1, the rifling bar is held in a fixed longitudinal position in the carriage bearing seen near the left-hand end of the runway, but the bar is free to rotate in this bearing. There is a spiral groove in the bar of the same pitch as the rifling that is required in the gun. The index head seen at the extreme right-hand end in Fig. 1 is provided with a pin which engages in the master groove of the rifling bar. This pin imparts the required rotary motion to the bar, while the longitudinal travel of the bar is obtained from the traveling carriage, previously referred to. A twisting tension is kept on the bar by means of the counterweight on the traveling carriage, danger of lost motion due to wear of the index pin being overcome in this way. The intermediate bearing merely provides an additional support for the bar. This bearing is geared to travel at exactly half the speed of the carriage, so that it always remains equidistant between the carriage and the index head and reaches the end of the runway at the same time as the carriage. The index head provides means of setting the bar for any required number of grooves.

The carriage and the intermediate bearing between the carriage and index head derive their motion from a quick pitch screw 4 3/4 inches in diameter, which derives its motion from a shifting belt drive shown at the extreme left in Fig. 1. If so desired, a direct-connected reversing motor of the form used on planer drives may be employed. This machine will rifle guns up to 8 inches bore and of any desired length. It is equipped with an oil pump provided with a telescoping pipe to deliver lubricant to the tool, the pump being driven by a three-horsepower motor. Machines of this type are being built by the Detrick & Harvey Machine Co., Baltimore, Md., for the Bethlehem Steel Co. Machines built to rifle guns of 8-inch bore by 30 feet long, weigh 50,000 pounds.

RED-E BELT SHIFTER

The "Safety First" belt shifter shown in the accompanying illustration is a recent product of the Ready Tool Co., 654 Main St., Bridgeport, Conn. Reference to the illustration will make it evident that this shifter is mounted on a pole for use in place of the ordinary belt stick; and it must not be confused with a belt shifter used for shipping the belt from a tight to a loose pulley or *vice versa*.



Red-E "Safety First" Belt Shifter

The device consists of a plate which is bolted to any convenient form of pole. At the end of this plate there is a swivel fork on which three rollers are carried. Two of these rollers are tapered in such a way that when the belt is pushed over the moving pulley there is no danger of the shifter getting caught and thrown through the shop, as sometimes happens with an ordinary belt stick provided with the usual form of pin. The taper of the rollers of the present device serves the double purpose of tending to force the belt onto its pulley, and at the same time force the belt shifter out from under the belt. The device is substantially made and can be depended upon to throw on any belts of the size for which it is intended, without requiring the power to be stopped.

"AMERICAN" PORTABLE LATHE

The accompanying illustration shows a portable lathe which was recently built by the American Tool Works Co., Cincinnati, Ohio, for use in a large railroad shop. This machine consists of the regular 16-inch "American" high-duty lathe mounted on three wheels and provided with a long lever for hauling it about the shop. The three-point bearing on the floor practically eliminates all chance of the machine getting out of alignment, even where the floor is quite uneven.

This machine is provided with motor drive so that it is entirely self-contained and ready for use in any part of the shop at a moment's notice. A portable machine of this type is especially serviceable in railroad shops and certain large machine shops, where it is more economical to take the machine to the work than to bring the work to the machine.

WESTINGHOUSE INDUCTION MOTOR

The Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has recently placed on the market a new line of large slip-ring induction motors which are adapted for continuous service, such as driving pumps, blowers, compressors, hoists, and other machinery requiring a heavy torque at starting. One of the chief characteristics of these motors is their great strength. The frame is massive, the bearings and shafts are extra large, and the windings are securely braced against vibration. The bearings are dust-proof and rest on three machined seats, a form of construction that has been found to be the best practice in steel mill service.

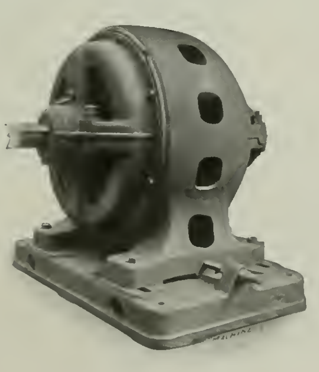


Fig. 1. Westinghouse Induction Motor

All coils are form-wound and completely insulated to ground before they are placed in the slots. The stator slots

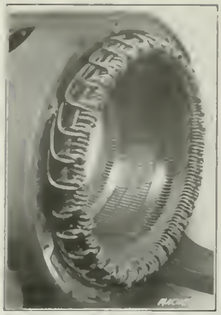


Fig. 2. Stator of Westinghouse Induction Motor

are straight open; and those of the rotor have an overhanging lip which assists in holding the coils in place, but the coils can be removed and replaced without bending, as readily as would be the case with the form of construction in which straight open slots are employed. The shaft can be removed without making it necessary to disturb the rotor winding in any way. The bearing shell may be removed and replaced without having to take off the lower half of the bearing bracket, and the brushes are readily accessible as shown by the illustration. It will be apparent that these are conveniences which greatly facilitate the work of making repairs and adjustments.

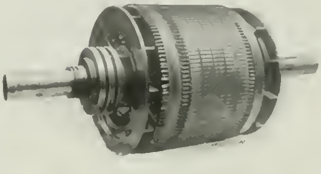
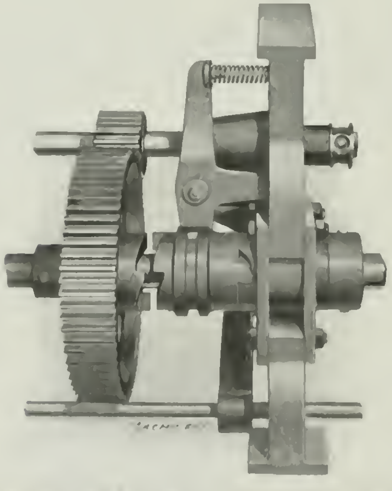


Fig. 3. Rotor of Westinghouse Induction Motor

CANTON POSITIVE CLUTCH

For use on sheet-metal working machinery the Canton Foundry & Machine Co., Canton, Ohio, has developed the positive clutch which forms the subject of this article. The design has been worked out along lines which are so simple that it is claimed the clutch can never get out of order. The following describes the manner in which the mechanism operates: When the foot treadle is depressed, it operates the bellcrank on the clutch by means of a connecting-rod. The lower end of the bellcrank carries a steel yoke which fits into the annular groove on the clutch block. This block has clutch teeth which engage corresponding teeth on the gear wheel, the clutch block being made to slide on the shaft to effect this engagement. The gear wheel is free on its shaft and rotates constantly, while the clutch block is keyed to the shaft, so that the engagement of the block with the rotating gear results in the rotation of the shaft.



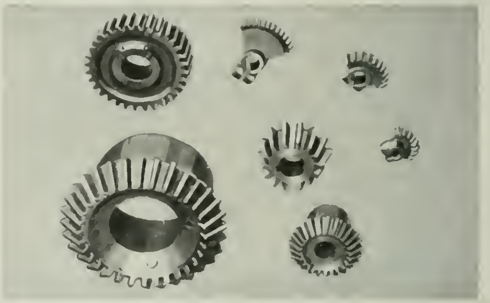
Canton Positive Clutch for Use on Sheet-metal Working Machines

As soon as the clutch block commences to rotate, the lug on the right hand end of the block is moved out upon the face of the boss and out of alignment with the notch in the boss. The clutch block and shaft are then allowed to make one complete revolution, at the end of which the spring acting on the upper end of the bellcrank throws the clutch block out of engagement with the clutch teeth on the gear wheel, and at the same time the lug at the opposite end of the clutch block is reseated in the boss, thus bringing the shaft to a stop. If it is desired to have the machine run continuously, the foot lever must be kept depressed. There are four teeth on the clutch block, so that not more than one-quarter of a revolution is lost in starting the machine after the foot treadle has been depressed. When the clutch is disengaged, there is a space of about ¼ inch between the ends of the clutch teeth.

DIE-CAST BRONZE MACHINE PARTS

Machine parts made of steel are inexpensive so far as the cost of the material is concerned, but when the cost of machining and kindred operations are taken into consideration, the cost of the part may equal its weight in bronze, silver or even gold. Where strength, toughness, resilience and durability can be dispensed with, white metal die castings have greatly reduced the labor cost incident to making machine parts of steel, as the die castings leave the molds in practically the form in which they are to be used, requiring little, if any, finishing.

Where the cost of machining steel parts has been prohibitive and where white metal die castings have not possessed the necessary strength, the most obvious expedient was to attempt to use some other metal for the die castings, and for this purpose brass, bronze or some other copper-base alloy would give suitable results. These alloys possess the necessary strength for many classes of work for which white metal is unsuitable, and although the cost of the material is greater than that of steel, the final cost of the finished parts would be less if they could be cast in permanent metal molds.



Examples of McGill Die-cast Bronze Gears

The McGill Metal Co., Valparaiso, Ind., has recently entered the field of casting bronze machine parts in permanent steel molds. After conducting systematic experimental work, this company has been furnishing die-cast bronze parts to a limited number of customers for about two years and the results which have been obtained are said to be highly gratifying. As a result, the McGill Metal Co. is at present erecting a new foundry and die-shop which will be furnished with the most modern equipment for handling work of this kind.

The difficulties incident to the die casting of bronze, which had to be overcome by research work, consisted of the development of bronze mixtures of perfect equilibrium at all temperatures, and of sufficient strength even at high temperatures to withstand the strains caused by shrinkage of the metal in the dies. Another important point was to develop a steel that would be proof against damage from the molten metal poured at temperatures ranging from 2200 to 2400 degrees F.

One field in which the McGill Metal Co. has been able to produce parts with extremely satisfactory results is in the quantity production of bevel gears. Here a marked saving has been effected by machining permanent molds in which any number of gears can be cast, instead of having to cut the teeth of each gear that is required. Furthermore, bronze gears are found superior to steel gears in those classes of machines for which die cast gears have been made.

The bronze used for die casting has a fine granular structure, the metal being extremely homogeneous. Vibration, shock, and strain, as well as the application of heat up to reasonable temperatures, will not influence the uniformity of the structure nor the strength, hardness, toughness and springiness of the metal. Parts made of this metal will take a high polish owing to its close structure. It is also well known that bronze is an excellent bearing material. As a result, such parts as gears, cams, valves, bearing bushings, etc., can be die cast from this metal and give excellent results.

Physical tests made with this bronze are said to have shown the following results. Tensile strength, 75,000 to 85,000 pounds per square inch with an elastic limit of from 30,000 to 40,000 pounds per square inch; an elongation of 18 to 23 per cent on a 2-inch test sample; and a reduction of area of 17 to 24 per cent.

NEW MACHINERY AND TOOLS NOTES

Foundry Tumbling Barrel: Kane & Roach, Syracuse, N. Y. A new form of foundry tumbling barrel which is particularly intended for breaking gates and sprues from malleable iron castings. In addition to performing this service, the tumbling of the castings in this barrel also removes the dirt and sand from them, so that the castings are ready to be packed in the furnace as they come from the barrel.

Facing Tool: Mummert-Dixon Co., Hanover, Pa. A tool adapted for facing operations performed on a drilling machine or vertical milling machine. In using this tool the operation is similar to that of facing work on the lathe, and an ordinary lathe tool bit is employed. Provision is made for the attachment of a pilot which enters a hole in the boss that is to be faced, and is relied upon to steady the tool.

Diamond Holder: Goodspeed-Detroit Mfg. Co., Detroit, Mich. A diamond holder designed to be held between centers on a grinder, with an adjustable vertical support resting on the table. This tool is intended for use on manufacturing work, the object being to true off the wheel to exactly the required distance from the centers, thereby maintaining the required diameter of the work and saving the time usually spent in readjusting the wheel.

Portable Internal Grinder: Standard Electric Tool Co., Cincinnati, Ohio. This tool is particularly intended for grinding gasoline and pneumatic engine cylinders, but can also be employed for handling a variety of other classes of work. The tool is provided with a shank which is carried in the toolpost of a lathe. The motor is adapted for operation on either alternating or direct current. The wheel is 3½ inches in diameter by 1 inch face width.

Inverted Drilling Machine: Foote-Burt Co., Cleveland, Ohio. An inverted drilling machine in which the drill operates from below. This machine is intended for drilling carbon steel billets containing 0.90 per cent carbon, which are 4 or 5 inches in diameter and 20 inches long. The purpose of having the drill arranged in this way is to have the driving spindle rigidly supported in the base of the machine.

Hydraulic Bending Press: Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. A 30-ton bending press particularly designed for bending heavy pipe, although it may be used for a variety of other bending operations. Various shaped blocks may be fitted to the ram, and the supporting blocks on the bed of the machine may be set at different distances from the center by means of toothed contact surfaces. The weight of the machine is 1100 pounds.

Concave Roll Grinding Attachment: Woods Engineering Co., Alliance, Ohio. The universal tool and cutter grinder of this company's manufacture has recently been equipped with a special extension head which provides for grinding concave rolls. For this purpose, the machine is set with the top table at an angle and the grinding head swiveled until the wheel is over the center of the roll. The angle at which the top table is set determines the radius of curvature of the concave roll.

Slab Miller: Newton Machine Tool Works, Inc., Philadelphia, Pa. A slab milling machine particularly adapted to the requirements of builders of textile machines, automobiles, etc. The dominant feature of the design is flexibility and capacity for handling a wide range of work. Cutters ranging from 1½ to 8 inches in diameter can be employed on either of the two spindles. The work-table is 60 inches wide by 9 feet long, and the width between the uprights is 72 inches.

Swedish Gage: Grönkvist Drill Chuck Co., 20 Morris St., Jersey City, N. J. Several new Swedish gages have been placed upon the market. These include the following: (1) A set of four gages 8, 12, 16 and 20 inches long, respectively, which may be used alone or in conjunction with other gages. (2) A new type of center and scribing point used in the regular holder for scribing circles, the radii of which are determined by Swedish gages. (3) A new vertical type of holder for testing the length of rods and gages. (4) Tolerance plug gages.

Automatic Rack Cutter: Gould & Eberhardt, Newark, N. J. In the February, 1914, number of MACHINERY, reference was made to the rack cutting machine of this company's manufacture with a capacity for cutting racks up to 36 inches in length by 10 inches face width. Since that time Gould & Eberhardt have brought out a machine of quite similar design, which has a capacity for cutting racks up to 60 inches in length by 10 inches face width. This machine will handle racks with teeth up to 1½ diametral pitch in cast iron and up to 2 diametral pitch in steel.

Hydraulic Ring Compressing Machine: West Tire Setter Co., Rochester, N. Y. A machine which follows the general lines of the hydraulic tire setter manufactured by this company, but which has been arranged to provide for compressing various forms and sizes of rings by hydraulic pressure. Among the applications of this machine may be mentioned the compression of steel rims for automobile wheels, the compression of pipe couplings onto pipes, and various similar classes of work. The material is compressed cold, and the machine is arranged for handling various sizes of work.

Gun Boring Lathe: Detrick & Harvey Machine Co., Baltimore, Md. An engine lathe particularly intended for gun-boring operations. The headstock is all-geared and the spindle which is of solid forged steel is 5¾ inches in diameter. The spindle thrust is taken by a roller bearing. Speeds ranging from 2 to 111 R. P. M. are available, and there are ten changes of feed ranging from 0.002 to 0.020 inch per revolution, these feeds being reversible. By shifting a clutch, ten other feeds are obtained, ranging from 0.030 to 0.333 inch per revolution. The machine is provided with a bed 30 feet long and weighs 24,000 pounds.

Die-Heads: National-Acme Mfg. Co., Cleveland, Ohio. A new type of self-opening die-head designed to cut extremely short threads in addition to threads of ordinary length. The head is adapted for cutting both fine and coarse pitches and large and small diameters, and may be used on hand screw machines, turret lathes and other machines where the tool is not revolved. Another die-head has been introduced by this company which is intended for ordinary threading operations performed on machines of the type referred to. A third die-head is designed for use on automatic screw machines, bolt cutters and other machines on which the threading tool revolves while cutting.

Upright Drill: In the February, 1914, number of MACHINERY, reference was made to the 20-inch drill manufactured by the W. P. Davis Machine Co., 305 St. Paul St., Rochester, N. Y. This machine was equipped with power feed and double back gears. Since that time the W. P. Davis Machine Co. has brought out a 32-inch machine of very similar design, except that the power feed and back gears have been dispensed with, the machine being simply provided with wheel and lever feed. This machine is particularly designed for drilling operations on switchboard work, truck wheels and other large pieces where holes up to 1 inch in diameter are to be drilled.

Metal Cutting Band Saw: Houghton & Richards, 1394 West Third St., Cleveland, Ohio. In the April, 1914, number of MACHINERY, a description was published of the "straight line" metal cutting band saw of this company's manufacture, with a capacity for cutting bars up to 6 inches in diameter. Since that time, a 12-inch machine has been placed upon the market. This machine has the same automatic stopping device and adjustable stops as the 6-inch machine. It also has the weight feed, as in the case of the 6-inch machine, in addition to which a positive worm gear feed is provided, which can be used independently or in conjunction with the weight feed. The design has been slightly modified in other respects to meet the requirements of the increased capacity.

Vertical Milling Machine: Becker Milling Machine Co., Hyde Park, Mass. In the February and October, 1913, numbers of MACHINERY, the models B and C vertical milling machines of this company's manufacture were described. Since that time the Becker Milling Machine Co. has brought out the model D machine, the design of which follows the same general lines except that the machine has a larger capacity and is of considerably heavier construction. Another point of difference is that it is equipped with single back gears in the head instead of double back gears, as in the case of the model C machine. The chief dimensions are as follows: Size of table inside oil pockets, 72 by 18 inches; diameter of rotary table, 30 inches; longitudinal table feed, 72 inches; rate of feed, 0.003 to 0.648 inch per revolution; cross-feed, 22 inches; vertical feed of spindle, 15 inches; vertical adjustment of knee, 20 inches; maximum distance from center of spindle to column, 25 inches; maximum distance from end of spindle to table 28 inches.

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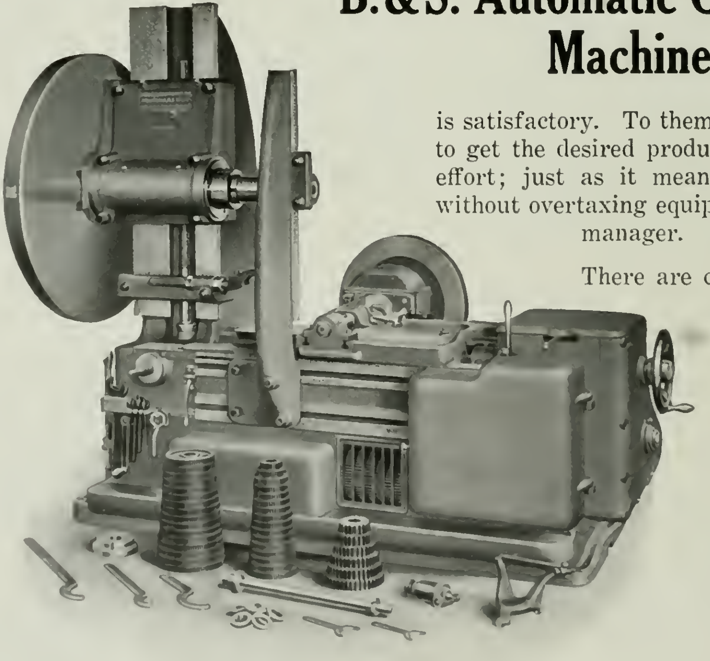

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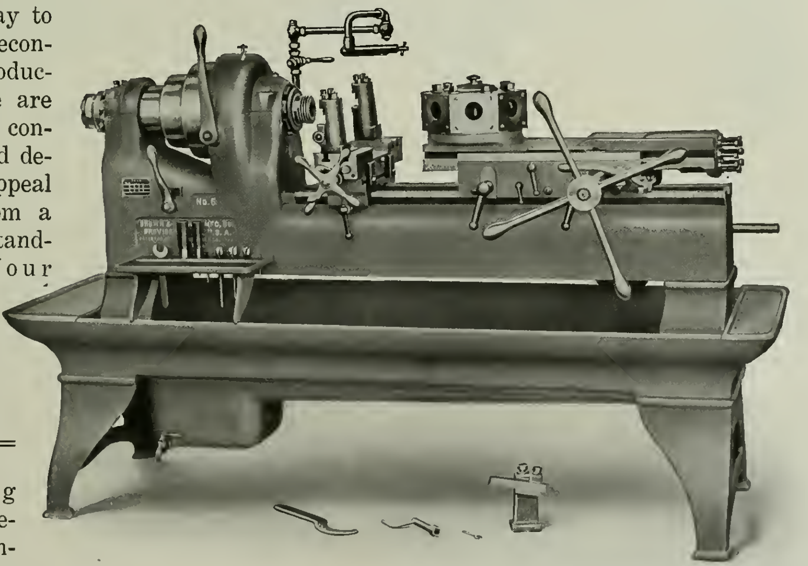

Interesting literature describing entire line on request.

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CANADIAN AGENTS: The Canadian Fairbanks-Morse Co., Ltd., Montreal, Toronto, Winnipeg, Calgary, Vancouver, St. Johns, Saskatoon. **FOREIGN AGENTS:** Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow. F. G. Kretschmer & Co., Frankfurt, a/M., Germany; V. Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway; Schuchardt & Schutte, Petrograd, Russia; Fenwick Freres & Co., Paris, France; Liege, Belgium; Turin, Italy; Zurich, Switzerland; Barcelona, Spain; F. W. Horne, Tokio, Japan; L. A. Vail, Melbourne, Australia; F. L. Strong, Manila, P. I.

READ PAGE 73

HOBBING OPERATION PERFORMED ON A CLEVELAND AUTOMATIC

The model B automatic screw machine made by the Cleveland Automatic Machine Co., Cleveland, Ohio, is shown in Fig. 1 equipped with a special attachment to provide for hobbing an eighteen-tooth worm-wheel at the center of a plunger. Details of the mechanism of the hobbing attachment are illustrated in Fig. 2, and Fig. 3 shows one of the completed plungers in which the teeth have been hobbed. This part, when finished, has a cam surface machined at the left-hand end, which drives the plunger of an oil pump. The driven plunger is set at an angle of about 30 degrees from the axis of the part on which the cam and worm teeth are machined, and is kept in contact with the cam by means of a compression spring. These parts are machined just as shown in Fig. 3, at the rate of forty per hour.

Referring to the detailed view of the mechanism of the hobbing attachment shown in Fig. 2, it will be seen that the worm gear hob *A* is mounted on a spindle carried in the housing *B*. This housing swings on the driving shaft *C* and is supported by a guide block *D* located on the front cross-slide. The rise and fall of the housing *B* is accomplished by means of an angular guide cam which is attached to the side of the housing, and engages a cam roller that is carried by a bracket secured to the guide block *D*. As the front cross-slide moves in, the guide block *D* is moved with it, and the roller engages the angular cam, thus causing the housing *B* to be drawn down until the hob *A* has cut to the required depth. When the slide recedes from the work, the conditions are reversed, thus causing the housing *B* to rise to its original position to clear the turning tool and centering attachment which are mounted on the milling slide *E*.

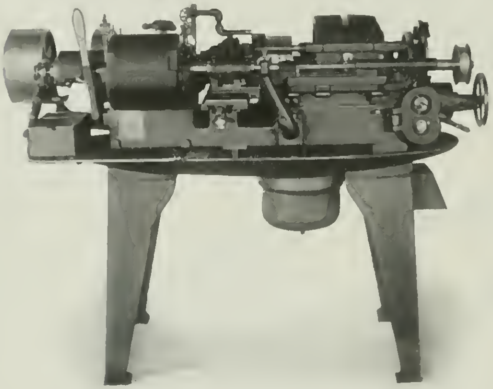


Fig. 1. Cleveland Model B Automatic Screw Machine

The performance of the hobbing operation requires the hob *A* to rotate eighteen times faster than the spindle of the machine, while the turning, forming, drilling and cutting-off operations require a second spindle speed to be employed. The machine is fitted with a No. 1 Cleveland belt shifter, which provides for the use of two belts. The forward gears *F* are used for the turning, forming, drilling and cutting-off operations, and run at a suitable rate to drive high-speed steel cutting tools at an efficient speed.

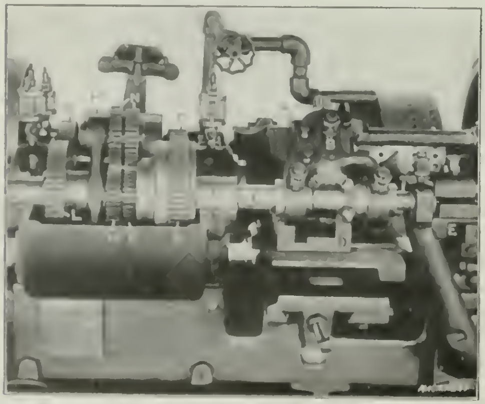


Fig. 2 Details of the Mechanism of the Hobbing Attachment

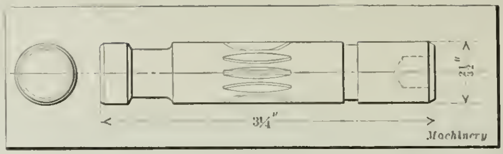


Fig. 3. A Finished Plunger with the Eighteen-tooth Worm-wheel hobbed in it

The rear gears *G* are arranged to give an 18 to 1 ratio between the hobbing spindle and the regular spindle of the machine. With the belt running on the pulley *H*, the gear *G* which is mounted loosely on the spindle engages the gear *L* which is fast on the driving shaft *C*. The gear *L* is provided with two arms which carry the planetary gears, one set of which is shown at *N*. The gear sleeve *M* is held stationary in its bearing at *O*, and the planetary gears revolve around it. The gear *P* is driven in this way, and by means of a clutch on the gear *P*, engagement is made with the gear *R*, which drives the regular front spindle gear. It will be seen that the regular spindle of the machine is driven through the planetary gears, while the hob is driven direct by the gear *L*, the 18 to 1 speed ratio being obtained in this way. This arrangement of the gearing is really the important feature of the mechanism of the attachment.

It will be evident to those who are familiar with the Cleveland "automatics" that the machine on which this attachment is used is the regular model B automatic screw machine, built by the Cleveland Automatic Machine Co., which is known as the plain automatic. The hobbing attachment is applied to this machine to adapt it for handling a special job. The complete view of the machine shown in Fig. 1 is presented with a view to emphasizing the fact that the machine itself is of standard design.

* * *

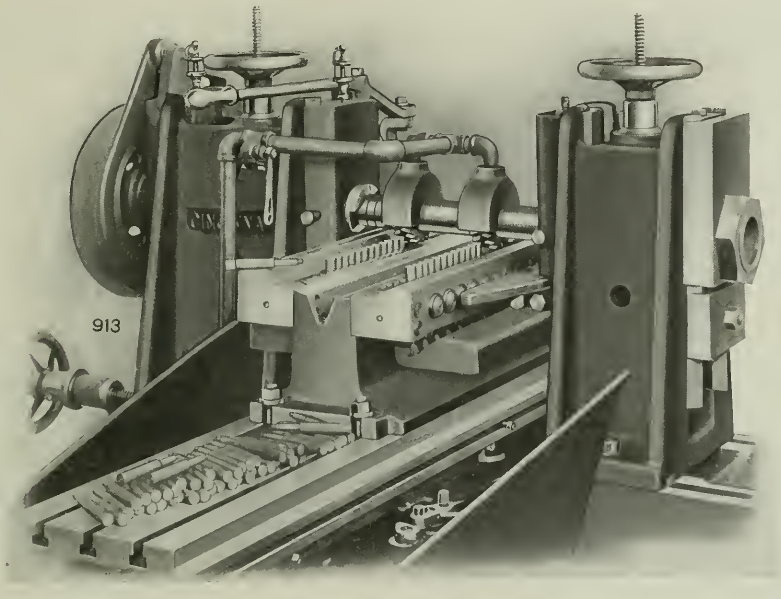
THE AUTOMOBILE INDUSTRY

The automobile show held in Grand Central Palace, New York City, in early January brought again to general attention the rapid growth of a relatively new industry and its present magnitude. The first automobile was built in the United States in 1891 and the first factory for building motor cars was established the following year. Although only a little more than twenty years old, the industry is now represented by about 480 concerns, whose annual production of automobiles, motor trucks and cycle cars has a value of over $249,200,000. The number of persons employed is 75,000 and the number of cars produced in 1914 is estimated to have been 500,000. This, added to the number estimated to be in use before, or 1,400,000, makes a total of nearly 2,000,000 cars in use in the United States alone. Before the end of 1915, the number of cars in use will probably be considerably more than 2,250,000 and the total investment represented will probably be not less than $1,800,000,000.

The exhibits shown at the automobile show totaled upward of $3,000,000 in value. Cars ranging in price from $295 to $6500 were shown, but the lower priced cars were clearly the most attractive to the greater number of visitors. The future of the automobile industry undoubtedly lies in the production of low priced cars, that is, cars costing less than $1000. There will always be markets for the higher priced cars but relatively small in volume. The application of automatic machine tools, improved alloy steels of low cost and the manufacture of parts in large quantities strictly interchangeable, have enabled the makers to supply cars in large numbers at low prices which could not have been produced at any price ten years ago.

The first automobiles were made with one-cylinder en-

THE INVERTED BATH



At 315 feet cutting speed and 6″ feed, eleven pins per minute are milled by the Edison Storage Battery Company on the Cincinnati Plain Semi-Automatic Miller. The flats are 5-8″ high by 5-32″ deep. The resulting tongues are smooth and accurate within .0005″. At the end of the stroke the table automatically returns to the starting point and stops, ready for the operator to unload. The gripping, releasing and ejecting are all automatic.

The **Inverted Bath** (patented) in which the cutters run positively cools them. This makes possible cutting speeds three to four times faster than the best former practice with a corresponding increase in production. The rush of lubricant from the hoods (12 gallons per minute) washes away the chips, giving a smoother cut and reducing the cleaning time to a minimum.

Cincinnati Stream Lubrication is synonymous with Increased Output—Smoother Finish—Reduced Chucking Time. Stream Lubrication on Cincinnati Millers will reduce your milling costs. Now's the time to investigate. May we send details?

The Cincinnati Milling Machine Co.

CINCINNATI OHIO, U. S. A.

gines, and the first two-cylinder engine was brought out in 1894. The advantages of the multiple-cylinder plan were recognized early in the development of the motor car and four-cylinder engines have been the rule for several years. Six-cylinder cars have also become popular, the reason being smoothness of operation and flexibility of speed which eliminates frequent gear changing. Smoothness of operation and flexibility of power are regarded as being so important that at least three automobile concerns have brought out eight-cylinder cars, the cylinders being arranged in two rows of four cylinders each, arranged in tandem and so-called V-form. The connecting-rods of all eight cylinders are connected to a common four-crank crankshaft.

A great automobile show like that held in Grand Central Palace gives the visitor some idea of the magnitude of the industry and of its many ramifications. It is not merely a metal-working industry but one that ranges the whole world for materials used in car making. The manufacturers of textiles, glassware, rubber, electrical apparatus and many other products have found in the automobile industry a very profitable outlet for their products.

* * *

The Engineering Foundation was inaugurated by the United Engineering Society, 29 West 39th St., New York City, Wednesday evening, January 27, before a large party of distinguished engineers. The Engineering Foundation is the name given to a fund to be "devoted to the advancement of the engineering arts and sciences in all their branches to the greatest good of engineering and to the benefit of mankind." The foundation was established by the gift of $200,000 from Ambrose Swasey, past-president of the A. S. M. E., and well known as a manufacturer of machine tools and builder of astronomical instruments, being vice-president of the Warner & Swasey Co., Cleveland, Ohio.

The administration of the fund will be entrusted to the engineering foundation board elected by the trustees of the United Engineering Society, and composed of eleven members, nine from the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Mining Engineers and the American Institute of Electrical Engineers, and two chosen at large.

* * *

PERSONALS

George C. Bardons, of Bardons & Oliver, Cleveland, Ohio, sailed for South America on a pleasure trip early in January.

Chauncey B. Heath of Boston, Mass., has been appointed general sales manager for the Bantam Anti-Friction Co., Bantam, Conn., with headquarters at Bantam.

C. E. Pratt, for the past eight years sales engineer with A. L. Ide & Sons, Springfield, Ill., has joined the Murray Iron Works Co., Burlington, Iowa, in the same capacity.

Frank E. Vandercook of Waterbury, Conn., has developed a machine for making common pins at the rate of 528 a minute. The new machine points the pins much more quickly than do the pin machines in common use.

J. W. Payne, formerly manager of the San Francisco office of the American Optical Co., has joined T. A. Willson & Co., Inc., Reading, Pa., makers of spectacles, eye protectors and goggles, as Pacific coast branch manager with offices in the Head Bldg., San Francisco.

Fred J. Miller, a well-known mechanical engineer and general manager of the Remington Typewriter Co.'s factories, has been elected a member of the Simplified Spelling Board, New York City, an organization having for its object the reformation of English spelling by the elimination of silent and useless letters.

Charles L. Benjamin, advertising manager of the Cutler-Hammer Mfg. Co., Milwaukee, Wis., for eight years, has acquired an interest in Klau, Van Pieterson & Dunlap, Inc., an advertising agency of Milwaukee. Mr. Benjamin will take an active part in the organization, with special reference to technical and trade press advertising.

T. Kennard Thomson, consulting engineer, delivered an illustrated lecture on the mechanical problems and the building of foundations for tall buildings at the monthly meeting of the American Society of Mechanical Engineers, New York City, Friday evening, January 15. Dr. Thomson also briefly described his plans for the development of a greater New York City.

Axel Bonthron, head of the machine department of Axel Ryden, machinery dealer, Stockholm, Sweden, is in the United States for the purpose of forming connections with machine tool builders with the view of representing them in the trade with Sweden and Russia. Mr. Bonthron will be in the United States until about March 1; his New York City address is Hotel Astor.

Ernest G. Gardner, 918 Madison St., Brooklyn, N. Y., sailed for South America January 30 to study commercial conditions and prospects in Ecuador, Peru, Bolivia, Chili, Argentine, Uruguay and Brazil. Mr. Gardner is being sent by manufacturers of Newark, Jersey City and Brooklyn. He also represents the Newark Board of Trade, Jersey City Chamber of Commerce, etc.

* * *

OBITUARIES

T. B. Pierce, superintendent of the Boston Gear Works, Boston, Mass., died December 19 following an attack of heart disease of two weeks' duration, aged fifty-four years.

A. O. Slentz, general manager and vice-president of the Canton Foundry & Machine Co., Canton, Ohio, died suddenly January 11 of heart failure, aged sixty-nine years. Mr. Slentz worked energetically for over fourteen years in developing the machines manufactured by the company. He brought the line of machine tool specialties and sheet metal machines up to a high standard and consequently his loss will be keenly felt by many in the sheet metal and iron industries.

COMING EVENTS

April 24-May 1.—Second Efficiency Exposition at the Grand Central Palace, New York City. Organized by the Efficiency Society, Inc., 41 Park Row, New York City.

June 9-11.—Annual convention of the American Railway Master Mechanics Association, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

June 14-16.—Master Car Builders' annual convention, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

July 19-21.—Seventh annual convention of the American Railway Tool Foremen's Association, Chicago, Ill., Hotel Sherman, headquarters. A. R. Davis, secretary-treasurer, 750 Pine St., Macon, Ga.

August 17.—Annual meeting of the International Railroad Blacksmiths' Association, Philadelphia, Pa. A. L. Woodworth, secretary-treasurer, C. H. & D. Railway, Lima, Ohio.

NEW BOOKS AND PAMPHLETS

Copper Wire Tables. 76 pages, 6 by 9 inches. Published by the Department of Commerce, Washington, D. C., as circular of the Bureau of Standards No. 31.

Third Annual Report of the Chief Inspector of Locomotive Boilers to the Interstate Commerce Commission. 77 pages, 6 by 9 inches. Illustrated. Published by the Interstate Commerce Commission, Washington, D. C.

Specific Heat of Copper in the Interval 0 to 50 Degrees C. By D. R. Harper. 72 pages, 7 by 10 inches. Illustrated. Reprinted from the Bulletin of the Bureau of Standards as Scientific Paper of the Bureau of Standards No. 231, by the Department of Commerce, Washington, D. C.

How to Run and Install Gasoline Engines. By C. Von Culin. 98 pages, 3⅝ by 6 inches. Illustrated. Published by Norman W. Henley & Son, New York City. Price, 25 cents.

This little pocket manual deals in a practical way with two-stroke cycle and four-stroke cycle marine engines, and was compiled for the use of all classes of motor boat operators. A complete index of subjects treated facilitates quick reference to the sections desired.

First Annual Report of the Commission on Industrial Relations. 70 pages, 6 by 9 inches. Published by the commission, Washington, D. C.

The report is devoted to the scope of the commission's work, organization, general results of hearings and an account of the research and investigation into trade unions and employers' associations, conditions of organized labor, scientific management, arbitration, women and children in industry, the elimination of human waste, agriculture and land problems, unemployment, social legislation, interstate competition, labor and the law, etc.

Universal Safety Standards. By Carl M. Hansen. 312 pages, 5¼ by 7½ inches. Illustrated. Published by Universal Safety Standard Publishing Co., Philadelphia, Pa. Price, $3 net.

This is a reference book of rules, drawings, tables, formulas, data and suggestions for use of architects, engineers, superintendents, foremen, inspectors, mechanics and others concerned with the administration of factories. It deals with buildings, fire hazard, stairs, floors, railings, elevator-hatchways, boilers, engines, power transmission, ladders, safety organization in plant, first-aid equipment, signs, etc. It is classified in four parts: general, machine shop, foundry and rules and practices. Illustrations of guards for many different types of machines show the principles of safeguarding machinery in general, and many common ones in particular. The illustrations are made from line drawings and the safety features are printed with green ink, thus bringing them out very clearly. The safeguarding of machinery is no longer a theoretical consideration, but a practical matter which must receive the attention of the shop engineer if manufacturers are to escape heavy damages through the operation of workmen's compensation laws. The book has already had a large sale, although first published in 1913. It was compiled under the direction of and approved by the Workmen's Compensation Service Bureau of New York State, and therefore represents the bureau's minimum requirements for industrial safety. This bureau is an association of twenty of the leading stock casualty insurance companies and its principal work is the determination of correct workmen's compensation and liability insurance rates. Compensation laws have made indemnity for accidents compulsory, and in order to reduce the cost of production and effect a saving in operation, accident prevention must be made one of the principal features of administration. The book is one that can be recommended to all manufacturing concerns, contractors and others employing labor in hazardous occupation.

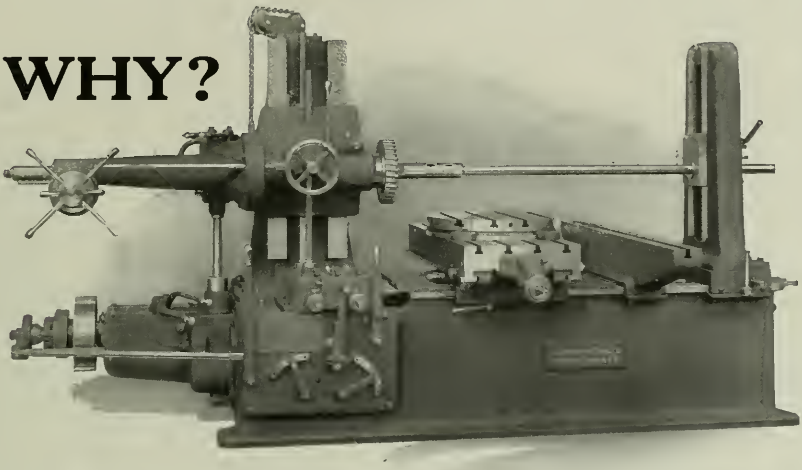
NEW CATALOGUES AND CIRCULARS

Emerson Electric Mfg. Co., St. Louis, Mo. Catalogue 6700 on alternating and direct-current fan motors.

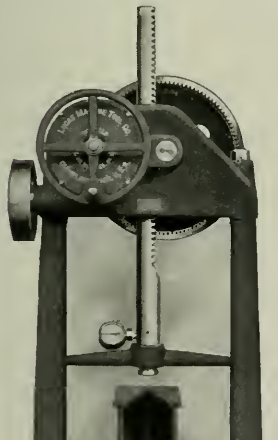
All the tools of a concern recently discontinuing business were offered for sale, and among the VERY FIRST TO BE SOLD were the

"PRECISION" BORING, DRILLING & MILLING MACHINES

WHY?



BROACHING



When the holes to be finished are so small that a long *draw* broach pulls apart, or when the amount of work does not justify investing in a regular

Broaching Machine

THE LUCAS
Power Forcing Press

is not only IDEAL for the work, but is always on hand for the many other jobs that *gravitate to it* soon after it is installed.

Look It Up!
(Don't be a Matthew Mears)

LUCAS MACHINE TOOL CO., NOW AND ALWAYS OF CLEVELAND, O., U. S. A.

AGENTS: C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Berlin, Brussels, Milan, Petrograd, Barcelona, Bilbao. Williams & Wilson, Montreal, Can. H. W. Petrie, Ltd., Toronto Ont. Donauwerk Ernst Krause & Co., Vienna, Budapest, Prague. Andrews & George, Yokohama, Japan.

F. W. Lindgren Co., Rockford, Ill. Circular of 20-inch high-speed all-geared drilling machine, having capacity to drive a 1¾-inch drill through steel.

Ready Tool Co., 654 Main St., Bridgeport, Conn. Circular of "Safety First" belt shifter for replacing belts on pulleys in motion without necessitating the use of a ladder.

Deschauer Wire & Iron Works, 2025 Seminary Ave., Chicago, Ill. Leaflet advertising wire guarding for windows, doors, partitions, tool-room enclosures, railings, fencing, etc.

Hoover Steel Ball Co., Ann Arbor, Mich. Price lists of steel, brass and bronze balls; micro-chrome steel balls; steel burnishing balls; and acid-resisting hollow bronze balls for pumps, valves, etc.

Gardner Governor Co., Quincy, Ill. Circulars A-C5 and G-R2 containing complete description of Gardner horizontal single-cylinder air compressors, and Gardner-Rix vertical air compressors, respectively.

Production Engineering Co., 1716 Spring Garden St., Philadelphia, Pa. Pamphlet of burners and equipment for fuel oil and a reprint of an article entitled, "Fuel Oil and Its Applications," by David Townsend.

Turner Construction Co., 11 Broadway, New York City. Bulletin 14 showing a number of structural concrete industrial buildings constructed by the company, and describing the organization and its general activities.

Maris Bros., Philadelphia, Pa. Catalogue describing and giving specifications of Maris double-beam hand cranes, single-beam cranes, I-beam trolleys, "Tribloc" chain hoist, combined hoist and trolley, and transfer crane.

Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass. Circular of the Baush worm drive, illustrating examples and showing a worm-gear efficiency machine with which the in-put and out-put of worm-gears is measured.

General Electric Co., Schenectady, N. Y. Bulletin 44004 devoted to railway line material for direct suspension. Bulletin 49901 describing an oil-testing set by means of which the dielectric strength of oil can be easily determined.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Announcement of the plan adopted by the company for employes' sickness and accident relief, accident compensation, and service compensation which went into effect January 1, 1915.

Webster & Perks Tool Co., Springfield, Ohio. Leaflet entitled "Safety First Appliances for Emery and Abrasive Wheels," illustrating exhaust type wheel guard or protection hood, plain type wheel guard or protection hood, and bevel safety flanges for grinders.

Cleveland Automatic Machine Co., Cleveland, Ohio. Circular of the new Cleveland model G, full automatic machine made in ¾ and ⅝ inch sizes. The circular shows a number of parts produced on this machine, and gives the output per hour for each in brass or steel.

J. T. Burr & Son, 429 Kent Ave., Brooklyn, N. Y. Circular of No. 11 Burr portable shaft keyseater, electric motor driven. The machine will mill 12 inches at one setting and any width of keyway from ¼ inch to 1¼ inch, and can be used on shafts up to 5 inches diameter.

Harding Distributing Co., Boston, Mass., is issuing a booklet entitled "Bearings—Use and Misuse," with the purpose of pointing out the defects in the present methods of scraping bearings and showing the advantage obtained through the use of the Martell aligning reamer for this work.

General Fire Extinguisher Co., 1 Liberty St., New York City. Grinnell automatic sprinkler bulletin for January, illustrating the ruins resulting from the fire in the Thomas A. Edison, Inc., plant, and the danger of letting manufacturing establishments go without adequate sprinkler protection.

Fulton Machine & Vise Co., Lowville, N. Y. 1915 catalogue on vises and centrifugal pumps. All the various types of vises illustrated have welded cast steel faced jaws, making them especially strong. The centrifugal pumps are belt, engine or motor driven and of a design that combines strength and simplicity.

Voorhees Rubber Mfg. Co., 18-40 Bostwick Ave., Jersey City, N. J. Sample of "Rub-steel," a combination of rubber and steel so perfectly united that the rubber cannot be removed without tearing. The rubber is united to the steel by a patented process and the accomplishment is the result of efforts extending over a period of forty years.

McGill Metal Co., Valparaiso, Ind. Circular of die-cast brass and bronze machine parts, having a tensile strength of 75,000 to 85,000 pounds per square inch and 30,000 to 40,000 pounds elastic limit. The company makes a specialty of casting gears which are claimed to be the equal of or superior to casehardened steel gears in every respect.

Houghton & Richards, 1302 W. Third St., Cleveland, Ohio. Circular describing the H. & R. straight-line metal-cutting band saw. This machine will cut work of any irregular form—bar stock, [illegible] beams, angles, rounds, squares, flats and other forms or shapes. It is built in two sizes to cut from 0 to 6 inches square and from 0 to 12 inches square.

Becker Milling Machine Co., Hyde Park, Mass. Leaflets and pamphlet describing the Becker model A vertical milling machine with cone drive; model A B vertical milling machine with rotary attachment; model B vertical milling machine with single-pulley drive, and model C vertical high-power milling machine for heavy work requiring great precision.

Mesta Machine Co., Pittsburg, Pa. Bulletin L descriptive of the "Mesta" quick-acting steam-hydraulic forging press with single lever control. These presses are built with single frames in sizes from 200 to 400 tons capacity, and the four-column presses range in size from 500 to 12,000 tons capacity. All motions of the press are controlled by a single lever.

American Pulley Co., Philadelphia, Pa. Loose-leaf binder containing data sheets on "American" pulleys. These sheets treat of the hub shell, spiders, rims, crown, groove in face, safety for belts and many other subjects of interest in connection with pulley construction. The company has also issued a number of circulars setting forth the advantages of the "American" pulley.

Armstrong Cork Co., Pittsburg, Pa. Booklet entitled "Permanent Fortifications," containing some interesting facts relating to the value of good heat insulation. After twelve years of special study of this subject, four types of heat insulation have been brought out, as follows: "Nonpareil" corkboard, "Nonpareil" cork covering, "Nonpareil" insulating brick, and "Nonpareil" high-pressure covering.

General Electric Co., Schenectady, N. Y. Bulletin 42010 describes in considerable detail the small turbo-generator sets—from 7 to 300 kilowatts capacity—made by the company. Bulletin 42300 describes the General Electric line of direct-connected generating sets, ranging from 2½ to 75 kilowatts. Bulletin 45602 deals with the subject of the protection of series lighting circuits by lightning arrestors.

St. Louis Machine Tool Co., St. Louis, Mo. Circulars illustrating and describing the "St. Louis" and "Western" lines of grinding machinery manufactured by this company. The illustrations make the construction of these machines very clear, and the tables of specifications give all the necessary information. A new tight and loose pulley of improved construction has been incorporated in the "St. Louis" grinders.

Black & Decker Mfg. Co., 113-115 S. Calvert St., Baltimore, Md. Catalogue showing some of the special machinery built by this company, which includes machines for making paper money, multiple letter writer, postage stamp slitting and coiling machine, and other special purpose machines. Milling fixtures, drill jigs, punches and dies, drill presses and milling machines manufactured by this company are also shown.

Hoefer Mfg. Co., Freeport, Ill. Catalogue of fixed center and adjustable center multiple-spindle auxiliary heads for drilling machines, showing a variety of designs, combinations of spindles, etc., which have been furnished for manufacturing drilling. The number of spindles in the auxiliary heads shown range from two to twelve, and the economy of the attachment in saving drilling machines and drilling time is clearly set forth.

Pelton Water Wheel Co., Inc., San Francisco, Cal. Bulletin 8 of Pelton water wheels, describing the construction and application of the Pelton system. The pamphlet points out that even a small stream under a moderate head when used by water wheels of high efficiency and modern design may be made to develop considerable power, and that such sources of power often may be profitably utilized even though they are not constant the year round.

James Clark, Jr., Electric Co., Louisville, Ky. Catalogue 24 on "Willey" electrically driven tools, showing hand drills, portable drills, electrically driven reamer, portable radial drill, special toolmaker's grinder, center grinders, surface and internal grinders, bench grinders, floor grinder, electrically driven buffer, electrically driven hacksaw, sensitive drills, notching press, winding machine, turntable motor, and direct-connected motor and dynamo.

New Process Twist Drill Co., Taunton, Mass. 1915 catalogue on hot-forged twist drills of carbon steel and high-speed steel. In addition to tables giving dimensions and prices, some suggestions on speeds and feeds are given, together with tables of speeds, decimal equivalents of drills in stock, drill list for machine screw taps, sizes of tap drills, and weights of round, square and hexagon steel. Prospective purchasers will find the book a comprehensive compilation of twist drill data.

Pedrick Tool & Machine Co., 3639 Lawrence St., Philadelphia, Pa. Catalogue for 1915 showing the line of portable machine tools manufactured by this company. Some of the tools described are: cylinder boring-bar, valve seat boring-bar, motor driving attachment for boring-bars, turning machine, milling machine, pipe bending machines, automobile cylinder reboring machine, piston ring grinding machine, armature and axle bearing boring machine, rotary planing machine, locomotive cylinder and dome facer. Complete descriptions of the various machines are given.

Detroit Fuse & Mfg. Co., Detroit, Mich. Catalogue on the line of electrical apparatus manufactured by this company, which comprises iron-clad switchboards, fused switches, motor starters, "Arkless" fuses, cut-outs, contact clips and terminals. As is well known, electrical apparatus is particularly hazardous to operate, and with this in mind, the Detroit Fuse & Mfg. Co. has given especial attention to safety requirements in the design of its product. How this has been accomplished is clearly set forth in the first two pages of the book, under the heading "Industrial Safety."

Conway & Co., Cincinnati, Ohio. Catalogue 1915-A devoted to the Conway patent friction clutches. Some of the advantages of these clutches are: simplicity of construction, there being but five parts; directness of action, the lines of force being directly central, without side pull or end-thrust; compactness and reliability. These clutches are made in two types—the compression and expansion type. The former is especially adapted for use on lineshafts, countershafts and all places where the power is transmitted by belt or chain. The expansion type is suitable for special machinery and couplings.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin 34-K descriptive of class N-SO and N-SG fuel oil and gas-driven compressors, and their application to the unit system of air power plants. This is a new line of machines and is intended to increase the economy and sphere of usefulness of these compressors, through the utilization of low-grade fuel oil for power purposes. Class N-SO compressors are made in four standard strokes, viz., 8, 10, 12, and 14 inches, and the catalogue gives their capacities, speeds and general dimensions conveniently arranged in tabular form.

Pawling & Harnischfeger Co., Milwaukee, Wis., is commemorating its thirtieth anniversary by the publication of a book entitled "Thirty Years of Progress" that gives the history of the activities of the concern from the time of its inception in 1884 to the present. The book is handsomely illustrated with views of the plant as it was and of the various departments that now exist, which indicate the remarkable growth that the last thirty years has seen. The work first undertaken by the company was general jobbing work (both in the machine and pattern line) and the building of machinery under contract. In 1887 the firm began the manufacture of electric-driven cranes, now the chief product of the company. These machines have been greatly improved, and the company now turns out a very extensive line of cranes and accessories.

TRADE NOTES

Hyatt Roller Bearing Co. has removed its general sales office from 1120 Michigan Ave., Chicago, Ill., to Newark, N. J.

E. G. Smith, maker of graduated beam calipers and other tools, has removed from Columbia, Pa., to 315 West Park Ave., Tampa, Fla., where he will continue his business as heretofore.

Patterson Tool & Supply Co., Dayton, Ohio, has removed to its new quarters, 123-125 E. Third St., in the Huffman-Harries Block, Dayton. The old store of this company was wrecked in the great Dayton flood.

Kearney & Trecker Co., Milwaukee, Wis., manufacturer of the Milwaukee milling machine, announces that L. H. Mesker, now connected with its sales department, will represent the company in the state of Ohio.

Hendey Machine Co., Torrington, Conn., has established three branch offices at 141 Milk St. (Oliver Bldg.), Boston; 85 Liberty St. (Singer Bldg.), New York; and 565 Washington Blvd. (Sharples Bldg.), Chicago.

Bellevue Furnace Co., 703-711 Bellevue Ave., Detroit, Mich., has purchased the drawings, patterns, brick molds, good will, etc., of the Industrial Furnace Co., formerly of Detroit, and is therefore prepared to furnish all appliances manufactured by this concern and repairs for same.

Hoover Steel Ball Co., Ann Arbor, Mich., is manufacturing a micro-chrome bearing ball which is claimed to be the most nearly perfect ball made. Special measuring instruments were made for measuring these balls, indicating variations of 0.00005 inch or one-twentieth of a thousandth inch.

Pratt & Whitney Co., Hartford, Conn., has purchased from the receivers of the Pope Mfg. Co. the Capital Ave. property for $300,000. The Pratt & Whitney Co. will immediately take possession of the plant and utilize it for manufacturing the machines and equipment required to fill the large orders received from Europe.

Bearings Co. of America, 250 W. 54th St., New York City, is successor to the J. S. Bretz Co., the Fichtel & Sachs Co. and the Star Ball Retainer Co. No change has been made in the personnel or the general management of the business, the plan being to continue the same as heretofore in the sale, production and importation of F. & S. annular ball bearings, etc.

Files Engineering Co., Providence, R. I., steam specialists and engineers, has established a branch office at 120 Kossuth St., Bridgeport, Conn. The company requests catalogues and other literature descriptive of apparatus and appliances relating to its lines of business (which are power, heating, drying, evaporating and steam specialty work of every description) sent to the Bridgeport office.

T. A. Willson & Co., Inc., Reading, Pa., was awarded the grand prize at the Second International Exposition of Safety and Sanitation held at Grand Central Palace, New York City, December 12-19. This is the highest award to the makers of eye protectors and was made in recognition of the merits of the Willson safety glass, the new Willson goggle and the "Albex" eye protector.

MARCH MACHINERY 1915

Wire-Winding Big Guns for Uncle Sam

by

Chester L. Lucas *

THE strengthening of artillery by wire-winding is a subject that has received the attention of ordnance experts for years. There are many different opinions as to the merits of wire-wound guns, and they have been freely expressed by authorities in this country and abroad; therefore, it will not be attempted in this article to discuss wire-wound guns from the engineering standpoint, but rather to describe the details of the operation of applying the layers of wire to the gun as done in the United States Arsenal at Watervliet, N. Y.

The antiquity of the principle of reinforcing guns with wire is evidenced by an early cannon now in the museum at the Woolwich Arsenal in England, that was said to have been used by Gustavus Adolphus early in the seventeenth century. This cannon is about six feet in length, with a copper barrel, and is reinforced by being wound with hempen cord and then covered with leather. The practical application of this principle to modern warfare, however, commenced about 1850, with the efforts of Longridge in England and his contemporary Woodbridge in America. Since that time, the wire-wound gun has been used to a growing extent in Great Britain and Europe, but it is only during the past eight years that wire-wound guns have received official recognition in the United States. At the present time the wire-wound gun is used for coast defense only.

The Principle of the Wire-wound Gun

Before taking up the operation of wire-winding, a few words on the principle involved may not be amiss. Many years ago it became apparent to ordnance experts that a gun built up of successive tubes shrunk in place was far superior to a gun made from a solid billet. Under the gas pressure of firing, it was found that the metal nearest the bore of a solid gun was stretched beyond its elastic limit, while the outside metal was unaffected, receiving none of the strain. Therefore, no matter how thick the walls of the guns were made, the inner metal around the bore was the only part that received the gas pressure, and as soon as this metal became fatigued the gun was unfit for use. By building the guns of tubes, successively shrunk one over the other, it was found possible to close in the metal of the inner tube by shrink-pressure of the outer tubes so that when the gun was fired the metal of the inner tube had to be first expanded back to its natural condition and then stretched beyond its elastic limit before being fatigued. As the succeeding layers of these tubes were shrunk in position, this stretching of the inner tube was resisted by the pressure of each of the outside bands, and consequently the life of the gun was greatly lengthened; in addition, it was possible to build a much lighter gun of the same relative strength as the solid gun. From the above it will be seen that the winding of guns with wire that is under tension brings about the same condition as is obtained by shrinking on tubes successively, and it is claimed that the use of high tensile strength wire gives the gun strength attainable in no other way.

There are two principles employed in applying wire to guns, one of which consists in winding successive layers of wire at the same tension. The second system consists in winding the wire at a varying tension, decreasing with each successive layer. The first system is, of course, applied with the minimum amount of trouble, but it is claimed that the second principle has the advantage of distributing the firing strain in as nearly uniform a manner as possible.

Fig. 2 shows a sectional view of the Crozier type of wire-wound gun, reproduced from "Ordnance and Gunnery," by Capt. L. L. Bruff. This view is reproduced to illustrate the manner in which the layers of wire are distributed over the length of the gun. In each series of reinforcements, about ten layers of wire are applied. At the breech end of the gun, the reinforcement is heaviest. At the muzzle end the layers are fewer in number, but the wire is put on at a higher tension in order to give the necessary strength with the smallest amount of wire. Covering tubes are shrunk in place over the wire and each of these tubes is "stepped" so

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* Associate Editor of MACHINERY.

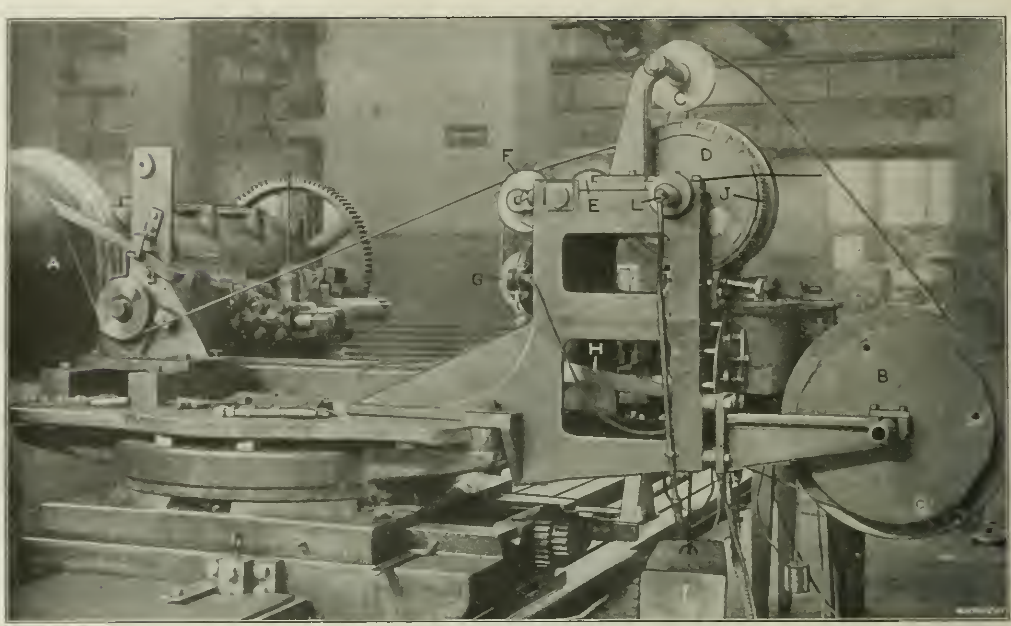

Fig. 1. Important Parts of Machine used for winding Wire on a 14-inch Gun

that it has a bearing on one of the adjacent tubes as well as on the layers of wire.

The wire used for this work in the United States is square in section, being one-eighth inch diameter with slightly rounded corners. The English and Continental practice employs for the most part wire of rectangular section. The material is cold-drawn steel, having a tensile strength of 180,000 pounds per square inch and an elastic limit of 140,000 pounds per square inch. Its quality is an all-important factor, and is maintained by rigid physical and metallurgical tests.

The Wire-winding Apparatus

Fig. 1 illustrates the operation of winding wire on a 14-inch gun. The work is done in a large gun lathe, and the gun itself is rotated, drawing the wire from the wire-reel as it is wound on the gun. Between the gun shown in Fig. 1 at *A* and the reel *B* is the tensioning mechanism. A similar tensioning mechanism is shown in Fig. 3, although the details of the latter are slightly different from those in Fig. 1. Both views, however, illustrate the principle. The wire, as it leaves the reel, passes over an idler *C* and thence between the two friction disks which are indicated at *D*. A guide wheel *E* is in contact with the edge of the friction disk, and insures that the wire enters properly.

When the wire passes between the halves of the friction disk, it just fits into a square recess, half of which is cut in each disk. A very powerful spiral spring presses the halves of the disk constantly on the sides of the wire, and it is one of the functions of guide wheel *E* to force the wire into the groove cut in the friction disk. The wire runs around the friction disks, being in contact for nearly three-fourths of the circumference, and then passes over the fixed pulley *F*. From there it runs down over the floating pulley *G*, forming a loop, and back again over another groove in pulley *F*. The arrangement of pulleys *F* and *G* is much the same as in the familiar block and tackle. Pulley *G* that floats in the loop of wire has suspended from its center a lever *H* that is pivoted on the extreme left-hand end, and on the extreme right-hand end of the long arm is hung the heavy weight *I*, shown only in Fig. 1. The weight on this lever may be varied, of course, to change the tension on the loop of wire, but in the illustration Fig. 1 this weight is 240 pounds and the leverage is so compounded that there is a pull on the wire amounting to 625 pounds. From these figures it may be seen that the wire, as it is wound on the gun, is under a tension of 40,000 pounds.

On the shaft with the friction disk is a brake drum that, in connection with two brake-bands, one of which is shown at *J*, impedes the rotation of the shaft. The object of having two brake-bands is to regulate the "drag" that is being applied to the wire. The wider of these bands is kept at a fixed tension, and the narrower is adjusted when increased or decreased drag on the wire is desired. The action of the brake and bands generates considerable heat, and to dissipate this, a stream of water passes through the center of the brake drum. The pipe for this purpose may be seen in the illustration, Fig. 3, entering the center of the axle at *L*. The drag of the friction upon the wire, on the one hand, and the pull of the wire as it is drawn onto the gun, on the other hand, support the wire while the tension is being secured. The compounded weight *I* that pulls upon the loop of wire around pulleys *F* and *G* gives this tension.

This lathe is geared so that the carriage holding the tensioning mechanism, wire and reel travels at the rate of one-eighth inch to each revolution of the spindle. As the wire is exactly one-eighth inch in diameter this, of course, is the proper lead. In order to make sure that the wire is wound closely, a spring finger bears against the strand of wire just before it is laid in place upon the gun. This insures that it is crowded over against the convolution previously applied. This may be seen on a large scale in Fig. 4. The wire is wound on the gun at the rate of 120 to 240 feet per minute.

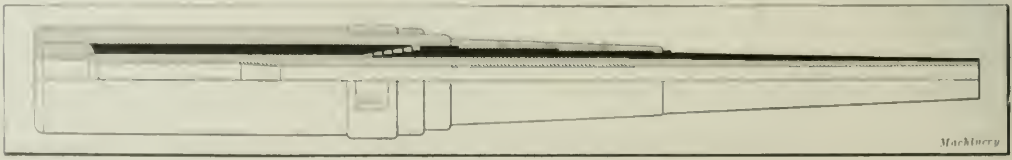

Fig. 2. Section of Crozier Type of Wire-wound Gun

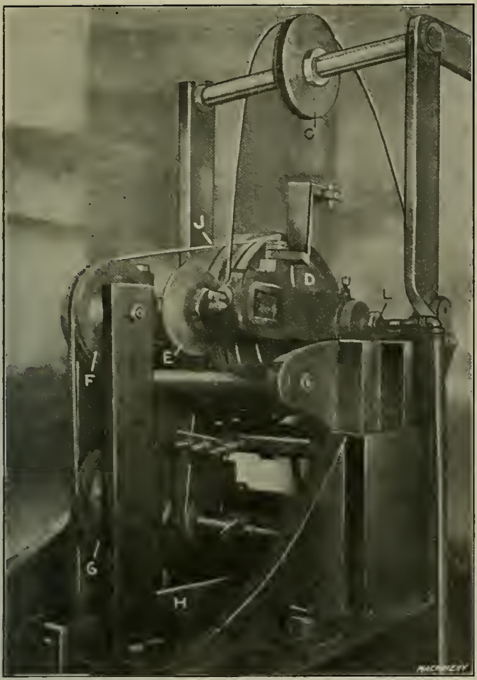

Fig. 3. Mechanism for obtaining Tension in winding Wire

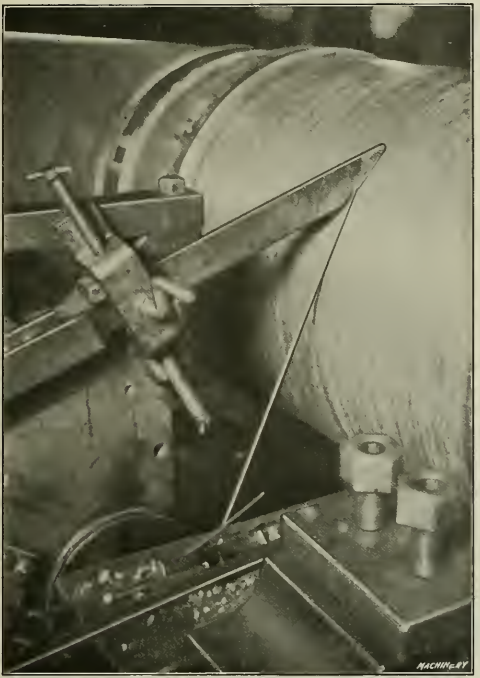

Fig. 4. Wire wound onto Gun

"Filling In" at the End of the Layers

At the end of each layer of wire it is obvious that there will be a space that the wire cannot fill on account of the fact that the turns are helical. This space is one-eighth inch wide at the beginning and tapers down to nothing at the end of the revolution, but even this slight space must be filled to complete the layer and form a good foundation for the next layer of wire. A strip of wire long enough to go around the gun is tapered for its entire length from one-eighth inch at one end to nothing at the other end. This is also tapered for about an inch at the thick end to fit in under the strand of wire as it passes up to the next layer. These points are clearly shown in Fig. 5. This length of tapered wire is carefully driven into place and the new layer started on its course. At the beginning of this new layer it is also necessary to insert another filler wire to close up the space left. Thus two filler wires are required for each layer of wire wound. As these filler wires are several feet long and only one-eighth inch square at the heavy end, it is rather difficult to hold them for planing the taper from end to end. The type of planing fixture used supports the wire on three sides, being clamped at six-inch intervals. Only the top is left open and but one wire is planed at a time.

When joining the end of one reel of wire to a new reel, the connection is made by electrically soldering with hard solder. The two ends of the wire are scarfed and clamped in the copper faced terminals of the electric heating fixture. Between the scarfed ends of the wire, a piece of sheet silver solder is placed and the joint well fluxed with a borax paste. The current is then turned on and ten seconds heats the ends, flows the solder, and completes the joining, and there is none of the "fuss" usually experienced when the blow-pipe is used.

On starting the strand of wire, the end is driven into a hole or recess in the gun body, and the end of the strand of wire on the last layer is also secured by being driven into a chiseled groove cut into the solid metal. The method of securing the end of the strand is illustrated in Fig. 6, and the groove is made small and deep enough so the wire can be driven down into it and the edges of the groove peened over onto the top of the wire, thus bolting it effectually.

After all the wire of the gun has been wound in place, a very light lathe cut is taken over the top layer, leaving the outside perfectly smooth so as to form a good surface upon which the next steel jacket may be shrunk. As the wire is cold-drawn to within limits of 0.001 inch there is very little unevenness, especially in view of the fact that it is under such high tension while being wound. The gun is now ready for the shrinkage on of the rings or covering tubes. The tubes are bored out to the external diameter of the wire, minus the allowance for shrinkage. Then, with the gun in a vertical position, breech down, and a stream of water within the bore to keep it cold, the shrink rings or tubes are heated and dropped into place. It may be well to draw attention to the fact that the shrinking on of these covering tubes is a very important operation and is done with great care. After the shrinkage allowances are calculated, the tubes must be heated very evenly before they are applied. The operation of heating is extremely important, but the careful manner in which this work is done at the United States Arsenal at Watervliet adds the finishing touches of strength, safety and reliability to the gun.

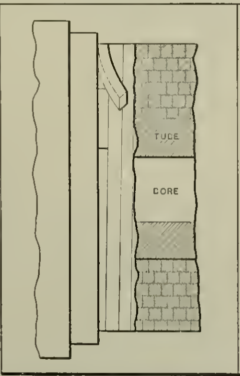

Fig. 5. Diagram showing Application of Wire to Gun

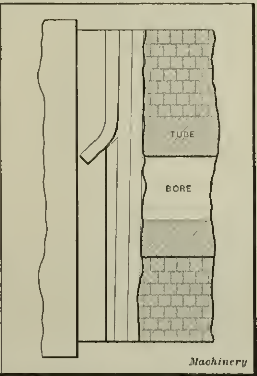

Fig. 6. Method of securing End of Strand

DIES FOR DRAWING FLANGED SHELLS*

METHOD OF FORMING FLANGED SHELL BY FORCING SURPLUS METAL FROM SHELL BODY UP INTO FLANGE

BY E. P. DAVIS†

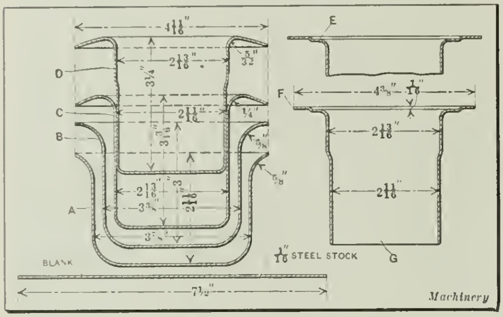

Fig. 1. Successive Operations on Flanged Shell

THE flanged shells produced in the dies to be described in this article are for automobile electric horns and are a "Made in Bridgeport" product. The successive operations from the flat blank to the finished shell are shown in Fig. 1, the order of the reference letters indicating the order of the operations. The dies used are shown in Fig. 2 and are marked with corresponding reference letters, die *A* being used for the first drawing operation *A* (Fig. 1), die *B* for the second operation, and so on. The finished shell has a flange 4⅜ inches in diameter with a recessed shoulder 1/16 inch deep. The body of the shell has two diameters of 2 13/16 and 2 11/16 inches, respectively, and it is 3 1/4 inches long. The shell is made of "three-quarter hard," cold-rolled steel, 1/16 inch thick. The blank diameter was computed by the ordinary method of finding the area of the finished shell in square inches, and then making the blank diameter to correspond to this area. In this case the area is about 43 square inches, which is approximately equal to the area of a circle 7½ inches in diameter. Several circular blanks of this size were cut to be used in making the trial drawing operations.

There are two methods of drawing a flanged shell which require more than one operation. The method that is commonly employed is to first draw the blank into a flanged cup and then reduce the size of both the cup and flange by means of successive redrawing operations until the required dimensions are obtained. When this method is employed, the width of the flange remains approximately the same, but the flange is reduced in diameter for each successive redrawing operation, the metal being drawn into the body of the cup or shell. The other method differs from the one just referred to in that the outside diameter of the flange remains about the same for all the drawing operations but the radius is diminished and the width increased for each successive operation, some of the surplus metal obtained when reducing the body diameter being forced up into the flange. Thus, as the diameter of the shell body is decreased, some of the metal flows up into the flange which is thereby increased in width; of course, the stroke of the press must be so adjusted that the drawing punch will not descend far enough to pull in the flange, thus reducing the original diameter. This second method makes it possible to secure a greater reduction in diameter of the shell body in one drawing operation, and a greater length of cup in the first operation, which reduces the strain on the metal in succeeding operations; therefore the second method ordinarily is preferable when the flange diameter is large in proportion to the diameter of the shell.

When the flange and shell body are both reduced, the flange width remaining about the same, the metal is subjected to a greater strain and more stretching, and, consequently, is made harder and more brittle, thereby necessitating several annealing operations. This additional strain upon the metal is due to the fact that a flat flange is reduced in size for each operation and must be drawn into the body of the shell. On the other hand, when the flange is gradually enlarged by pushing the metal up into it from the shell body, the stress

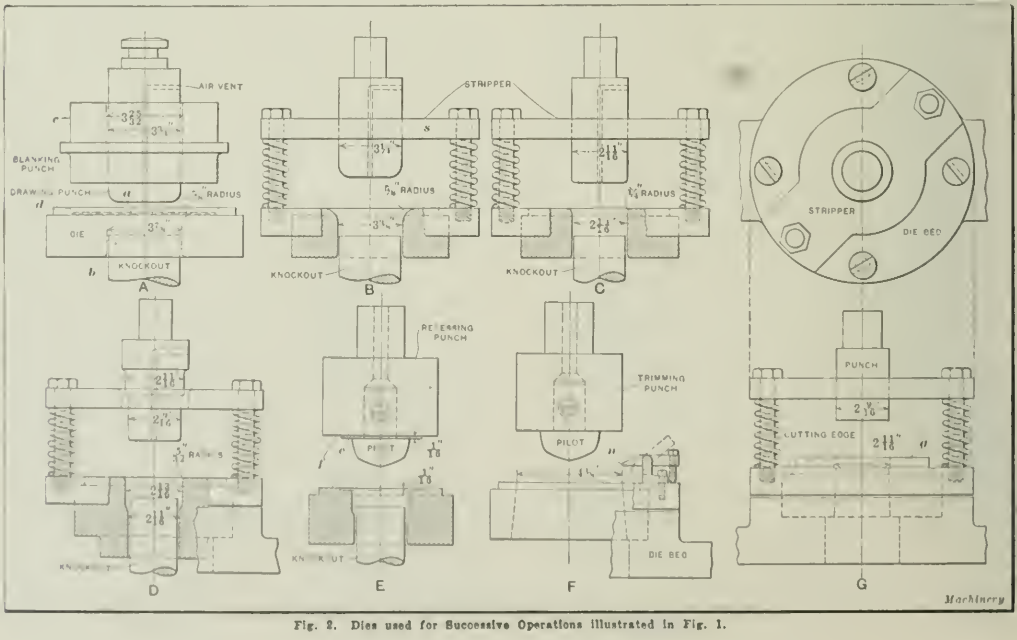

Fig. 2. Dies used for Successive Operations illustrated in Fig. 1.

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* For additional information on drawing shells, see "Drawing a Flanged and Tapered Cylindrical Shell," March, 1912, and articles there referred to.

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on the metal is less. Even though the same number of press operations may be required with one method as with the other, the second one referred to is often preferable, not only because it reduces the number of annealings necessary but also because it enables cheaper dies to be used and gives a more uniform thickness of metal in the finished part.

When designing dies for forming a flange by pushing the metal up into the flange, it is advisable to have as large a radius on the drawing edge of the first die as possible, the radius on dies for succeeding operations being reduced when necessary, thus forcing the surplus metal into the flange. When designing dies for the shell illustrated in Fig. 1, the method of establishing the diameters of the drawing dies described in the following was employed. First the diameter of the blank was determined from the area of the finished shell and, as previously mentioned, was found to be 7½ inches, the shell area being about 43 square inches. Now assuming that a flange was not required on this shell, the blank diameter would be 6 9/16 inches. Thus, as the total area of the shell is 43 square inches and the flange area approximately 9 square inches, the area of the shell without a flange equals $43 - 9 = 34$ square inches, which equals the area of a circle 6 9/16 inches in diameter. Having these two blank diameters, the respective diameters of plain flangeless cups into which they could be drawn in one operation are determined by dividing each blank diameter by the constant 1.8. (Incidentally this is a good general rule for determining the diameter of a first-operation or "cupping" die, or, in other words, the diameter to which a flat blank can be drawn in one operation.) The arithmetical mean between these two cup diameters is then determined and the diameter of the first drawing die made equal to this mean diameter. Thus, $\frac{6\ 9/16}{1.8} = 3.64$ inches, which represents the diameter to which the blank for a flangeless cup could be drawn in one operation. Similarly, the diameter into which the larger blank could be drawn equals $\frac{7\frac{1}{2}}{1.8} = 4.166$ inches. The mean diameter equals $\frac{4.166 + 3.64}{2} = 3\frac{7}{8}$ inches, approximately. Now, one operation could be eliminated in the drawing of this shell by making the first-operation or cupping die 3½ inches in diameter and the second die equal to the large size of the finished shell or 2 13/16 inches in diameter. If this were done, however, the metal would be strained and made hard and thereby require two annealings; consequently, the mean diameter of 3⅞ inches was selected for the first-operation die, as it was within the limits of three drawing operations.

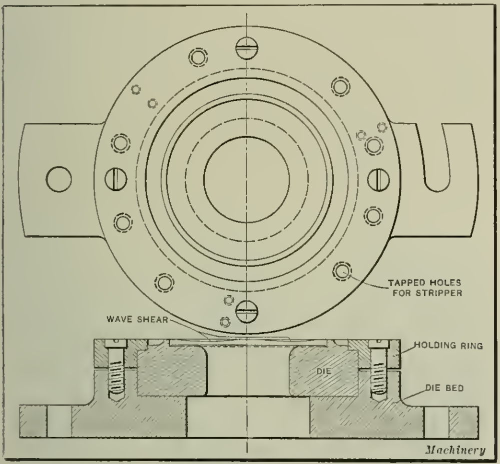

Fig. 3. Drawing Die and Die-bed

A uniform thickness of metal was required in this shell which necessitated great care in making the drawing corners of the punch and die as round and smooth as possible, in order to insure an even distribution of the metal. The outside surfaces of all dies were turned concentric with the center holes and were made interchangeable in several different die-beds of the type illustrated in Fig. 3. The holding ring which clamps the die to the bed has several tapped holes, as shown by the plan view, for fastening the stripper plates, which will be referred to later.

The die for the first operation, by means of which the flat blank is drawn into cup *A*, Fig. 1, is shown at *A*, Fig. 2. A double-action press is used. The blank, after being cut by the blanking punch, is held between surfaces *a* with sufficient pressure to prevent the blank from wrinkling while the drawing punch pushes it through the die to the proper depth, which, in this operation, is 2 11/16 inches, leaving the flange diameter 4 11/16 inches. It should be mentioned that the correctness of this flange diameter was determined by several trial drawing operations, which also showed that a shell of the required depth could be obtained. The knock-out rod *b*, the upper end of which is shown, is actuated by a cam on the crankshaft and serves to push the shell out of the die. The shank *c* of the blanking punch was turned straight and pressed tightly into the punch block of the press, where it was retained with a set-screw. As the illustration shows, the drawing punch is provided with an air vent to prevent the formation of a partial vacuum between the end of the punch and shell when the latter is being stripped. These air vents are also used on the drawing punches for succeeding operations, as the illustration shows.

The blanking punch of die *A* is bored 1/32 inch larger in diameter than the drawing punch to prevent any binding between the two. Each drawing punch is ⅛ inch smaller in diameter than the die to allow for the thickness of the stock. All of the punches were ground after hardening and were made slightly tapering, the lower or drawing end being 0.002 or 0.003 inch small to facilitate stripping the shell from the punch. The recess *d* which forms the cutting edge of the blanking die was not turned until the correct blank diameter was determined by trial drawing operations. After deciding on the exact blank diameter, the recess in the die was ground and the hardened blanking punch also ground to fit into it. The hole in the drawing die was not only ground but lapped, because a lapped hole has a longer life than one that is merely finished by grinding. This die, when in use, was held in the type of die-bed illustrated in Fig. 3. The shell was annealed after this first operation and did not require any further annealing.

A very safe rule for determining the diameter of a redrawing die and the amount that a shell can be reduced in diameter in a redrawing operation, when using steel varying from 1/32 to 3/32 inch in thickness, is as follows: The diameter of redrawing die $=$ shell diameter $- \frac{\text{shell diameter}}{5}$; that is, the shell is reduced an amount equal to 20 per cent of the diameter. Applying this rule or formula to the cup shown at *A*, Fig. 1, we have $3\frac{7}{8}$ inches $- \frac{3\frac{7}{8}}{5} = 3.1$ inches, which according to the formula should be the diameter of the die for the second operation; as the diameter of the finished shell is 2 13/16 inches, and as it was not considered practicable to reduce the cup to this dimension, the second-operation die was made 3⅜ inches, thereby equalizing the work and producing a better shell.

The die for this first redrawing operation is shown at *B*, Fig. 2; it is equipped with a stripper *s*, the shape and position of which is clearly shown by the plan view of die *G*, the strippers of all the dies being of the same form. As will be seen, the stripper is set at an angle to clear the guides of the press ram. The cup is placed on top of the die under the stripper, the springs shown holding the stripper in its upper position. When redrawing the cup, the punch descends and enters it and then the ram press strikes the stripper, carrying it down while the punch is pushing the cup into the die. On the return or upward stroke of the press, the shell sticks to the punch until the stripper plate strikes the heads of the bolts shown; then the shell is stripped from the punch as the ram continues to ascend to its upper position. The radius on the drawing corners of the punch and drawing die is ⅝ inch and corresponds to the radius on the punch and die shown at *A*. Die *B* produces the cup *B* (Fig. 1) and is used in a single-action press.

The third operation (second redrawing operation) is performed in the die shown at *C*, which is also used in a single-action press and is similar to die *B*, excepting, of course, that it is smaller in diameter. The diameter corresponds to the large size of the finished shell or 2 13/16 inches. According to the formula previously given, the diameter would equal $3\frac{3}{8} - \frac{3\frac{3}{8}}{5} = 2.7$. Therefore the reduction to a diameter of 2 13/16 inches is a little less than the safe maximum, which tends to produce a better shell. As the illustration shows, the radius on the corners of the punch and die is ¼ inch. When the shell has been drawn in die *C*, the flange is curved down somewhat as illustrated at *C*, Fig. 1. The flange is curved in this way as the surplus metal from the body of the shell is forced up into it, but is flattened by a subsequent operation.

Shell *C* is next changed to the form indicated at *D* in the die *D*, Fig. 2. This operation simply reduces the lower part of the shell body ⅛ inch in diameter or to the finished size of 2 11/16 inches, and retains the 2 13/16-inch size previously drawn. The next operation is that of forming the recess *E* in the flange, die *E*, Fig. 2, being used for this purpose. The shell is placed in the die and on top of the knockout rod. When the punch descends, the pilot attached to it enters the shell and the knockout rod also descends at the same time. The shoulder *e* on the punch is ⅛ inch smaller in diameter than the recess in the die, and it forms a recess in the flange, while surfaces *f* flatten the remaining part of the flange. When the punch ascends, the knockout rod pushes the shell out of the die. The pilot has a shank which is a light driving fit in the punch and is held by a set-screw.

The punch and die for trimming the flange to the required diameter of 4⅜ inches is shown at *F*. When the shell is dropped into the die, the flange strikes the ends of three gravity strippers *n* which tilt to allow the shell to pass, as indicated by the dotted lines, and then fall back to the horizontal position. These gravity strippers are adjusted so that the inner ends *n* just clear the punch. When the punch descends, the pilot locates the shell in a central position and then the flange is trimmed. The shell drops through the die, and as the punch ascends the scrap which was trimmed from the flange sticks to it until it is stripped off by the strippers *n*.

The punch and die for the final operation of blanking out the bottom of the shell are shown by the elevation and plan view at *G*. The shell is placed in the ring or "nest" *g* and under the stripper plate. The punch is made long so that the ram of the press will not strike the stripper when it descends, the stripper for this operation simply being held up against the heads of the retaining bolts.

* * *

NICKEL-PLATED ALUMINUM

There has been no method in the past by which aluminum could be nickel-plated, but a British patent has been issued recently by means of which this can now be accomplished. The method is known as the Canac process, in which the aluminum is first treated with a boiling potassium carbonate solution, then brushed with milk of lime, and then immersed for a few minutes in a 0.2 per cent solution of potassium cyanide, and in a solution of 15 grains of iron to each quart of hydrochloric acid, until it obtains a moiré appearance. The nickel is deposited in the usual way from a bath containing about 750 grains of nickel chloride and 300 grains of boric acid for each quart of solution. The addition of iron to the last preparing solution is essential. A minute deposit of iron is found on the aluminum, causing a cellular structure on the surface. The iron appears to form a network of microscopic galvanic couples, which produces a rough surface. This accounts, it is stated, for the strong adhesion of the deposit which cannot be detached without also tearing off aluminum particles.

CONVERTING AN ENGINE LATHE INTO A SEMI-AUTOMATIC MACHINE

Many ingenious arrangements have been applied to engine lathes for increasing their capacity and adaptability for certain special manufacturing operations. An interesting attachment of this class is used on an R. K. LeBlond 18-inch heavy-duty engine lathe in the plant of the Reo Motor Car Co., Lansing, Mich., for machining the rear wheel hubs shown in Fig. 1. The hub is made from a steel casting, and previous to the lathe operation the tapered hole, back and front faces, and counterbored recess, are machined in a New Britain semi-automatic chucking machine.

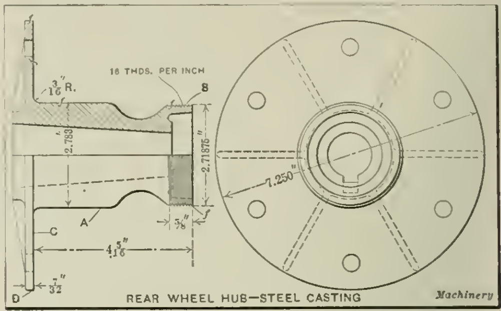

Fig. 1. Rear Wheel Hub for an Automobile

The next operations consist in turning the bodies *A* and *B*, facing the flange *C*, and turning the large external rim *D* in the Le Blond heavy-duty engine lathe shown in Fig. 2. Referring to this illustration, it will be noticed that a turret toolpost takes the place of the ordinary standard toolpost, and the regular tailstock spindle is removed and replaced by a special spindle in which a Geometric self-opening die *F*, Fig. 5, is held by means of a tail-spindle. A strap *G*, Fig. 3, fastened to the rear of the tailstock carriage, acts as a fulcrum point for the operating lever *H*, which fits in a slot in the special tailstock spindle. This lever is used to force the Geometric die forward and start it on the work, after which, of course, it leads along automatically. The special tailstock spindle is prevented from turning by dog *I*, one end of which rests on the bed of the lathe.

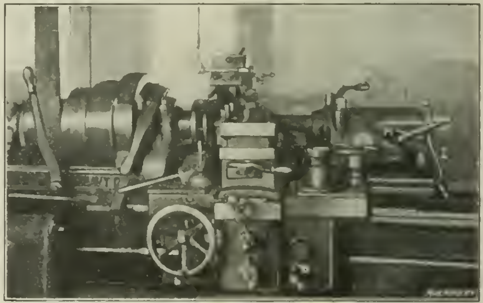

Fig. 2. R. K. LeBlond Engine Lathe fitted up for machining Rear Wheel Hubs

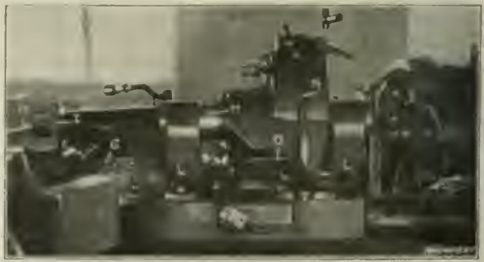

Fig. 3. Rear View of Machine showing Plate Cam for operating Facing Slide

For turning the surfaces *A*, *B* and *D*, three tools held in the toolpost *J* are used. The operation is clearly illustrated by the diagram shown in Fig. 4. At the same time that these three tools are working, two other tools, held in a special cam-operated slide at the rear, face the flange *C* and chamfer the corner *E*. The construction and operation of this special slide can be more clearly seen in Fig. 3. Fastened to the ways of the lathe are two brackets *L* held stationary by cap-screws. These brackets carry a trunnion *M*, which serves as a fulcrum member for the arm *N* carrying the facing slide. For the operation of this slide, a special irregular-shaped cam-plate *O* is used. This is fastened to the carriage of the lathe and consequently travels with it. A roll held to the arm carrying the additional cross-slide operates in the cam groove in this plate and transfers a movement to the arm, forcing the forward end downward and bringing the tools into operation on the work. This chamfering and facing operation takes place at the same time that the body and flange of the casting are being turned by the tools held in the toolpost on the regular cross-slide.

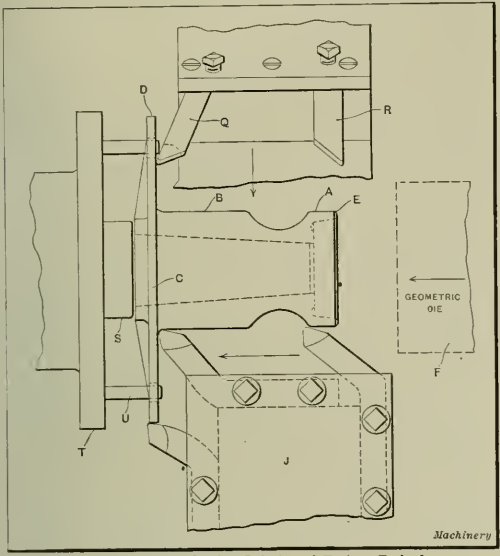

Fig. 4. Diagram showing Relation of Various Tools for machining a Rear Wheel Hub

The additional cross-slide *P*, as shown in Fig. 5, fits in a dovetail groove in the top face of the arm *N* and is adjustably mounted in position. A hand crank, as shown, is used to move this slide along so that it can be brought into the proper relation to the work—that is, so that the turning tools held in it can be brought into the proper relation with the tools held on the front of the cross-slide. This adjustment is necessary in order that the facing tools will finish their work at the same time that the front tools finish turning the body diameters. Tool *Q* is used to face the flange, whereas tool *R* is used to chamfer the edge of the work to enable the Geometric die to start easily.

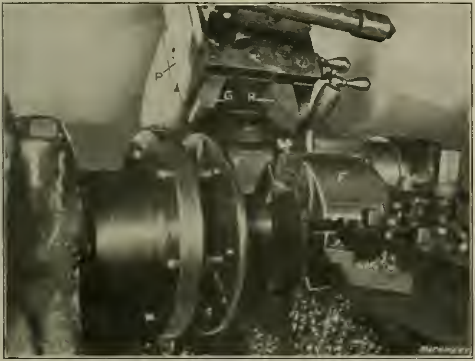

Fig. 5. Geometric Threading Die cutting the Thread on the Hub

Upon the completion of the turning and facing operations, these slides are backed out of the way, and the Geometric die is brought into operation. This is clearly shown in Fig. 5. The work, which has a tapered hole, is forced onto a special arbor *S* in the faceplate *T*, and pins *U* held in the faceplate locate in previously drilled holes in the flange of the work to act as driving members. The only attention that this fixture requires is to put on and remove the work, bring the cross-slides into position, throw in the feed, and start the die. The turning and facing is done automatically. There are five operations performed on this casting, and one hundred and sixty-seven pieces are turned out complete in nine hours—turned, faced, chamfered and threaded. D. T. H.

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NON-PRODUCTIVE LABOR

In a paper presented before the American Society of Mechanical Engineers, December, 1914, H. L. Gantt referred to the absurdity of considering as non-productive all labor which was not directly employed at machines or in manufacturing operations. In many factories, the foreman is not supposed to permit the ratio of cost for non-productive labor to exceed a certain percentage of the cost of productive labor—a most harmful rule. The absurdity can best be made clear by an example, showing the fallacy of establishing such a ratio. A foreman had ten men on a job which he said could have been done by eight men, providing he could employ a boy to supply the men with the work. However, if he employed a boy for this purpose, the latter's wages would be called non-productive labor; the ratio between productive and non-productive labor in his department would be increased, and as a result he would be criticised; hence he did not make the change. As another example was mentioned the case of an energetic officer in the United States Navy who studied the loading of ammunition and greatly reduced the direct labor cost, but being unable to reduce the indirect or non-productive labor cost in the same proportion, the ratio between the non-productive and productive labor went up, and he was severely criticised, notwithstanding the fact that the total labor cost was decidedly reduced.

One of the arguments made by employers against scientific management is that it increases the non-productive labor cost. This may be true in many instances, although by no means in all, and if the management is what it claims to be—scientific—it will reduce the productive labor costs in a much greater ratio than it increases the non-productive costs, so that after all there is bound to be a substantial gain. Of course, there are many systems of management passing under the name scientific that lack the fundamental principles of the system that should properly be so called and in which a great deal of red tape is introduced, adding to the non-productive labor cost without producing any material saving; but the fact that many people are unable to grasp the inherent principles of scientific management does not make this system less valuable in reducing costs, where it is properly applied.

* * *

Scientific management suffers more from the fact that too great claims have been made for it than from anything else. It will reduce costs or, what is its equivalent, the time and effort necessary to do a certain amount of work, but it will not solve the labor problem; it will not, in the long run, tend to raise the wages of the workers or the profits of the manufacturer. A far more fundamental reform is necessary for that. When everybody employs scientific management, no one will have any advantage over anybody else, assuming that all other conditions remain as they are at present; a certain percentage of wages and profits then as now will tend to go to a non-producer—not a non-producer employed in the factory, but one who owns or controls natural resources and who can charge those who work by brain or hand for the use of these resources.

MACHINING IRREGULAR CONTOURS

SOME FIXTURES AND ATTACHMENTS FOR TURNING AND FORMING SHAPES NOT READILY PRODUCED BY REGULAR METHODS

BY ALBERT A. DOWD*

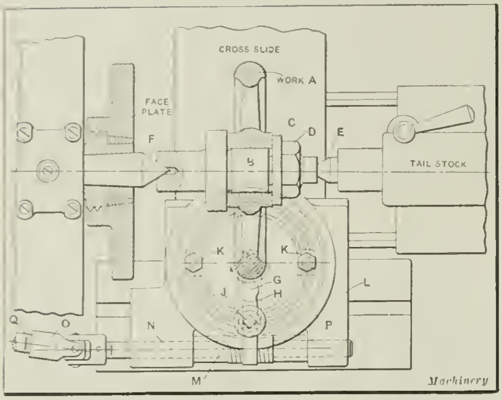

Fig. 1. Lathe Forming Attachment for Handwheel

THERE are numerous instances in general manufacturing when external or internal surfaces must be machined to a form or contour which cannot readily be developed by ordinary methods. If the required form is a plain taper or a perfect radius, it can usually be machined by some one of the methods described in MACHINERY, December, 1913, in the article "Taper Boring and Turning Attachments," or January, 1914, "Machining Convex and Concave Surfaces." When, however, the surfaces are irregular, having possibly both angular and curved portions adjacent, it is apparent that other means must be provided.

The character of the castings or forgings, and the material of which they are composed, together with their size and shape, have an influence on the design of the tools and devices which are to be used in the process of machining. The machines to which the devices are to be applied also affect the design to a considerable extent. For formed work of irregular shape which is not cylindrical, several methods may be used in the machining. The work may be done on the milling machine using special cutters of the required form, a profiling machine may be used, or a milling machine may be adapted, with a swivel or sliding fixture having a roll which follows a fixed form, thereby generating the required contour. For work of a cylindrical character, the engine lathe, horizontal or vertical turret lathe, or the vertical boring mill, are the machines most frequently used.

When the work is of small size and of such material that it can be formed to advantage, special forming tools of the required shape can be employed with excellent results, but when of large size or of some material which does not lend itself well to wide tool forming, it will be frequently found necessary to generate the contour by means of special devices or attachments.

There are a few general points in the design and construction of forming attachments for this class of work which are of interest, and these should be carefully considered both in the preliminary stages and during the progress of the design.

Points in Design

1. The number of pieces to be machined should be one of the first points considered, for if designed for a small number, the fixtures should be made up as cheaply as is consistent with the nature of the work to be done and the accuracy required. On the other hand, when designed for the machining of a large number of pieces, rapidity of action and upkeep of the fixture should receive more consideration than the first cost.

2. The accuracy required in the finished work is very important; if two cuts are needed to produce the piece to the desired limits, it is obvious that some provision must be made so that both roughing and finishing tools can be used. This may be done either by using a revolving or swinging tool-holder, or by making it in such a way that the tools can be accurately interchanged.

3. Take-up for wear is important. Moving surfaces which are subject to wear should be provided with means of adjustment, by which they may be brought into their proper positions when worn. Gibs, straps or other devices should always be incorporated in the design with this end in view. Parts subject to extreme wear which can not conveniently be made adjustable should be so designed that they can readily be replaced when necessary. Cam-plates should be so placed and located that their replacement will not cause inaccuracies, due to slightly varying locations.

4. Rigidity is a feature that must always receive consideration. In order to avoid any possibility of "chatter," the various parts of the attachment must be proportioned generously, with an ample amount of metal to withstand shocks. It is well to note in this connection that solid masses are better than ribbed parts (within certain limits), and less vibration will be apparent in a fixture or attachment having well distributed metal of generous section in its construction than in one of lighter section which is ribbed to give the desired stiffness. Excessive overhang in the tool-holder or carrier should be avoided as far as possible, and a bearing provided as nearly under the tool as can be arranged. In the method of holding the work which is to be machined, care also must be used so that no vibration will take place, due to excessive overhang or fragile construction.

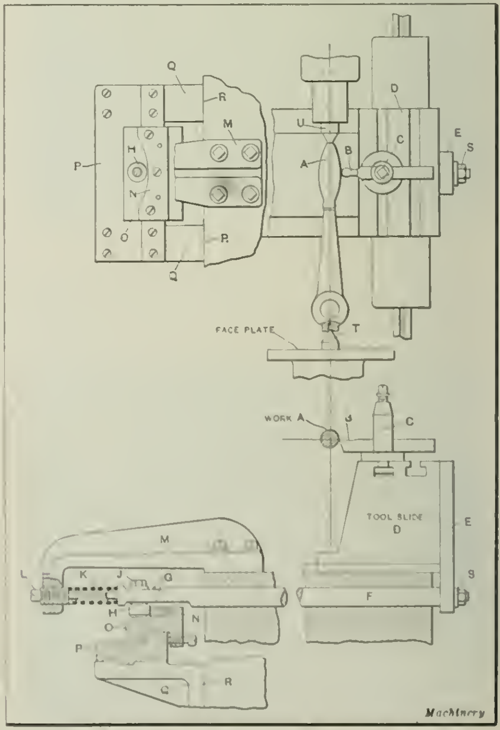

Fig. 2. Lathe Forming Attachment for Lever Handle

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5. The direction of thrust against the cam surface which controls the shape of the contour to be formed should be definitely controlled. Whenever possible, this arrangement should be such that the thrust of the tool will carry the roll or guide pin against the forming plate instead of in a contrary direction. If this is done the form of the work is positively assured, while if dependence is placed on a spring or weights to keep the guide pin in contact with the form, there is always a chance for errors due to hard spots in the casting which tend to throw the tool away from the work.

6. Convenience in handling and adjusting should be carefully considered during the progress of the design, looking into the matter from the operator's standpoint.

7. Interferences with other moving portions of the machine, such as turret, cross-slide, chucking device or special tools which may be in position for other work on either cross-slide or turret are of supreme importance on turret lathe work; it is sometimes possible by the exercise of forethought to make combinations of tools in such a way that several can be worked simultaneously.

Other points in design and construction will be noted in specific cases during the progress of this article.

Lathe Forming Attachment for a Handwheel

The work shown at *A* in Fig. 1 is a handwheel such as is used commonly in machine construction. The work has been previously chucked and faced and the periphery is to be formed in the operation shown, an old-style engine lathe being used for the machining. There were six different sizes of wheels to be formed, and the same attachment was used for the various pieces, although separate arbors were required. The piece is located on the cylindrical portion of the arbor *B*, this being centered in the usual manner at *F* and *E*, and driven by a dog (not shown) through the medium of the faceplate on the spindle end. A nut *D* and washer *C* are used to draw the hub of the work up against the shoulder on the arbor so that both clamping and positive longitudinal location are assured.

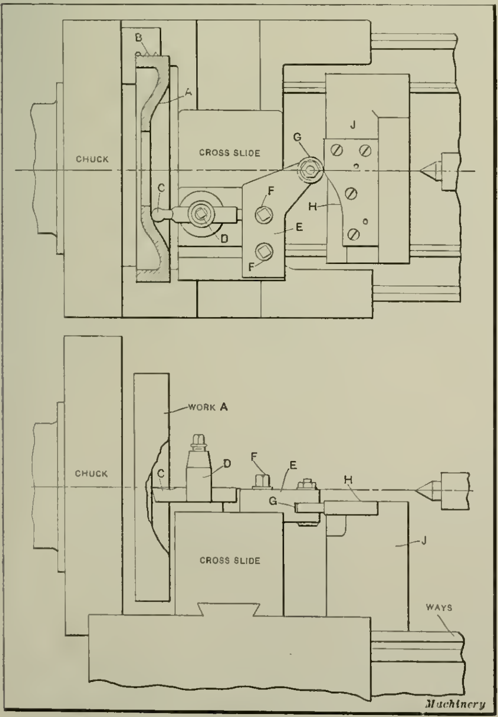

Fig. 3. Simple Forming Attachment for Engine Lathe

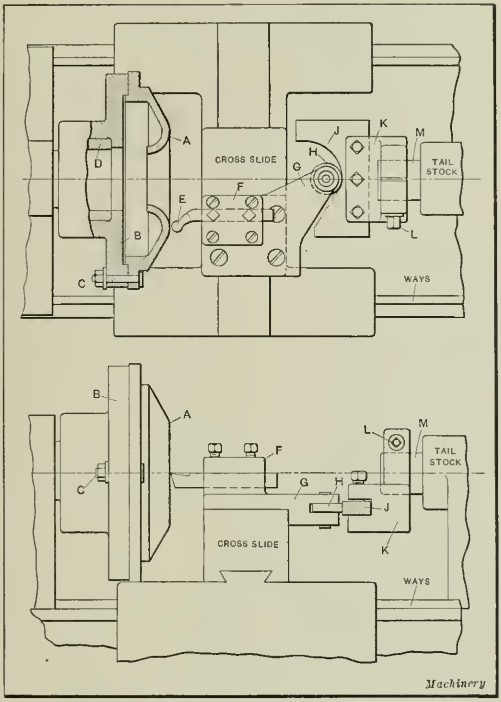

Fig. 4. Lathe Forming Attachment for shaping Steel Casting

A special casting *L* is mounted on the front of the cut-off slide and carries the revolving plate *P*, on the under side of which a worm-wheel is fastened which meshes with the worm-gear *M* on the shaft *N*. This shaft is journaled in the overhanging portion of the casting *L*, and is provided with a universal joint *O* which allows flexibility of movement and is furnished with a sliding sleeve, and another universal joint at the other end where it is carried on a special bracket attached to the bed of the machine. It is given the necessary rotary motion by a spur gear which meshes with another on the end of the lead-screw shaft. These connections are not shown in the illustration.

The tool *G* is of the round-nose type and formed to a radius on the end. A tee-slot *H* is cut on the revolving plate and a regular lathe toolpost *J* carries the tool, being adjustable in the slot so that various radii may be generated. The cut-off slide may be readily adjusted for diameters, so that a number of sizes of wheels can be turned. After the work has been done the screws at *K* are loosened and the tool-carrying plate pulled around by hand to the original starting position. A tee-slot of circular shape is cut in the worm-wheel, and the two shoes draw it up against the under side of the plate when the screws are tightened. This was a somewhat crude arrangement and could have been improved by mounting the tool on an arm with a quick-acting binder, so that it could have been rapidly swung to any desired position and locked. This attachment was made over twenty years ago, however, and the value of time in machining was not as carefully considered at that time as it is at present. That the attachment was successful is indicated by the fact that it is still in use and performs its work in a satisfactory manner.

Lathe Forming Attachment for a Lever Handle

The work shown at *A* in Fig. 2 is an ordinary hand lever which has been chucked faced and centered in a previous operation, and which is to be formed to the contour required on the handle portion during this operation. An old-style lathe was selected for the purpose, which had had a taper turning attachment, a part of which was utilized for the work in hand. The work was located on the lathe centers at *T* and *U*, and was dogged and driven through the faceplate in the usual manner.

A new steel rod *F* was made to take the place of the old

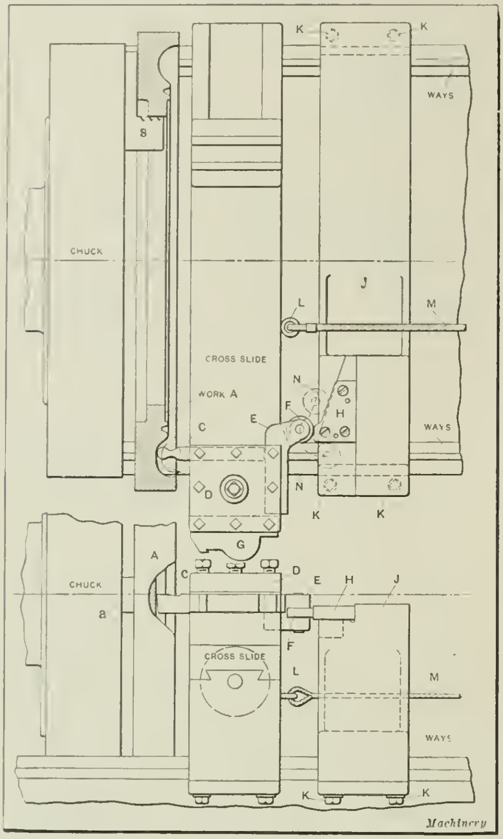

Fig. 5. Lathe Forming Attachment for Tire Mold

one used on the taper turner and a steel block *E* fastened to the front of the cross-slide was given sufficient overhang so that a connection could be made with the rod by the nut and washer at *S*. The brackets *Q* at the rear of the lathe were screwed to a finished pad at *R* and the plate *P* was tongued to fit them and screwed in place. The brackets were a part of the old attachment, but the plate was made up for the new arrangement. The adjustable plate *O* was drawn up on the dovetailed portion by the two square-head set-screws shown, and the forming plate *N* was of hardened steel, and screwed and doweled in position. A special bracket *M* was fastened to the rear of the carriage, and it carried at its outer end a screw *L* by which variations in the stiffness of the spring *K* could be quickly made. Incidentally it is well to note that this spring was of 3/16-inch square section, and very stiff.

The rod *F* was milled off at *G* to give a seat for the head of the stud on which the roller *H* was mounted, and for the collar and nut at *J* which held it in position. Attention is called to the fact that the form generated by this attachment is positive, for the thrust of the cutting tool has a tendency to carry the roll against the form, and it is assisted by the action of the spring so that no variations in the contour can develop due to an imperfect contact between the roll and the forming plate. An attachment of this kind will be found useful for many purposes, and the upkeep is low. Forming plates of various contours can be readily applied, and for ordinary conditions no other parts will be required.

Cheap Forming Attachment for an Engine Lathe

The work shown at *A* in Fig. 3 is of cast iron and it is required to form the contour shown to a rough approximation of the size, no great amount of accuracy being called for, however, and the quality of finish not being particular, the important point being that a certain amount of clearance must be obtained. The machine selected for the work was an engine lathe, and the attachments were made up as cheaply as possible. The work was held by the outside in the jaws *B* of a three-jaw geared scroll chuck, and the tool *C* was held in the regular manner in a toolpost *D* on the cross-slide of the lathe. The tool was formed to a perfect radius on the end so that the form would not be affected by the constantly changing cutting faces presented to the work.

A special bracket *J* was fastened to the inner ways of the lathe by means of screws and straps on the under side, these not being shown in the illustration. Longitudinal adjustment could therefore be readily made to compensate for slight errors in the setting. On the bracket a hardened steel plate *H* was screwed and doweled, this plate being formed to a contour determined by a line through which the center of the roll would pass in generating the required form. This point is of importance and should not be overlooked in laying out a cam-plate. A bracket *E* is mounted on the cross-slide and held in position by the two screws *F* which enter shoes in the tee-slots of the cross-slide. At the outer end of this bracket is a roller *G* which is of tool steel, hardened and ground and mounted on a stud secured in the end of the bracket.

When this device is put in action the tool is started at the center, the cross-slide feeding outward while the operator holds the roll in contact with the forming plate with continued pressure on the longitudinal feed handwheel. The greatest objection to a forming attachment of this kind is that the operator is a somewhat uncertain quantity and may fail to keep the roll in contact with the form under all conditions. In the case of the kind mentioned slight variation was of no great consequence so that no trouble was experienced from this source.

Another Lathe Forming Attachment

The work shown at *A* in Fig. 4 is a steel casting requiring an internally generated radius together with an external taper. The work has been previously machined and is located by a finished surface, the faceplate *B* being screwed onto the spindle *D* in the usual manner for this purpose. Screws *C* are passed through previously drilled holes in the casting

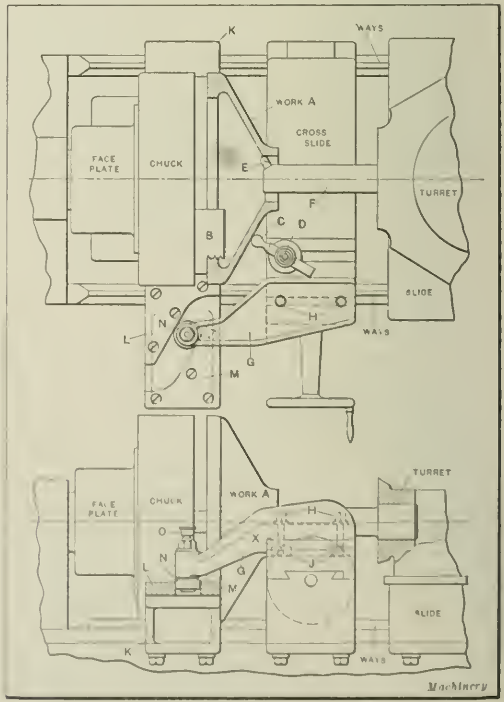

Fig. 6. Turret Lathe Forming Attachment for Steel Casting

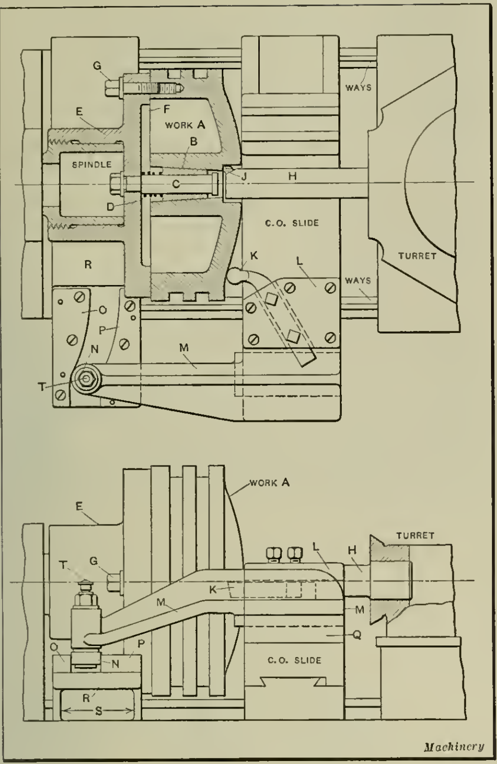

Fig. 7. Lathe Forming Attachment for Piston Head

to draw the work against the faceplate. The tool *E* is formed to a radius on the cutting end, and is mounted in the special tool-block *F*, which is located on the cross-slide of the machine. An overhanging end *G* on the tool-block supports a roller of tool steel which is hardened and ground and revolves on a pin in the end of the bracket.

A special steel holder *K* is split on the upper side and bored to fit the tailstock spindle *M*, being clamped thereto by the screw *L*. A portion of the holder *K* is slotted to receive the forming plate *J*, the contour of which determines the form of the finished work. This attachment is subject to the same objections as that shown in the previous instance and variations in the form are likely to be occasioned by the carelessness of the operator. In addition to this there is always a possibility of a slightly angular setting of the forming plate carrier which may result in slight errors or variations in the form. The attachment can, however, be made up cheaply and can be adapted to a great variety of uses by the simple expedient of making up a forming plate to suit the contour desired.

Lathe Forming Attachment for a Tire Mold

The machining of tire molds involves several points which are not usually considered in forming operations. In the first place, they are usually made of chilled cast iron or cast steel with a finish allowance in the mold cavity of from ¼ to ⅜ inch. This requires the removal of a considerable amount of very hard stock, and the limits of accuracy required in the finished work are very close. The finished surface must be as smooth as glass and highly polished.

The work shown at *A* in Fig. 5 is half of one of these molds, and the machine upon which the forming is done is a special short-bed lathe of large swing. The work is held by the inside in the jaws *B* of the three-jawed gibbed scroll chuck, and a driver is provided on the inside of the mold ring so that it comes in contact with the side of the jaw and assists in carrying the work along. The tool *C* is mounted in a revolving toolpost on the front of the cross-slide and is formed to a radius on the cutting end. On the other side of the toolpost a steel roll holder *E* is fastened which carries the hardened steel roll *F*. In order to generate the desired form in the mold cavity, the center of this roll must follow the path shown by the dotted line *N*, and the plate which controls the form must be so shaped as to carry the center of the roll along this path. This plate *H* is of tool steel and is located against the shoulder on the bracket *J*. This bracket is of cast iron and extends completely across the ways and is gibbed underneath by two straps which are held there by the screws *K*.

Positive contact of the roll with the forming plate is assured by the cable *M* which is fastened into a ring bolt *L* in the side of the carriage, the other end of the cable being attached to a heavy weight. The cable passes over a grooved pulley at the end of the lathe. As it is not possible to form the clincher portion of the mold by means of the roll, other tools are provided for this purpose. A final sweeping cut is taken in the mold cavity by the forming tool *G* which both smooths and polishes the work to the required finish.

Turret Lathe Forming Attachment

The steel casting shown at *A* in Fig. 6 has an angular external surface in combination with two curved portions. The machine on which this work is done is a horizontal turret lathe of standard make, and the casting is held by the inside in the special jaws *B* of a geared scroll chuck. The tool *C* is formed to a radius on the end in the usual manner, and is held in a regular toolpost *D* on the front of the cut-off slide. A cast-iron bracket *K* extends across the ways from side to side and is dropped down to give clearance for the chuck. This bracket is adjustable longitudinally along the ways, and is gibbed to them by straps on the under side. The front end of this bracket extends a considerable distance beyond the ways and is ribbed underneath to give sufficient strength. The two plates *L* and *M* are fastened to a finished pad on the top of the bracket and are cut out so as to form a path by which the correct contour is generated. A hardened and ground steel roll *N* is located at the end of the bracket *G* and is provided with a refinement in the shape of an oiler *O* at the top of the stud on which it revolves. The other end of the bracket is finished and tongued on the under

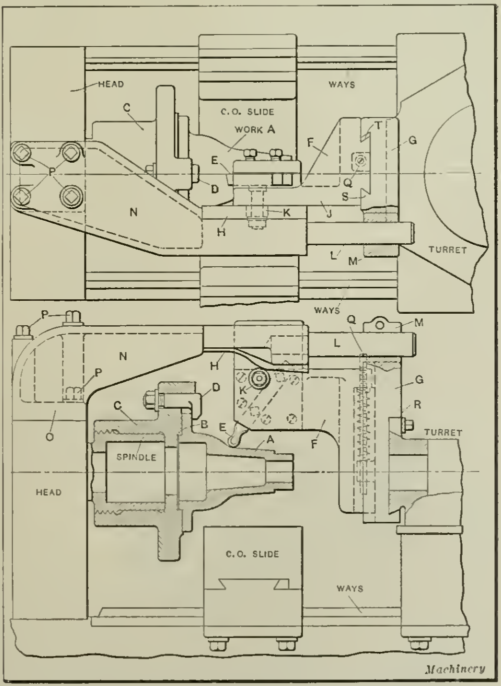

Fig. 8. Overhead Forming Attachment for Horizontal Turret Lathe

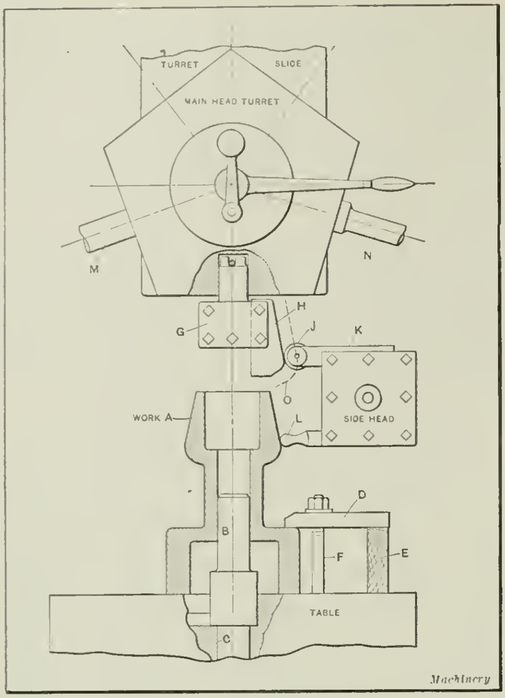

Fig. 9. Simple Forming Attachment for Vertical Turret Lathe

side to fit the tee-slot on the front of the cut-off slide, and it is held in position by the two screws *H* which draw it down firmly by means of the shoes *J*. The bracket has a heel at *X* which takes the thrust of the roll so that no shifting of the bracket is possible during the working of the device. In the operation of this mechanism both hand and power feed are used, hand feed being employed to form the two radius portions, while a cross-feed of the machine takes care of the angular part. It will be noted that although there are two plates so shaped as to give the desired form, the plate *M* is the one by which the contour is generated, the other simply acting as a guard. During the process of machining the irregular portion the turret is utilized to bore the hole by means of the bar *F* having a tool *E* at the forward end. The application of a device of this kind is suitable to many conditions and will be found very useful on horizontal turret lathe work. In using this attachment it is well to note that the longitudinal feed-screw on the under side of the cut-off slide must be either removed or disengaged, depending on the construction of this portion of the lathe.

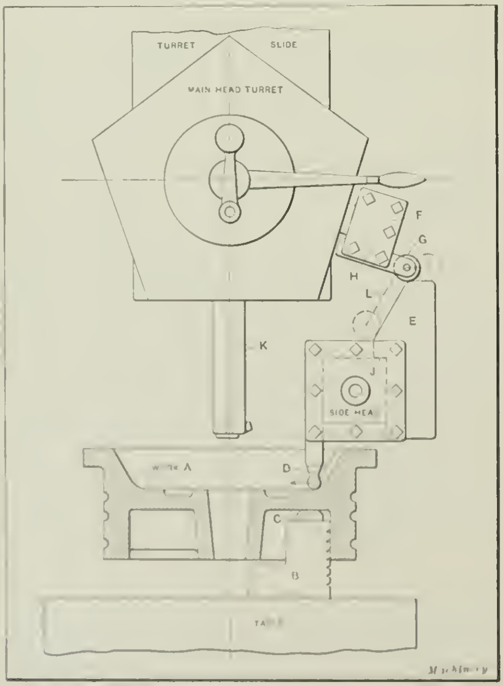

Fig. 10. Simple Forming Attachment for Vertical Turret Lathe

Forming Attachment for a Piston Head

The work *A* shown in Fig. 7 is a cast-iron piston head which has been previously machined on the open side and had the taper hole bored and reamed. In addition to this several holes have been drilled and tapped on the rim. As it is necessary to locate the work from the previously finished surfaces, some method of locating must be used which will take into consideration slight variations between the tapered hole and the finished face of the casting. A special faceplate *E* is screwed to the end of the spindle and is provided with a stud *C* on which a sliding taper bushing *B* is located, this bushing being forced outward by the action of the coil spring *D* so that the location of the work from the taper is always insured even though there may be slight inaccuracies between the taper and the faced end of the casting. The screws *G* are used to draw the work back against the finished face of the plate and also to act as drivers.

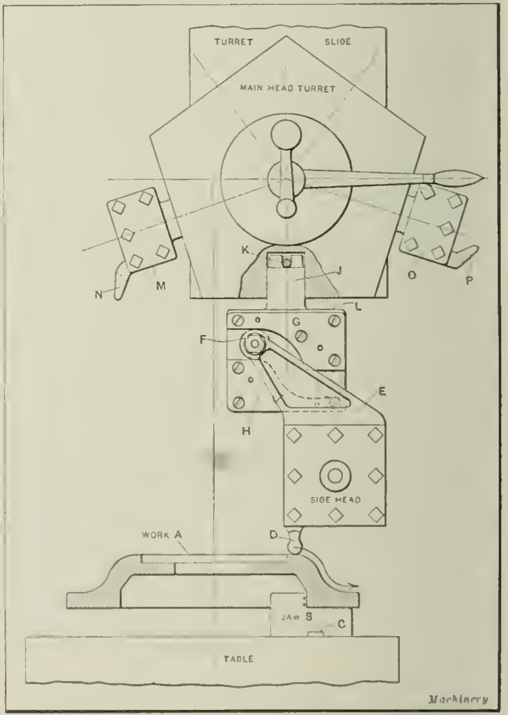

Fig. 11. Box Plate Forming Attachment for Vertical Turret Lathe

This attachment is considerably different from the one illustrated in Fig. 6, as it is not necessary to disconnect the longitudinal feed-screw in order to put it into use. A cast-iron base *Q* is located on the front of the cut-off slide, and is tongued on its under side to fit the tee-slot, being held down on the finished surface by screws and shoes in the slots. The upper portion of this base is dovetailed to fit the under side of the sliding portion *M*, and is provided with an adjustable taper gib to take care of wear. The forward part of the sliding member is slotted to receive the tool *K* which is round-nosed for the reason stated previously, and a steel block *L* acts as a cover plate and a medium to receive the holding-down screws. The outer end of the bracket arm *M* contains a hub or boss in which is located the stud which forms a bearing for the cam roll *N*, this roll being of tool steel hardened and ground. An oiler is provided at *T* as in the previous instance.

A cast-iron bracket *R* is fastened to the ways and overhangs them to a considerable extent at the front of the machine, but being well ribbed at *S* the rigidity is not impaired. On a finished pad at the upper part of the bracket, the two plates *O* and *P* are located, and these control the shape of the surface to be formed, one of them, however, giving the form while the other acts simply as a guard. In connection with the forming of the irregular surface, the turret tools are used to finish out the pocket, one of these tools *J* in the boring-bar *H* being shown at work in the illustrations. A device of this kind is very good for work not requiring a high degree of accuracy, but slight variations and ridges in the machined surface are apt to appear from time to time because the roll will fluctuate between the forming plate and the guard. If a coil spring is provided of sufficient strength to keep the roll in positive contact with the cam at all times, the action of the attachment can be made perfectly satisfactory.

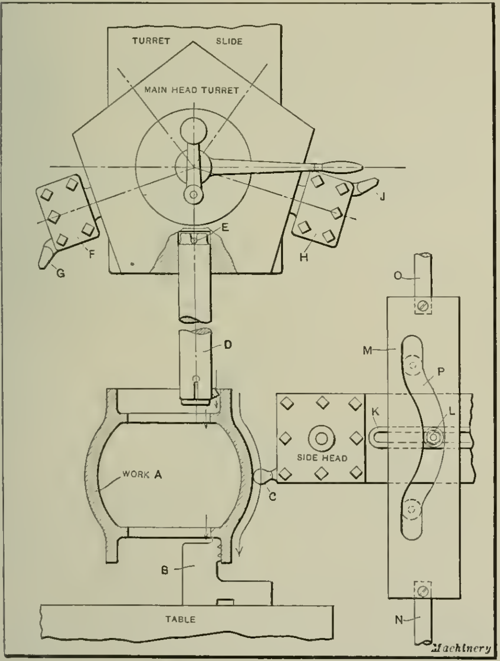

Fig. 12. Forming Attachment for Vertical Turret Lathe

Overhead Forming Attachment for a Horizontal Turret Lathe

A departure from the methods generally used is shown in Fig. 8, the attachment in this instance being used in the vertical plane instead of the horizontal. This attachment was made over thirty years ago and although it has been subjected to considerable abuse during this time it is still in existence, and not only that, it is in working order and in use on the average about three months in the year. It has been repaired a number of times, and slight changes have been made in it, but it is still, to all intents and purposes, the same attachment that was originally made.

The steel forging *A* has been previously partly machined, and it is located for the operation shown by the shoulder *B* and its adjacent face, a special faceplate *C* being utilized for holding the work. Three hook-bolts are employed for clamping the piece, one of these being indicated at *D* in the illustration. Attention is called to the manner in which these hook-bolts are backed up by the lug so that there is no danger of springing them when set up on the work. The tool *E* by which the exterior of the work is machined is carried in a slot on the sliding member *F*, and is held in place by the square-head set-screws in the steel cap which is screwed to the sliding member. A hardened and ground steel roller *K* is mounted on a stud on the front of the slide and this follows a form cut on the edge of the steel plate *H* by which the desired contour is produced. A box-section bracket *N* is screwed to the finished surface of the spindle cap *O* by the screws *P*, and to this the forming plate is attached. A pilot *L* is placed at the forward end of the bracket in order to obtain greater rigidity, and this enters a split boss *M* on the fixed member *G* which fits the turret dovetail and is gibbed thereto by the angular gib *R*. The surface of the sliding mem-

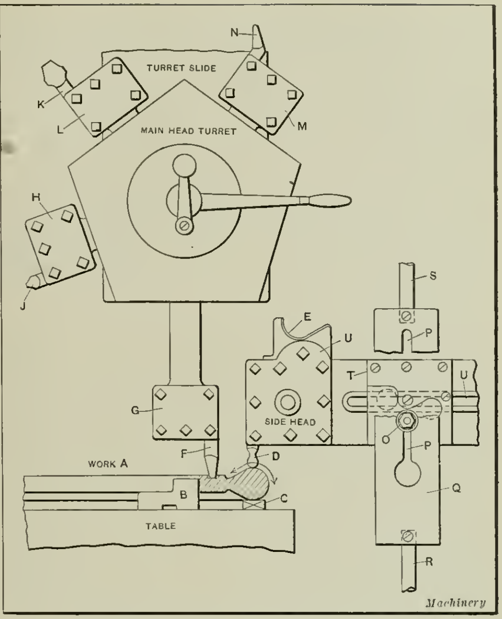

Fig. 13. Forming Attachment for Tire Core

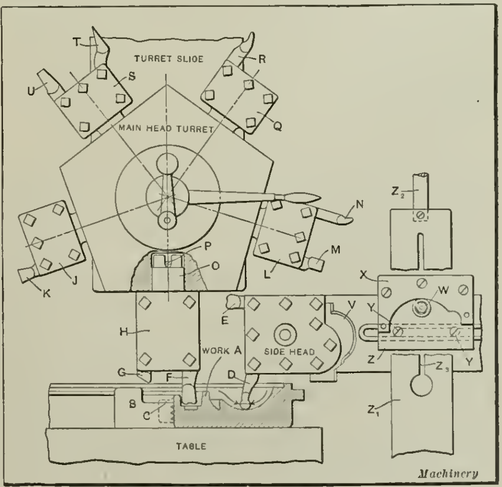

Fig. 14. Forming Attachment for Tire Mold

ber *F* is a nice sliding fit on the back of the steel forming plate and assists in stiffening the entire mechanism as the thrust of the tool carries it against the plate and prevents vibration, by giving it a solid surface to slide upon. The sliding member *F* is dovetailed at *S* and *T* to fit the member *G* and is furnished with a taper gib *T* for adjustment. In order to insure a positive contact between the roll and the forming plate at all times a stiff coil spring is pocketed in a recess between the two members, and a means of adjustment is provided in the screw *Q* so that the desired compression can be obtained with little trouble. The operation of the device is obvious, but attention is called to the fact that the thrust of the cut tends to carry the roll against the forming plate instead of in a contrary direction, so that the contour is always positively insured.

Simple Forming Attachment for a Vertical Turret Lathe

In the application of forming attachments to the vertical turret lathe and vertical boring mill, due consideration must be given to the fact that these machines are generally used for work of the heavier variety, and that as a consequence all attachments are subjected to greater stresses because of the heavier cuts which are naturally taken on these machines. In view of these facts it is well to make all fixtures and devices of such section that the factor of safety will be ample to take care of both use and abuse.

A very simple arrangement for forming an irregular contour is illustrated in Fig. 9, the work *A* being of cast steel which has been partially machined in a previous operation. A centering plug of steel is fitted at *C* to the center hole in the table, and is finished at *B* to the size of the previously machined hole. The work is slipped onto the stud until the finished face of the large end of the hub rests on the top of the table. A set of three U-straps *D* are used to hold the work down on the table, by means of the tee-bolts *F* which enter the tee-slots in the table, the outer ends of the clamps being supported by wood blocks *E*. The tool *L* is of the round-nosed variety previously mentioned, and is held by the screws in the side head turret. In opposition to the tool is a roll-holder *K* which is provided with a hardened steel roller *J*. A tool-holder *G* of the regular type furnished with these machines is used as a support for the forming plate *H* which is so proportioned as to generate the desired form when its edge is in contact with the roller in the side head. It must always be borne in mind that the *outline* of the formed plate must be such that it will cause the *center of the roll* to travel through the path required on the finished work, as indicated by the dotted line *O* in the illustration. Boring-bars *M* and *N* are used in this same setting of the work to rough- and finish-bore the pocket bearing at the upper end of the work.

Much depends on the operator in using a device of this kind, for unless he is particular to keep the roll in positive contact with the plate the resulting work will not be satisfactory. With a reasonable amount of care, however, excellent results can be obtained with this type of forming device, and as it is comparatively inexpensive, it may be used in many cases where the expense of a more complicated arrangement would not be permissible.

Another Simple Forming Attachment for the Vertical Turret Lathe

Another simple and inexpensive attachment is shown in Fig. 10, yet the application in this case is entirely different from that shown in Fig. 9. In the previous case the roll was held in the side head, while in this instance it is the formed plate which is so held.

The work *A* is held in its rough state by the inside of the rim in the jaws *B*, and is supported on the buttons *C* which strike the under side of the casting web. The tool *D* which generates the contour is, as usual, of the round-nose variety, and is carried in the side head. On the other side of the side head turret the forming plate *E* is clamped by means of the set-screws shown, an additional precaution against slipping being provided in the shoulder *J*, which brings up against the shoulder in the turret. The roll holder *H* in this instance is held in a regular tool-holder *F* in the main head turret. The boring-bar shown at *K* is used for boring the tapered hole after the forming has been accomplished.

In operation, the main head is locked securely in the position shown in the illustration, the roll being in the position with relation to the side head shown by the lower dotted circle, and the tool just ready to start at the top of the casting. The forming plate in the side head is held in contact with the roll in the main head and the down-feed started, the tool taking the position shown by the arrow, and the roll changing its position in relation to the forming plate as indicated by two dotted circles, the dotted line *L* indicating the path of the roll. This arrangement is open to the same objections as that shown in Fig. 9 but can be made to do good work providing reasonable care is used in this operation.

Box Plate Forming Attachment for the Vertical Turret Lathe

The work *A* shown in Fig. 11 is in its rough state and is held for the operation of forming and machining by the inside of the flange in the special jaws *B*, these jaws being keyed to the sub-jaws of the table by the keys *C*. A round-nose tool *D* is used to generate the contour, the tool being held during the operation in the side head of the machine. A special roll-holder *E* is fastened on the upper side of the side head by the regular screws, and has a shoulder which thrusts against the head so that no change of location can occur during the progress of the work. A special holder *L* has a shank *J* which enters the main head turret hole, and is prevented from turning by the pin *K*. The plate *G* is of steel and is screwed to the face of the holder and doweled in position, its lower contour being such as to produce the desired form on the work. The lower plate *H* acts as a guard and prevents the tool from dropping too low and gouging into the work.

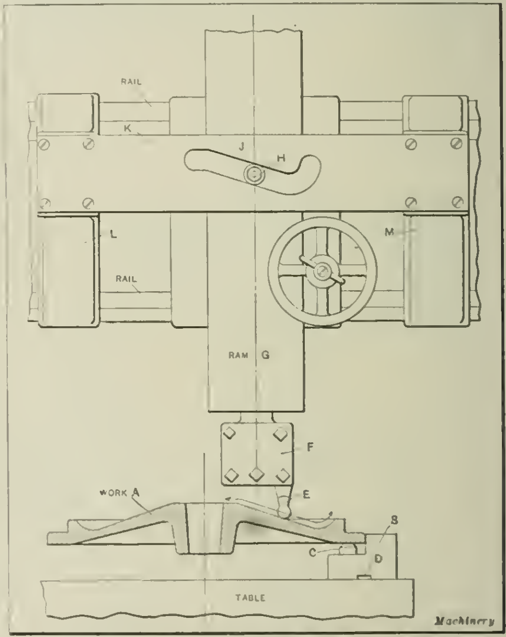

Fig. 15. Forming Attachment for Vertical Boring Mill

This device is operated partly by hand feed and partly by power, the roll *F* being forced against the upper cam surface by the operator. The tools *N* and *P* in the tool-holders *M* and *O* are used for roughing out and finishing the inside work on the casting as well as boring the hole. For work not requiring a very high degree of accuracy, a plate cam of this sort with its attending guard gives very good results.

Another Forming Attachment for the Vertical Turret Lathe

In order to obtain the greatest efficiency from a machine of this type it is highly desirable to keep both the main head and side head in operation as continuously as possible. The forming attachments which have been shown for this machine have all been open to the objection that one of the heads was inoperative during the forming operation. In the arrangement shown in Fig. 12 the attachment is a special one supplied by the Bullard Machine Tool Co., manufacturer of the vertical turret lathe, and being independent of either head it allows both to be used simultaneously. The work *A* is held by the inside of the lower flange in the special jaws *B*. The round-nose tool *C* is held in the side head turret as shown in the illustration. A tee-slot *K* is cut along the full length of the ram, and in this slot a special stud containing a roll *L* may be moved into any position required by the work in hand. The forming plate *M* is supported at each end on the rods *O* and *N* which are vertically adjustable in brackets fastened to the bed of the machine. The required form *P* is cut in the plate, and the side head down-feed being thrown into engagement the roll *L* follows the slot in the plate, thereby causing the tool *C* to follow the line indicated by the arrow.

While this operation is in progress the boring-bar *D* in the main head turret may be used to bore the surfaces indicated by the arrows, and the tools *G* and *J* in their respective tool-holders *F* and *H* can also be utilized for facing, so that there is no lost time necessary when this device is being used.

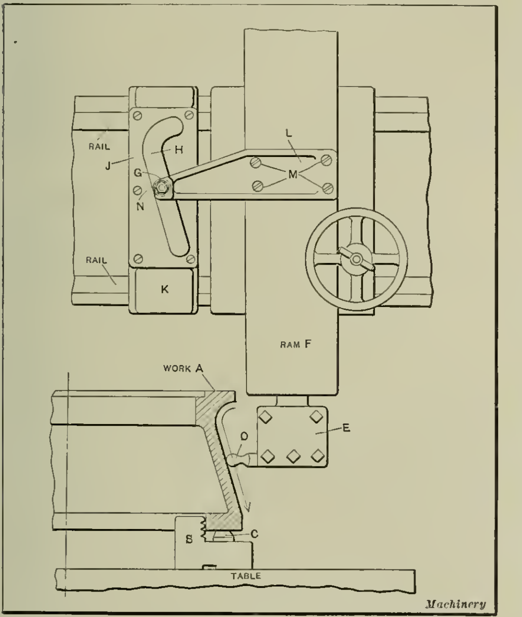

Fig. 16. Forming Attachment for Vertical Boring Mill

Forming Attachment for a Tire Core

Another attachment which allows the independent use of both heads simultaneously is shown in Fig. 13, the work in this instance being a tire core of chilled cast iron. The operation of this device is just the opposite of the usual forming attachment, for the roll *O* is held stationary in a slot *P* of the plate *Q*. This plate is supported at each end by the rods *S* and *R* which are adjustable vertically in brackets on the bed of the machine. A forming plate *T* is located on the side head ram and is held in any desired position by tee-bolts which enter the slots *U* in the ram. It will be noted that the form of this plate appears to be such that it will not produce the work shown, but if it be remembered that the plate moves while the roll stands still the matter will be more easily understood. In using the device the operator keeps pressure on the roll by means of the down-feed crank on the side head, being careful that positive contact is kept at all times. The tool *F* in a special length tool-holder *G* roughs out the grooves in the core. The tool *J* in the holder *H* rounds the corners; the tool *K* in holder *L* finishes out the bevel groove; and tool *N* in holder *M* makes the fillet. Attention is called to the fact that the work *A* is set up on small steel blocks *C* and is gripped by the inner rim in the jaws *B*. The final finishing for the first operation on the core is done by the sweep tool *E*, the machine being reversed during this operation in order to take advantage of the slight spring which this reversal gives, so that the action in sweeping is somewhat similar to that of a goose-neck tool and gives a very smooth contour to the work and a mirror-like finish perfectly free from chatter.

Forming Attachment for a Tire Mold

The work shown at *A* in Fig. 14 is a tire mold of larger diameter and more complicated structure than the one previously illustrated in Fig. 5. The forming attachment used for this work is the same as that shown in Fig. 13 but its application is somewhat different. The work itself is held by the inside in the jaws *B*, a driver *C* being cast on the inside of the rim in order to relieve the jaws of some of the strain incident to holding a piece of this character under very severe machining conditions. A special round-nose tool *D* is used to rough out the mold cavity, the form of which is controlled by the contour of the plate *X*. This plate is mounted on a supplementary one *Z* which is secured in position by the screws *Y* in the side head ram tee-slots. The plate Z_1 is supported by rods as in the former instance, one of these being shown at Z_2. The roll *W* follows the contour *X* and is supported in the slot Z_3 as in the preceding case. A sweep tool *V* is used to finish out the mold cavity after reversing the machine, as on the core work. The tool *F* in a special holder *H* roughs out the angular pocket where it is shown at work, and the tool *G* cuts out the recess at the outer portion of the mold. The tool *K* in the holder *J* sizes the groove in the angular pocket while *U* in the holder *S* trims up the angular sides. The pointed tool *T* is used as a marker at the bottom of the mold cavity. The tools *R* and *N* in the holders *Q* and *L* rough and finish the clincher portion of the mold, while the facing tool *M* finishes the shoulder of the recess.

Forming Attachment for a Vertical Boring Mill

The application of forming attachments for machines of this character are somewhat unusual but are nevertheless needed on certain classes of work or when other machines in the shop are so tied up that they cannot be spared. The work *A* shown in Fig. 15 is a center for a Mallet locomotive piston head, and is held by the outside in the jaws *B* being supported at three points on raising buttons *C*. A round-nose tool *E* is held in the regular holder *F* which is placed in the ram *G* of the right-hand head. Two brackets *L* and *M* are gibbed to the upper and lower rails as shown. These brackets carry a plate *K* which is cut out at *J* to the form required to generate the desired contour. A stud screwed into the ram supports the roll *H* which bears against the edge of the plate and causes the tool to take a similar path.

Another Forming Attachment for a Vertical Boring Mill

When forming is required in a vertical plane and the work is to be done on a vertical boring mill it becomes necessary to disconnect the horizontal feed-shaft on the ram. A special nut is required for this purpose somewhat on the principle of a lathe lead-screw nut. The work shown at *A* in Fig. 16 is an example of a piece which requires this change in the machine. The work is held by the inside of the lower flange in the jaws *B* and is supported at three points on the buttons *C*. A special bracket *K* is mounted on the upper and lower rails of the machine and on this bracket the forming plate *J* is fastened by means of screws and dowels. The plate is cut out to the form *H* which controls the path of the tool *D* through the medium of the roll *G*. A bracket *L* is attached to the ram by means of the screws *M* and the end of the bracket is slotted at *N* to allow the rapid removal of the stud on which the roller *G* is mounted. An attachment of this kind can be readily applied to nearly any standard make of boring mill and will give very satisfactory results if properly used.

Great care must be used in designing brackets for heavy work of this character. They must be made of very heavy construction so that all chance for vibration will be eliminated.

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THE RIGHTS OF SPECIAL MACHINERY BUILDERS

In building special machinery the manufacturer is often confronted by a question of commercial ethics. He is called upon, for example, to build a special machine based on ideas furnished by his customer, but in working out the design the builder usually develops a number of additional ideas of his own. Later he may be approached by a competitor of the first customer, who wants a special machine built for similar work. To what extent is he justified in using the ideas employed in the first machine when building the second one?

If the complete drawings and all the ideas for the first machine were furnished by the customer, the builder would certainly have no right to construct an identical machine for a competitor; but that is seldom the case. Builders of special machinery are more than anything else developers of ideas in connection with their product, and in the building of machines for one customer they necessarily gain experience which may be used greatly to the advantage of another. To what extent this experience may be legitimately employed in the construction of such machinery is a question upon which makers of special machinery and those who order it do not quite agree.

Perhaps the rights of the builder may be more easily defined by comparing him with an employe who gains a great deal of valuable experience when engaged on special work. It is quite evident that after changing his position he will make use of that experience for another employer, and it is conceded that such use is a natural right. Is not the builder of special machinery in a similar position? Has he not the right to use the experience gained working for one customer in the building of machines later for others; if not, where should the line be drawn?

• • •

BALL AND ROLLER BEARINGS IN LIGHT MACHINERY

Ball and roller bearings are used in machinery almost universally for the purpose of reducing the frictional resistance and thus increasing mechanical efficiency. But they may be applied to light machines for another important purpose—to eliminate the necessity for frequent lubrication. The bearings of light machines used in homes and offices are generally neglected, oiling being irregularly done. If oiled too much, the bearings are likely to become dirty and gummed, causing undue friction. Cleaning the bearings is a dirty, disagreeable job, out of keeping with the surroundings of the home or office, and is generally put off as long as possible.

Office appliances, dictating machines, adding machines, typewriters and other machines used in the office which have no rapidly moving parts could advantageously be provided with ball bearings mounted in sealed races. If the races were filled with vaseline or other heavy lubricant, the bearings running at slow speed could be operated indefinitely without damage. Machines thus equipped would never require oiling, and seldom cleaning, during their working life.

The idea is slowly gaining ground that oiling machinery is not necessarily a function that must be performed by an attendant. This is noticeable in the design of high-speed engines, turbines, machine tools, etc. In high-speed, heavy machines of these types, lubrication is effected by systems of pipes and circulating pumps which insure copious supplies of cool oil to the bearings. The use of anti-friction bearings in light machinery for the purpose of eliminating the trouble of lubricating the bearings is but another logical application of the idea of saving labor and insuring uniform and dependable lubrication. The mechanic may be inclined to sneer at the idea of building machines with no provision for lubrication, but the practical business man who has had experience in the sale and maintenance of such appliances knows that neglect is practically universal, and having to face the fact, it is better to provide against it by making bearings "neglect-proof."

• • •

RATIONAL PUNCH AND DIE DESIGN

The development of sheet-metal-working tools has played an important part in modern manufacturing methods, but there is still room for improvement, especially in the application of the knowledge acquired. It is practically impossible to find definite information on some phases of sheet-metal working. It is true that certain manufacturing concerns have collected considerable information on this subject, but few have put this matter into such shape that it can be used as a rational working basis to eliminate costly experimenting when something new comes up. General formulas have been developed for determining the approximate amount of reduction in the drawing of shells and cups; but the results obtained vary with different metals, and experimental designs are necessary to obtain satisfactory results. Diemakers believe that there are conditions in this branch of metal-working which defy analysis, and "experience" seems to them to be the only reliable guide. This is not creditable to the sheet-metal-working industry, considering its importance and the large savings that might be made.

The ductility of the material to be worked, commonly referred to as hardness, is an important factor. When the kind of material, its hardness and elastic limit are known, the other data required for rational design should readily be deduced from practice. The available hardness testing devices have not been used to an extent that their usefulness may warrant.

An improvement which could be made in punch and die design is the standardization of certain parts. There is no apparently valid reason why certain parts of ordinary press tools such as bolsters, die pins, bushings, punches, stops, tripping and feeding devices could not be made to standard shapes with resulting reductions in first costs. Now each designer apparently works to his own ideas, the result being a multiplicity of designs throughout the sheet-metal industry, some of which are low-priced and efficient while others are inefficient and costly.

The literature on punch and die work is by no means complete. Many articles have been published descriptive of punch and die design, some of them interesting and valuable, but the lack of material dealing with fundamental principles and analysis is apparent. More analytical articles dealing with basic principles are needed, and fewer articles describing specific examples of design. MACHINERY has undertaken to compile available data and will publish the results of investigations in a series of articles now in preparation.

SOUTH AMERICAN MARKETS FOR MACHINE TOOLS[*]

THE FIELD FOR MACHINE TOOLS IN SOUTH AMERICA AND METHODS OF OBTAINING ORDERS

BY B. OLNEY HOUGH[†]

MANY American machine tool manufacturers seem inclined to dismiss possibilities of trade in South America with a more or less contemptuous shrug; a few, on the other hand, think, or at least talk, in an exaggerated fashion of the wonderful prospects awaiting them in that part of the world. The truth of the matter is that there is undoubtedly an attractive and regular market for many of our commoner, simpler tools in the principal South American countries, while the gradual development of others of those countries is bound to come sooner or later, as native industries expand, internal communications are promoted, and population increases. As those markets exist today, there are certain peculiar features affecting possible trade in machine tools which it is important to understand, because they affect the methods of cultivating that trade, differentiating them in some respects from other markets with which American tool builders are perhaps more familiar. But, before we go any farther, we may well stop to remind ourselves of a number of misapprehensions which are provokingly widespread just now.

First, there is no lack of ships to South American markets. Any manufacturer who has machinery or anything else to send will have no difficulty in finding a ship to take them. Ships are leaving New York, Mobile, New Orleans and the Pacific Coast ports with usual regularity, and reaching every seaport of commercial importance.

Second, the theory that we must give the "long credits," which the Germans are said to have done, has been thoroughly discredited, and most people now know that these long credits were in the great majority of cases nothing more than ordinary drafts at ninety days' sight, paper which any American house of good standing can sell for cash to foreign exchange bankers, now as heretofore, with only this complication: because of the disruption of the international exchanges following the outbreak of war in Europe, a certain degree of patience may be required in finding those particular banks offering to handle the paper on advantageous terms. Some of the bankers who in normal times have been seeking this business have now, for reasons of their own, or for reasons beyond their control, curtailed their business with Latin markets. It is true, of course, that in exceptional cases machine tools, like other products, have been sold on more liberal terms, ranging up to possibly five or six months' credit, but with the Germans or the English, or any other nation, terms of this sort have been exceptional, and have been granted only in cases and under conditions where Americans as well as Europeans are willing and glad to offer similar accommodation.

Third, machine tool makers, more than any other class of American manufacturers, have to depend on catalogues, printed matter, photographs, specifications, and proposals. You cannot take a sample of a lathe along with you in a trunk when you go to visit Latin-American prospects; so a good deal of the advice so liberally offered to American exporters as to the impossibility of doing business in Latin markets in any other way than through a traveling salesman may be disregarded by machine tool houses. They must depend largely, but not exclusively, on advertising and on correspondence.

Finally, while the acknowledged economic embarrassments of certain South American governments undoubtedly may, for the moment, operate to restrict immediate purchases, American manufacturers in this line, above all others, have to look to the future, to make plans for the days bound to come before long when purchases of new equipment will be imperative. No buyer of machine tools in Latin America or in any other part of the world will or can place orders with unknown manufacturers, or for tools which he has never heard of or has not had an opportunity of studying thoroughly. Hence, because prospects are distinctly encouraging in the principal South American republics, especially those of the East Coast, it is emphatically the part of the progressive and aggressive manufacturer to take immediate steps to let possible buyers and users of the tools he manufactures know all about them, to impress these prospects duly with the peculiar qualities and advantages of the tools offered. The maker cannot wait until the identical day, the very week or month, when the tool will be required.

The Field for Machine Tools

It is not to be denied that in some of the markets we are now considering business is likely to be occasional, rather than regular, and it is the user of tools more frequently than the tool merchant who is the buyer. While at two or three of the principal towns of Brazil, at Buenos Aires and a few other points, there are established merchants doing a regular business in machine tools, possibly carrying some of the commoner forms in stock, yet the greatest field for the machine tool manufacturer is with the actual users of tools, chief among them the railway shops. There are railways of more or less importance in every one of the South American republics. Some of them have fairly big shops, employing as many as 1500 or 2000 hands each. If, in some instances, the railways are of small account, perhaps having only forty or fifty hands to a shop, yet all use machine tools, need new ones from time to time, and, with the growth of territories which they serve and the extension of their lines, must contemplate every now and then new shops or the enlargement of old ones.

There are some rather important shipyards in South America. There are also mines of all sorts and sizes, and everywhere electric light and power plants. There are sugar mills in some territories which have to maintain their own little machine shops. Everywhere there are boiler shops and general repair shops, and technical schools which have some of the commoner tools in their shops and want to know all about all sorts of tools. The rapid and continuous growth in the use of automobiles and motor boats is contributing in important degree to the increased demand by repair shops for suitable tools. On the other hand it is not to be denied that the boiler and machine shops, which of course must exist in every community of the least importance, are (in the great majority of cases) exceedingly small and boast little more, perhaps, than a forge and a foot power lathe. Moreover, the supremely ignorant and unskilled labor which they can command, may retard for some time the introduction of more complicated machinery.

Granted the primitive character of the overwhelming proportion of so-called machine and repair shops throughout South America, none the less the continent remains an important and promising field for up-to-date machine tools. The railways alone, in their construction work and in their repair shops, require in the aggregate a considerable number of tools. Most of those that have thus far been installed come from the United States. British tools are a close second to us, partly because of the nationality of the railways' engineering forces or the character of the financing of the companies. In recent years Germany has been making increased and successful efforts to secure a part of this trade. For the moment Germany can, of course, do nothing, and whatever the result of the war in Europe may be, it seems quite certain that for some time after the war the many South American railways which are virtually controlled by Englishmen will not look with especial favor on tools from Germany.

South American Railways

Each one of the following railways must have at least a repair shop, and many of them maintain large construction shops at various points. In the Argentine Republic there are two government railways. Fourteen other lines are controlled by companies most of which have headquarters in London. The operating headquarters of all but three or four are located in Buenos Aires. At Rio de Janeiro are the headquarters of eleven steam railways and seven electric railways. Headquarters for twenty-four other steam roads and about four electric roads are found at other points in the republic of Brazil. In Uruguay there is one American railroad and one partly American; five others are English companies; of two native steam roads one belongs to the government. The only important electric line is owned by a German firm.

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[*] For other articles on South American trade see "South American Trade Conditions" in the February, 1915, number of MACHINERY, and "The Right Way of Obtaining Foreign Trade" and "Establishment of American Banking Facilities in South America," November, 1914.

[†] Editor, "American Exporter," 17 Battery Place, New York City.

Chile boasts 1979 miles of government railway and 1937 miles belonging to fifteen private companies. There are electric tramways in Valparaiso, Santiago and Concepcion. In Peru there are nine steam railways owned by the Peruvian Corporation and no less than nineteen other lines, some of them short, of from three to sixty miles. The railway shops in connection with these Peruvian lines employ all the way from 40 to 400 men each. Electric tramways are confined to the city of Lima. Paraguay's railways are said to be in the hands of British companies. There is but one electric line. Four steam railways in Ecuador are all owned by the government. Private companies control two electric tramways. In Colombia there are six companies operating steam railways.

In Venezuela there are ten different companies operating steam roads, three of them around Lake Maracaibo. Of the principal lines, two are English and one German. A rather curious condition exists regarding the main system of Venezuela, that is the line running from Caracas to Puerto Cabello, which is divided between two ownerships, the point of division coming about midway of the line. From Caracas half way down the management is German; from Puerto Cabello half way back, joining the German line, the road is British.

From the foregoing it must by no means be assumed that railway shops offer the only opportunities for selling machine tools in South America. As has already been intimated, there are numerous other shops which require considerable equipment, as in connection with steamship lines and dock works, for example. An important installation, made not very long ago for certain large interests in Brazil by the company which is probably acknowledged to be the largest American builder of machine tools, is an example of what is likely to happen in other South American republics.

Obtaining the Orders

The question of how to secure orders from these users of machine tools is one which undoubtedly will chiefly interest American makers who would like to obtain a share of the business. Apart from the railway shops, it is probable that the great bulk of the tools required by other shops is purchased through local concerns of the description usually characterized as "general importers." Merchants of this sort bring out from the United States and from Europe all sorts of supplies, of no matter what description, that may be required locally. Accordingly, local machine shops, like local boot and shoe shops, entrust their orders for foreign goods to the bigger local merchants who make importing their business. It may follow that anything but a good technical description of what is wanted reaches the American suppliers, since the owners and mechanics in boiler shops, or other small industries requiring a new tool of some sort, are themselves neither well educated nor highly trained, while the general importer who transmits the order, often to a New York export commission merchant, probably does not know the difference between a lathe and a drill press. To some extent this can be remedied by the freer distribution among all possible buyers of properly illustrated catalogues, which—it goes without saying—ought to be in Spanish, unless they are to go to Brazil, where people speak Portuguese and not Spanish; but it is not desirable to attempt to translate the ordinary English technical description of a tool into these languages. The American manufacturer will do well to remember the unskilled, untrained, uneducated character of the men who buy his tools as well as the men who operate them. The whole description of a tool ought to be of the simplest, most elementary character. The description, no less than the tool itself, ought to be "fool-proof." This applies, it should be understood, to the literature intended for native perusal; English catalogues will answer for British engineers of railways owned in Great Britain.

Advantages of Local Selling Agents

A rather large proportion of the various railway lines are not owned or controlled by native interests, but are either British or German organizations. This may bring about certain complications in the seeking of orders for shop equipment required by these roads. Nevertheless, as all of them buy their equipment on tender, very often tenders for commonplace tools are locally advertised. In such cases often no more than sixty days is allowed for the receipt of offers. In the majority of instances, this precludes the possibility of an American manufacturer obtaining specifications and returning bids within the time limit.

This is one reason why it is desirable that the machine tool manufacturer be represented on the ground by a competent local agent. It may not be necessary to add that there are other good reasons for making a connection with a local representative, for there are purchasing agents in Latin America who resemble some in other parts of the world, in that they should frequently be "visited" and "seen." Government and municipal enterprises can usually be sold in no other way than by those local representatives at strategic points, who are the possessors of the right sort of acquaintances and the right sort of diplomatic ability, to make offers for the American manufacturer in the right way and be able to make those offers within the time limits that may be set. Such connections of the best sort may often be secured without the necessity of a personal visit. Advertising and corresponding may be very effectively utilized.

Two Ends to be Worked

The fact that most of the largest railway lines in South America buy the largest volume of their supplies through headquarters in London virtually means that the manufacturer who wants to sell them his tools must cultivate both ends, the engineers or purchasing agents in the actual field of operation, and the buying agents in Europe. This does not always overwhelm with satisfaction the traveling man whom the American manufacturer has sent to get orders in South America, nor does it, apparently, pay his rather heavy traveling expenses. He may have worked hard and cleverly with the people he has met at the operating headquarters in the several republics and may not have sent in an order for a single tool; but if he has worked in the right way, and has called to his assistance, while he was on the ground, the best local representative that he can find, he may easily have succeeded in impressing on the engineers or the purchasing agents of the large companies, the peculiar advantages of the tools which he is offering. He may have done even more, as has been done scores of times; he may have so impressed his acquaintances with regard to his tools as to cause certain requirements to be inserted in the specifications of tenders which nobody's tools but his own can fill.

The advantages of a personal visit to the South American markets by the machine tool manufacturer or by some thoroughly competent representative are evident enough from the foregoing. Yet is is possible, so far as the railways are concerned, that orders for tools as the result of such a visit will be placed by London offices or the London buying agents for the South American roads. The manufacturer who thus attempts to cultivate South American business in South America should, therefore, follow up his effort by providing suitably strong approach to the London people from whom orders may actually come. Existing representatives in London ought to be advised to cultivate more intimately the competent London agencies of the South American interests. But the rest of the South American field for tools must by no means be forgotten or neglected. A careful, intelligently devised campaign of correspondence will be found to go a long ways, even without the help of a traveling salesman; it will, indeed, penetrate farther and reach more prospects than would be possible to any traveler. In any event, machine tool literature for South America is of vital importance.

PRESS TOOLS FOR MAKING A ROLLER BEARING CAGE[*]

DIES AND TOOLS USED FOR MAKING A ROLLER BEARING CAGE FROM SHEET METAL

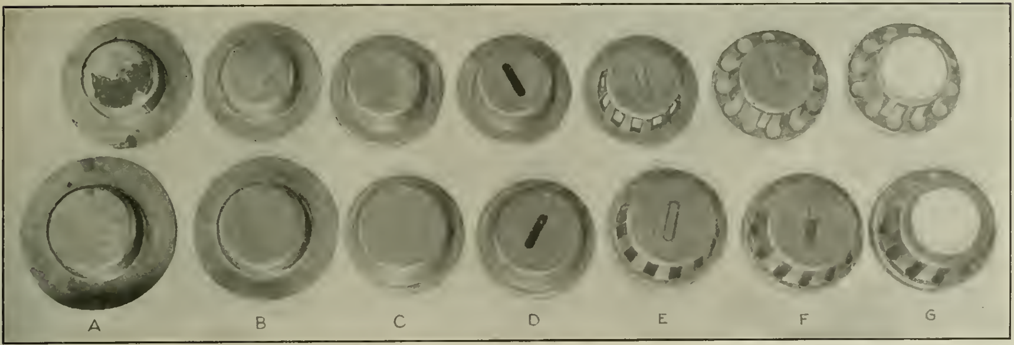

Fig. 1. Evolution of Inner and Outer Members of Bock Roller Bearing Cage—Operations performed Complete in Punch Press

THE making of a roller bearing cage from sheet metal in the punch press involves some unusual methods in press working. This particular roller bearing cage, which is patented and is one of the many sizes made by the Bock Bearing Co., Toledo, Ohio, is shown in its various sequence of operations in Fig. 1. It is made from 0.032 inch bright strip steel and is completed in seven operations. The dies and tools used in making it were designed and built by the Acklin Stamping Co., Toledo, Ohio, who also makes the stampings. This cage comprises an inner and outer section, drawn up into cone shape and serrated so that it forms, when assembled, the retainer for the tapered rollers. The cage must be made accurately and the slots through which the rollers project must be very evenly spaced. This cage is entirely completed in the punch press, not one other machining operation being necessary. As the tools for making the outer and inner members of the cage are identical in construction, only those for making the outer member will be illustrated and described in the following.

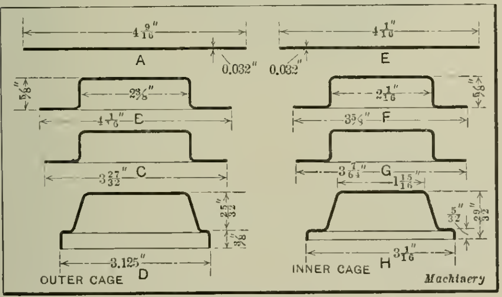

Fig. 2. Sequence of Operations on Inner and Outer Members of Bock Roller Bearing Cage

The Combination Blanking and Cupping Tools

The punch and die for performing the blanking and cupping operations, which is of the inverted type, is shown in Fig. 3, and the result of this operation is shown at *A*, Fig. 1, also at *A*, *B*, *E* and *F*, in Fig. 2. The die part *A*, Fig. 3, of this combination die, is a composite forging made from low- and high-carbon steel welded together, which is bolted to the cast-iron base *B*. This construction is commonly known as the Ferracute type. As is usual there is a rubber pressure pad underneath the bolster of the press to operate the pressure pad *C*. Particular attention should be called to the air holes in the punch and die, which facilitate the action of the die and prevent air from collecting in the stamping. One hole is located on the top of the plug *D* and two are in the knock-out pad in the punch *E*.

Trimming the Cup

Before performing the subsequent operations on the outer and inner cage, it is necessary to trim the outer edge or flange of the cup. This is accomplished with the punch and die shown in Fig. 4 and in section in Fig. 5. Both die, and punch in this case are composite forgings; that is, the top part of the trimming die *A* is of high-carbon steel, whereas, the lower part of the die ring is of wrought iron. It will also be noticed that the top edge of the die is sheared, which assists greatly in the ease of trimming this blank. The shear is about 1/32 inch deep, and the lands about ½ to ⅝ inch wide. Four lands are provided on this die. This is an extremely fast cutting punch and die and also a die that is easy to keep sharp and in repair. The two hook gages *B*, Fig. 4, regulate the position of the blank approximately, and the exact position is determined by the spring pad *C* on the bottom of the punch. The cutters *D* shown on the sides of the punch are worthy of note, these being two in number. As the shells are trimmed, the scrap is forced up around the punch and is gradually cut into two pieces which separates it and allows it to drop clear of the die. These knives are of crucible steel, hardened. Fig. 5 gives a better idea of the construction of this punch and die, and upon referring to this illustration it will be seen that the lower part of the trimming die is soft steel, whereas the upper part is high-carbon tool steel. It will also be seen that the spring pad *C* is held down by means of a spring surrounding the knock-out punch *E*, which is operated, of course, by a bar passing through the ram of the press. The two shearing blades are backed up by the punch body, and are held in place by cap-screws; otherwise the construction of this die is comparatively simple. The results of the trimming operation just described are shown at *B* in Fig. 1, and diagrammatically at *C* and *G* in Fig. 2.

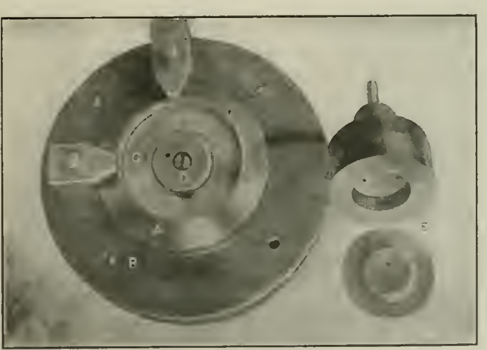

Fig. 3. Combination Blanking and Cupping Die—First Operation on Roller Bearing Cage

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[*] For other articles on punch and die work see "Tube Making in a Punch Press" in the October, 1914, number of MACHINERY and articles there referred to.

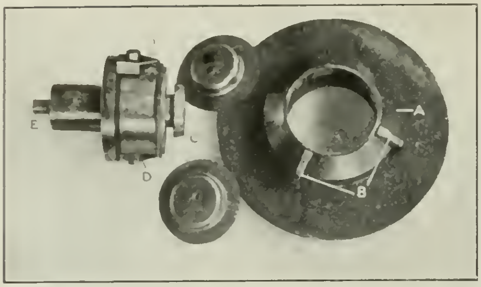

Fig. 4. Trimming Punch and Die—Second Operation on Cage

Final Drawing and Forming Operation Tools

The die and punch for performing the final drawing and forming operations on the inner and outer cages is shown in Fig. 6, and in section in Fig. 7. This punch and die not only sets the taper on the main body of the inner and outer cages, but also edges up the flange. This combination of the two operations is not generally considered good practice, but in the present case it worked out very well and has saved an extra operation, without sacrificing either speed or ease of upkeep of the tool. The pressure ring *A* operates on a rubber pressure pad located beneath the bed of the machine in the regular combination die manner. Reference to Fig. 7 will show the construction of this die more completely. *B* is the die shoe carrying the forming punch *C* that is surrounded by the pressure ring *A*, the latter being operated by a rubber pad beneath the press acting on four ½-inch by 4¾-inch spring pins. The forming part of the punch is held to the lower member of the die by the ⅝-inch screw indicated. The outer member of the forming punch *E* is a composite forging, the shank being of machine steel and the lower member of tool steel, while the inner member is a tool steel forging machined out to the shape of the finished pieces. Screwed to the inner forming pad *F* is a knock-out plunger *G* which is operated by a rod passing through the ram of the punch press. It will also be noticed in this case that particular attention has been given to the provision of air holes to prevent the work from being distorted and to facilitate the operation of the tools. The result of this operation on the outer and inner cages is shown at *C* in Fig. 1, and at *D* and *H* in Fig. 2.

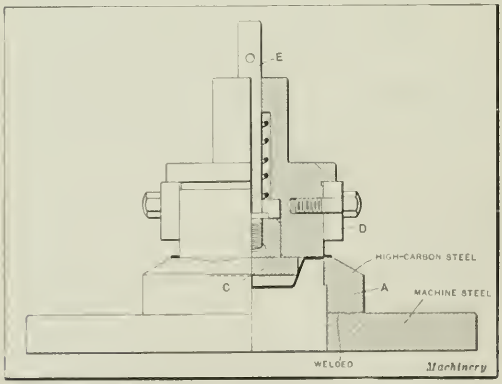

Fig. 5. Sectional Elevation of Trimming Punch and Die showing Construction

Serrating or Piercing the Outer and Inner Cages

Following the forming of the outer and inner cages is a series of piercing operations. The first operation, which is shown at *D* in Fig. 1, is a comparatively simple one, consisting in cutting an elongated slot which acts as a locating point for the subsequent piercing operations. The die for performing the serrating or piercing operations on the inner and outer cages is shown in Fig. 8. This is of the automatic indexing type, and is of rather unique design. The center shaft *A* of this indexing fixture is on an angle with the bed of the press so as to present a horizontal surface of the work to the cutting edges of the punch. The ratchet *B* is operated through the universal joint *C* which is connected to the ram of the press.

In operation, when the press is tripped, the clutch *D* is held in engagement by means of the bar *E*, so that the punching is continuous until the required number of slots has been cut. Upon the completion of one revolution of the shaft *A*, which extends entirely through the mechanism, the pin *F* held in disk *G*, which is located on this shaft, comes in contact with the pawl *I*, tripping the bar *E* and releasing the clutch, at the same time stopping the press.

The stamping is held in place in the die by a hinged handle *J* and a latch shown at the front. Provision has been made in the interior of the die so that the plugs when punched out of the cups pass through easily. The punch, as shown at *K*, is provided with a spring stripper *L* to strip the work from the punch after the slot has been cut. The punching out of these slots is done in a press which operates at 250 revolutions per minute, or 250 strokes, and the indexing is accurate within 0.003 inch. This accuracy is necessary, not so much for the sake of the cup itself as for the fact that in the following piercing operation if the indexing is not accurate the parts trimmed out will not be cut clean and will hang on the stamping.

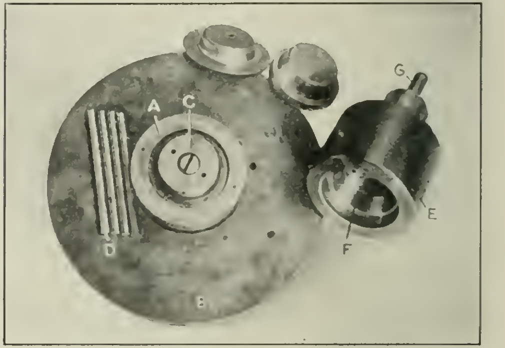

Fig. 6. Final Forming Die for Roller Bearing Cage

The next operation on the outer and inner members of the cage consists in cutting out half circles as shown at *F* in Fig. 1. These are cut out with a die of the ordinary type, all the slots being cut out at one time. The last and final opera-

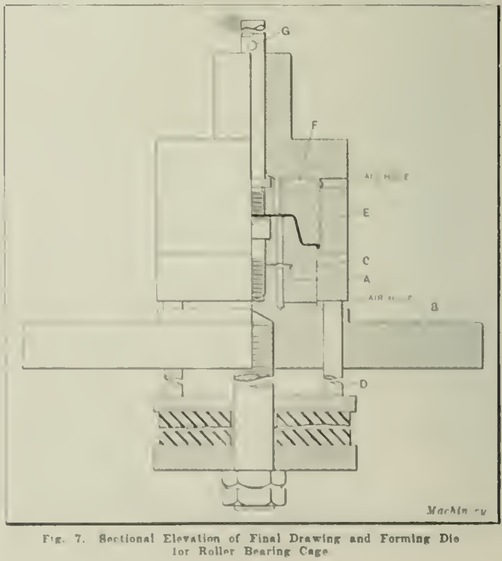

Fig. 7. Sectional Elevation of Final Drawing and Forming Die for Roller Bearing Cage

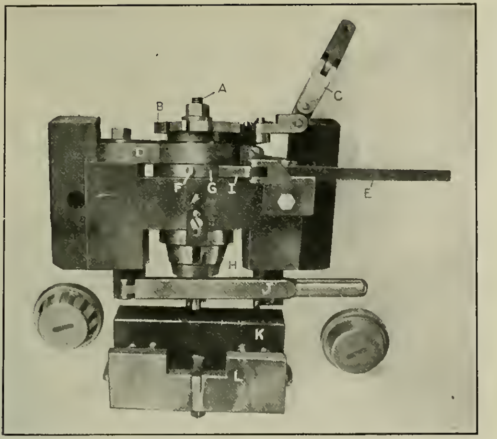

Fig. 8. Automatic Indexing Piercing Die for cutting out Slots to give Clearance for Rollers in Roller Bearing Cages

tion is the cutting out of the bottom of the cages, which is shown at *G* in Fig. 1.

After the cages have been completed, the inner cage is dropped into the outer one, the proper number of rolls are put in place, and then the top or outer part of the cage is wired down to prevent the rolls from coming out. This wiring is done by dropping the assembled cage into a recess in a block on the bolster plate of a light press and using a punch which has a recess in its face shaped exactly like the curve that it is desired to produce. The operation, of course, is very simple, and this finishes the work on the cages, which is representative of the press work turned out by the Acklin Stamping Co., Toledo, Ohio. D. T. H.

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EFFICIENCY IN THE PURCHASE OF MACHINERY*

American manufacturers have long been noted for their readiness to discard workable machinery when by so doing they believed they could reduce costs or increase output. For various reasons such action has not always resulted in the expected economy, the reason being the lack of proper consideration of the requirements before buying new equipment. There are few plants to be found in which all machines are of the most suitable type. In many plants flagrant examples of hasty purchase are numerous enough, and often managers buy new machines to replace others not yet worn out, because the first machines were absolutely unfitted to the work they were called upon to perform.

Efficiency work, to many, means only the payment of a bonus to workmen or the setting of standards of production for men and equipment. The principles of efficiency, however, may be applied with even greater advantage to the purchase of new machinery, for the possibilities of obtaining the best results from any plant are largely dependent on the equipment provided. High efficiency in the purchase of equipment may best be attained by placing the selection of machinery in the hands of a committee on equipment, to consist of the works manager as chairman, the purchasing agent, superintendent, master mechanic, efficiency engineer, consulting engineer, and foreman of the department for which the machine is to be provided. Each of these men has a different point of view, and from their combined ideas the works manager will be able to decide exactly what machine will come nearest to meeting the more or less conflicting requirements and will give the desired output for the lowest unit costs.

When the choice rests with but one or two men, personal prejudices for or against certain machines gain undue power, or the first salesman to get the ear of the purchaser may sway his judgment. The purchasing agent is often ready to accept unsupported statements of the manufacturer as to performance, if the first cost is low. The superintendent would be attracted by machines which would give large outputs for low direct labor costs without great regard to first cost, probable life, or maintenance charges. On the other hand, freedom from breakdowns, cheap maintenance, and simple power requirements would especially appeal to the master mechanic. The foreman may furnish the most practical ideas of all as to what the machine will be required to do, and his personal knowledge of the previous machine will prove illuminating.

If an efficiency engineer or consulting engineer, or both, are on the staff their assistance may be of considerable value. The latter should have knowledge of machine design and leisure to work out the details required, which the other executives do not have, being responsible for costs, output, and daily supervision of the plant employes. The efficiency engineer, from his familiarity with the planning department, will know the capacity needed in the new machine to fit into the general production scheme, the speed at which it should run, the attachments required for the operative's assistance and convenience, and where it should be located to accord with present or proposed plans for receipt and delivery of materials. The diversity of opinion indicated in the foregoing shows the advantage of utilizing the knowledge of all the different heads of departments interested.

The principal points for direct consideration by the committee should be:

1. Type of machine required.
2. Proper design of type desired.
3. Capacity.
4. Class of operator and his rate of pay.
5. Operation costs—*i.e.*, power, oil, and supplies.
6. Life of machine—depreciation.
7. Price of machine.
8. Maintenance costs.
9. Adaptability to other work.
10. Cheapness of accessory tools, fixtures, etc.
11. Installation costs.
12. Floor space needed and its yearly value.
13. Safety provisions inherent in the machine or possible to supply.

The comparative costs per unit can be easily computed by adding to direct labor costs the indirect costs for power, supplies, maintenance, rent, depreciation, and interest on first cost and installation. Divide the sum by the estimated production for the period considered. If similar machines to those under consideration are in use, it will pay to see them in operation if possible. Defects may appear, and estimated capacity may be checked up with actual performance.

A further consideration which comes after the choice of the machine, and where lack of forethought may occasion serious waste, is the proper location of the equipment. We have seen parts moving through a shop in fairly direct course until a certain operation was reached. For this the parts had to be taken to the floor above and later brought back to continue through the shop. A workman may be moved from machine to machine or from one department to another, but it is costly to relocate machinery, and sometimes the cost of doing so is prohibitive. It is therefore better to plan carefully before the installation.

The location of the machine should be decided with reference to:

1. Logical points in the course of manufacture.
2. Distance material has to travel from preceding and to subsequent operations.
3. Distance power has to be transmitted.
4. Space for storage of material.
5. Lighting.

A common error is the placing of small light equipment, which requires a small amount of power and floor space, in a location suitable for heavy and powerful machinery.

Through the methods outlined above the manager of any plant may avail himself of an amount of knowledge and experience which, if utilized with systematic care, will prevent him from falling into the errors of selection which are still entirely too common. They will further enable him to choose new machines and so locate them that he will secure the desired output for the lowest unit cost at the logical point in the course of manufacture.

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* From an article by E. C. Stueler and W. C. Nisbet in "Industrial Engineering."

PYROMETERS FOR SHOP USE

FUNDAMENTAL PRINCIPLES GOVERNING THE DESIGN AND CONSTRUCTION OF ELECTRICAL PYROMETERS

BY J. M. JOHNSON[*]

WITHIN the last few years, the importance of the pyrometer has greatly increased owing to its extensive application in the heat-treatment of steel, and also to the general recognition of the fact that a more uniform product can be turned out by less highly skilled men using accurate instruments than by men of the widest experience in the heat-treatment of steel who determine temperatures by the "color" method. Furthermore, pyrometers are the means of saving expense due to loss of work through overheating, and the consumption of an unnecessary amount of fuel to obtain a desired result. In several commonly used types of pyrometers, the accuracy of the results obtained with the instruments are dependent upon the way in which they are used. But as many foremen and others engaged in the heat-treatment of steel often know relatively little of the underlying principles upon which the instruments that they use operate, such men fail to obtain the degree of accuracy of which the pyrometers are capable. As a result, the instruments are blamed where the real cause of complaint is attributable to the ignorance of the workman. Realizing the importance of this condition, it is felt that the following article describing the fundamental principles of the design and use of pyrometers will be of value to many readers of MACHINERY.

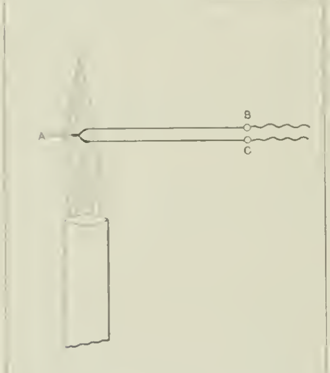
Fig. 1

Fig. 1. Diagram illustrating Principle of Thermo-electric Couple

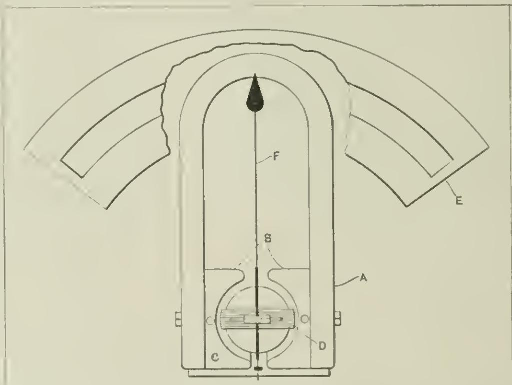
Fig. 2

Fig. 2. Principal Parts of a Typical Form of Millivolt Meter

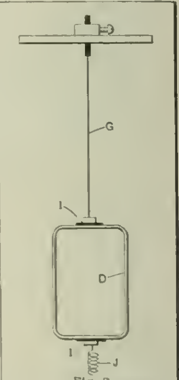
Fig. 3

Fig. 3. Coil of Suspension Type of Pyrometer

A Brief History of Pyrometers

By pyrometer we mean an instrument used to measure temperatures over 500 degrees F. Perhaps the first instruments made use of as pyrometers (if they may be called such) were the Seiger cones which were made from clay and placed in a furnace whose temperature was to be ascertained. These cones would soften and bend over when the temperature for which they were calibrated was attained. They, of course, were of little use, as they did not show whether the temperature was rising or falling, and when once used were rendered useless. Another early form of pyrometer, now used to some extent (the copper bomb) consists of a vessel of water with a low range thermometer in it. A copper ball of known weight is placed in the furnace whose temperature is to be measured, and after leaving the copper ball in the furnace long enough to acquire the same temperature as the furnace, it is quickly transferred into the vessel of water. The increase in the temperature of the water is noted, and by reference to the table supplied by the maker of the pyrometer, the temperature of the furnace is obtained. Other types of heat gages could be mentioned, but very few of them are practical enough for the measurement of high temperatures to be worthy of mention. The only really practical instrument yet devised is the one to be described, which operates on the thermo-electric principle.

Different Thermo-couples and the Fundamental Principles of the Thermo-couple

When two dissimilar metals are held in contact and the point of contact is heated, a small current of electricity is generated, and in most cases the magnitude of this current is proportionate to the intensity of the temperature. As an example, when an iron and a copper wire are twisted together and welded and the junction *A*, Fig. 1, is heated, a current of electricity is generated due to the difference of temperature between the hot junction *A* and the cold junctions *B* and *C*. The greater this difference in temperature between *A*, *B* and *C*, the greater the voltage generated. Any two unlike metals when twisted together and welded will generate an electromotive force when heated, but they may not be suitable for the couple of a pyrometer: first, because some combinations of metals do not give as high an electromotive force as other couples; and second, because some metals do not have a melting point that is high enough to make them useful. The requirements of a good thermo-couple are: first, a high melting point of the elements; second, the ability to generate as large an electromotive force as possible, and an electromotive force which will increase as nearly as possible in direct proportion to rise in temperature in order to obtain a uniform scale; and third, constancy of couples throughout their life.

To meet all these requirements we find that our choice of metals is cut down to a comparatively small number. Platinum and platinum rhodium is a thermo-couple largely used. One wire is pure platinum and the other platinum alloyed with 10 per cent of rhodium. This couple is what is known as the Le Chatelier couple, and is considered a standard when received with a certificate giving the millivolts corresponding to degrees of temperature. This certificate is issued by the maker and can, for a small fee, be certified by the Bureau of Standards at Washington, D. C. The objection to this couple for everyday shop use is its high cost and the small electromotive force generated, which amounts to only 17 millivolts (0.017 volt) when the junction *A*, Fig. 1, is heated to 3000 degrees F. and the ends *B* and *C* are at 32 degrees F. This couple, in common with other couples, absorbs gases rapidly and becomes very brittle, causing it to break easily after some months of use, if it is not properly protected. The electrical resistance of the couple is also very high, and being nearly a pure metal couple its temperature coefficient is very high, which is an objection in shop use, as will be explained later; although in the laboratory it is undoubtedly the recognized standard where the proper conditions can be had for its use.

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[*] Address: 1 New St., Naugatuck, Conn.

The Instrument or Millivolt Meter

This is the name given to the instrument which measures the small voltage generated by the thermo-couple, and which is calibrated to read in degrees F. or C., as the case may be. As before stated, the voltage generated by the thermo-couples, even with the strong base metal couples, is only a few thousandths volt, so that a very sensitive instrument is required to record it. There are two distinct types of millivolt meter movements in use, *i.e.*, the "suspension type" and the "pivoted type," and as regards their electrical construction they are quite similar, differing only in their method of supporting the moving element carrying the pointer. Both types have five distinct parts, namely, the magnet, moving coil, pointer, scale and control springs (or suspension). The magnet is generally of U-shaped design, as shown at *A* in Fig. 2, and has two pole pieces *B* fastened to its ends. The pole pieces are accurately bored out, and a round core *C* is supported in this space. The core is somewhat smaller than the opening of the pole pieces, thereby leaving an annular opening in which the coil *D* moves. The purpose of the core *C* is to shorten the path for the magnetic lines of force, rendering the instrument more sensitive and aiding in keeping the strength of the magnet constant.

Fig. 3 shows the moving coil and suspension *G*. The coil generally consists of an aluminum frame, wound with copper wire, the frame serving the double purpose of supporting the wire and suspension sockets *I*, and also renders the instrument "dead beat," due to the Foucault currents generated in it. The suspension type of movement is the only movement that is practical for use with a platinum couple, because it is possible to make this type of movement very sensitive to small voltages, which is necessary with this couple. The disadvantage of the suspension type of instrument for shop use is that it must rest on a very solid foundation and it is not a portable instrument in the true sense. It must be accurately leveled up before using, and it is quite fragile due to the thinness of the suspension. It also has a rather long damping period, *i.e.*, when using it with a number of couples by means of switches, it takes an appreciable time for the pointer to become steady to indicate the correct temperature. As a laboratory instrument, however, and for very accurate checking purposes, when properly handled, it is a very satisfactory instrument. Fig. 4 shows the most common method of securing the suspension *G* and lower lead spring *J;* this spring exerts no torque on the moving coil, but merely serves to lead in the current. The top suspension, in which the coil hangs, acts as control and lead-in for the current.

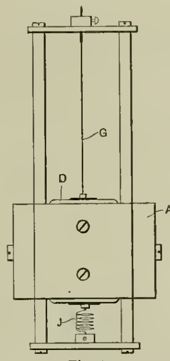

Fig. 4

Fig. 4. Method of securing Suspension G and Spring J

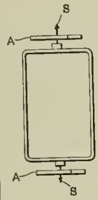

Fig. 5

Fig. 5. Coil of Pivoted Type of Pyrometer

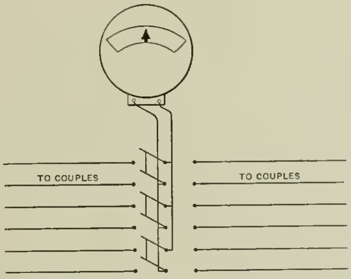

Fig. 6

Machinery

Fig. 6. Diagram showing Arrangement of Double Pole Switches used to connect Several Couples with one Instrument

The pivoted instrument, as the name implies, has the coil supported in jewel bearings instead of on the suspension. The current is led into the moving coil by means of two flat spirally wound phosphor-bronze springs shown at *A* in Fig. 5, which serve as the control and also for leading the current into the moving coil of the instrument. The pivots *B* are of hardened steel and rest on sapphire jewels. This type of movement is generally the one adopted for shop pyrometers on account of its ruggedness and quickness in coming to rest. After connecting to any one of several couples it can be located in any position and needs no leveling. The pivoted type instrument is, however, only practical in connection with the base metal couples (base metal couple meaning couples that are not platinum) on account of the greater voltage generated by the base metal couples giving more power. At this point it may be well to mention that suspension instruments are termed high-resistance instruments, while pivoted instruments are termed low-resistance instruments. Suspension instruments generally have an internal resistance anywhere from 200 to 1000 ohms, while the pivoted instrument has a resistance of only from 5 to 15 ohms. The effect of this difference in resistance will be discussed under the following heading.

Leads and Switching Devices

By leads is meant the wires that carry the current from the thermo-couple to the instrument. In all cases the length of lead that is supplied by the maker should never be cut or lengthened, except when used with the suspension type of instrument where the resistance is equal to 500 or 600 ohms as stamped on the scale of the instrument. In the case of an instrument having 500 or 600 ohms resistance, the addition of 200 or 300 feet of wire will not introduce any appreciable error. As an example, suppose we have a suspension instrument and that on its scale or on the certificate sent with it, it is stated that the instrument has a resistance of 500 ohms; and that the leads that were supplied are not long enough to reach to some solid foundation. We could safely add 200 feet of No. 14 B. & S. gage copper wire, because this wire has a resistance of only 0.005 ohm per foot double, which for 200 feet would be 200 × 0.005 = 1 ohm. This introduces an error in the reading of the pyrometer of only 0.2 per cent, which at 1500 degrees F. would mean that the instrument reads low by 3 degrees F., and for shop use this would be a negligible error. On the other hand, with a low-resistance pivoted type of instrument having only 10 ohms resistance, if we should add 200 feet of No. 14 B. & S. copper wire having 1 ohm resistance, we would have an error of 10 per cent. At 1500 degrees F., that would equal an error of 150 degrees that the instrument would read low.

The above examples also hold for the length of thermocouples used on the suspension instrument. It does not matter much whether the thermo-couple is shorter or longer than originally supplied with the instrument, but with a low-resistance instrument it is important that the thermo-couple be kept within 12 inches of the original length as supplied by the maker, for the reasons stated. In some makes of instruments called high-resistance, it is found that they have an internal resistance of only 100 ohms, or even less. It is, of course, evident that shortening or lengthening the leads will cause an appreciable error with an instrument of this class. Also, on an instrument having about 100 ohms resistance and using a platinum couple, it is important to expose the same length of couple to the heat at all times on account of the temperature coefficient of the couple before mentioned. Platinum, in common with all pure metals, changes its re-

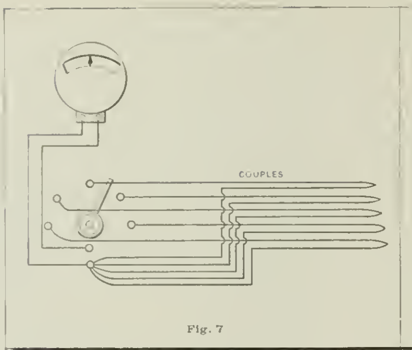

Fig. 7

Fig. 7. Arrangement of Rotary Switch connecting Several Couples with one Instrument

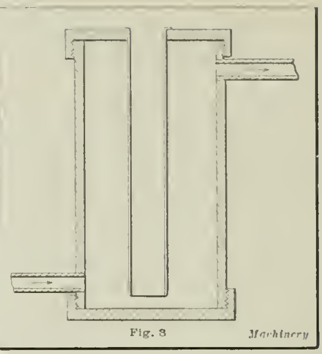

Fig. 8

Fig. 8. Cross-section of Steam Jacket for maintaining a Constant Cold-end Temperature

sistance with change of temperature, the change equaling approximately 0.002 ohm per degree per ohm, or it about doubles its resistance for every 500 degrees F. rise in temperature. To illustrate how this may affect the accuracy of a so-called high-resistance instrument, the actual resistance of which is only 100 ohms, consider an instrument with 24 inches of couple exposed to the heat in the furnace, 12 inches of the platinum couple having a resistance of 0.5 ohm at room temperature. At 1500 degrees F. this resistance is increased to $1500 \times 0.002 \times 0.5 = 1.5$ ohm. The instrument will read 1.5 per cent low at this temperature if its scale has been drawn, taking into account the heating of 12 inches of the couple. The base metal couple is practically a zero coefficient; therefore it can be heated any length.

Switching Devices

Several thermo-couples are often used with one instrument; therefore, some switching device must be used, which in most cases consists of a double pole switch or a rotary switch. Connections to double pole switches are made as shown in Fig. 6, while connection to a rotary switch is made as illustrated in Fig. 7. Switches should be kept clean and bright, and this is especially important on low-resistance systems. Where a furnace is so large that two or more thermo-couples are required, the double pole switch gives the best results on account of the fact that the rotary switch has one common point of connection to all thermo-couples and it is almost impossible to thoroughly insulate the thermo-couples, stray currents between the thermo-couples themselves being liable to cause a considerable error. The rotary switch is, however, more desirable than the double pole switch where two or more furnaces each having one thermo-couple are indicating on one instrument, as it is possible to take readings faster and it shows at a glance which furnace is switched onto the instrument.

The Cold End of the Couple

The cold end is the name given to the points where the couple ends and the conducting wires are soldered on, *B* and *C* being the cold end of the couple shown in Fig. 1. The instrument, as already mentioned, measures in millivolts (0.001 volt) and its scale has been marked to indicate directly in degrees of temperature. The number of millivolts obtained from the couple depend upon the difference of the temperature between the junction *A*, Fig. 1, and the cold end *B–C*. For example, suppose the junction *A* is at a temperature of 1500 degrees F. and the cold end *B–C* has a room temperature of 75 degrees F. The difference is 1425 degrees, and assuming that we get 50 millivolts for this difference, where the 50 millivolt point should come on the scale we find marked 1500 degrees F., which is the correct temperature of the furnace, providing the instrument has been calibrated for a cold end temperature of 75 degrees. When the wire is disconnected from the instrument, the pointer should stand at 75 degrees, which is at the beginning of the scale. Should we now raise the temperature of the cold end to 100 degrees F., our difference between the hot end and cold end which was 1425 degrees is now only 1400 degrees, and the number of millivolts generated is less in direct proportion, causing the instrument to read only 1475 degrees F., while the furnace is still at 1500 degrees, thus giving an error of 25 degrees that the instrument reads low. To conclusively demonstrate the correctness of the preceding explanation: should we heat the hot junction *A* and the cold end *B–C* to the same temperature we would get no indication on the instrument, because the temperature difference would be zero, which gives us no generated millivolts.

The high-resistance platinum couple instrument, known as the "Le Chatelier" pyrometer, is as a rule calibrated for a cold end temperature of 32 degrees F., which is the temperature of melting ice. It can be readily seen by observing the scale of an instrument, at what point the cold end is to be kept. In the case of the high-resistance instrument just mentioned, the pointer comes to rest at 32 degrees, which is generally marked in small figures on the scale. In using this instrument for obtaining actual indications of temperature, it is necessary to provide a vessel containing a little water and chopped ice, and immerse the cold end in the ice water. The commercial shop instrument, or the low-resistance type, is generally calibrated for a cold end temperature of 75 degrees F., it being assumed that 75 degrees is a fair average temperature in a shop; but in many cases it is found impracticable to go far enough away from the furnace with the cold end to obtain a uniform temperature of 75 degrees. Therefore, some means of keeping the cold end temperature constant is desirable. Many schemes for doing this have been tried, such as the use of water jackets and burying the cold end in the ground, which of course is all right if one is certain that the temperature does not vary greatly; but one of the surest ways of taking care of the cold end is to place it in boiling water, which can be done by using a chamber made from a pipe having a cap screwed on the top and bottom, and a copper well closed at one end extending down into this pipe. The outside pipe, as shown in Fig. 8, should have a small inlet and an outlet. Steam can now be connected to the lower pipe, which will condense inside of the chamber, and very little of the steam will escape through the top pipe, thus maintaining a uniform cold end temperature of 212 degrees F. Now, to adjust the instrument to correspond to this cold end temperature, all we have to do is to set the pointer at 212 degrees on the scale when the leads are disconnected. This is accomplished by a zero adjuster that is found on most instruments. If the instrument is not provided with a zero adjuster, the cover may be taken off, and on the movement there will be found a cross piece shown at *A* in Fig. 9, having a clip *B* on it to which the spring *A*, Fig. 5, is soldered. Holding this clip are one or two little screws shown at *C* in Fig. 9. To adjust the pointer to 212, loosen the two screws *C* and move clip *B* until the pointer stands at 212 degrees F. Of course while doing this the leads to the instrument should be disconnected. If we now insert the cold end into the steam jacket, when steam is going through, the instrument will be correct as far as the cold end temperature is concerned, and will stay correct as long as the steam is flowing through the steam jacket.

Methods of locating the Thermo-couple in a Furnace and how it should be Protected

The base metal couple—the one that is best adapted for shop use—is generally made up of two wires having a diameter of about 1/8 inch, so that the couple is quite rugged. It is generally insulated by winding each one of the wires with asbestos thread and afterward painting it with some cement composed of alundum, or carborundum and silicate of soda. The couple, insulated as described, is then placed in a 3/4-inch iron pipe, which is supposed to go into the furnace. In most cases, however, and especially in the case of pyrometers used in high-temperature annealing furnaces,

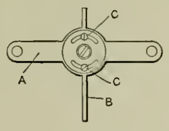

Fig. 9

Fig. 9. Adjustment on Movement for setting for Proper Cold-end Temperature

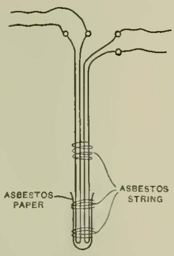

Fig. 10

Fig. 10. Method of checking "Shop Couple" against "Standard Couple"

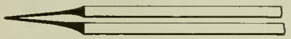

Fig. 11

Machinery

Fig. 11. Diagram showing Modification of Pyrometer Couple for obtaining Recalescence Point of Steel

it is desirable to put one more thickness of pipe over the ⅜-inch pipe, as it gives a longer life to the thermo-couple; and when the temperature does not change very rapidly the couple is found to be sensitive enough. The couple should be mounted in the furnace either from the top or from the side, and it should not be near the source of heat, but should be placed in such a position that it receives the average heat. The thermo-couple should project into the furnace at least 6 inches, and if possible 10 inches, because there is a great amount of conduction along the pipes that form the protection of the couple, which would tend to make the temperatures indicated by the pyrometer too low, if the thermo-couple was not inserted in the furnace for at least this distance. After the thermo-couple has been used for some time, it should be examined to see if the wires are broken or bare of insulation. If the wires are broken close to the twisted and welded end, the couple may be cut off and scraped clean for an inch or two, twisted together again and welded by means of the oxy-acetylene flame, or electric arc. Of course before welding the couple—should it be bare of insulation—it should be first wound with asbestos, as it will be found more convenient to wind the wires when they are apart than when they are welded together. Platinum couples may be welded very successfully in the electric arc, and in this way the life of the thermo-couple can be considerably lengthened, because as a rule the loss of 12 or 14 inches of the couple will not introduce any appreciable error.

Methods of Checking a Pyrometer in the Shop

A pyrometer, like any other instrument, must be frequently checked. In order to do this easily and with a fair degree of accuracy, it is desirable to have on hand one portable instrument that is used only for checking purposes. If such an instrument is at hand, the easiest way to check the shop pyrometer is to take the thermo-couple of the standard instrument and remove it from its pipe protection. Likewise with the pyrometer that is to be checked: remove its couple and protection from the furnace and remove the protection from the thermo-couple, and tie the standard couple and the couple that is to be tested together with asbestos thread, first insulating each with a small piece of asbestos paper at the tip. Fig. 10 shows the method of tying the couples together and protecting with asbestos paper. A small cast-iron pot or crucible with commercial lead can be used as the source of heat. The lead can be heated to a temperature of 1500 or 1600 degrees F., and the couples, having very little protection on them, are immersed in the lead but not allowed to touch the bottom of the pot. Under these conditions, the couples will very rapidly acquire the temperature of the molten lead; also being of the same cross-section, they will follow each other with a very slight temperature difference between the two. By observing the shop instrument on the test and the standard instrument, the difference in reading may be easily noted, which should be marked down in tabulated form for three points on the scale; and these records should be kept, as they show a history of the instrument, *i.e.*, whether its error, if any, is constant or varies.

If the pyrometer installation is a small one and it would be too expensive to keep an instrument only for the purpose of checking, tests are made by using known melting points. Two points on the scale may be easily checked, as every metal when it solidifies keeps its temperature constant for an appreciable length of time—long enough so that one can easily determine the melting point by observing the pyrometer pointer. For instance, lead solidifies at 618 degrees F., which forms our first checking point. Common table salt, or sodium chloride, solidifies at 1440 degrees F., approximately, and gives a fine high point for checking. Of course it is understood that the couple should be insulated with asbestos paper, as previously mentioned, and immersed directly into the lead, or salt, as the case may be. More refined methods could be mentioned, but it is impossible to make use of them outside of the laboratory with any degree of accuracy.

General Points to Observe in the Use of the Pyrometer

The most common sources of error with pyrometers are, as a rule, found to be due to variations in the cold end temperature or to dirty contacts at the switches or binding posts, and special attention should be given to these three points to insure good results. Another common source of trouble is that the indicating instrument is hung up on the furnace where the temperature of the instrument sometimes is as high as 150 degrees F., which is too hot for an electrical instrument; and no great accuracy can be expected under this condition. The moving copper coil of the instrument has a high temperature coefficient and its resistance changes appreciably with change of temperature, it being negligible for a few degrees, but rises of 50 or 75 degrees above room temperature—for which the instrument was calibrated—will cause a serious error. Also the phosphor-bronze control springs will fatigue when exposed to this high temperature. tending to make the instrument read low.

How to Obtain the Recalescence Point of Steel

It is often desirable to find the recalescence point of steel. This can be done with a commercial indicating or recording pyrometer with a very slight modification of the thermo-couple, by taking the thermo-couple and reducing the tip of the junction, Fig. 11, for a length of about 1½ inch. Reducing it to a diameter of about 1/16 inch, winding it with asbestos and again rewelding the ends, will render the thermo-couple very sensitive to rapidly changing temperatures. A small sample of the steel of which the recalescence point is to be taken, has to have a hole drilled in it about 1 inch deep and large enough to take the reduced end of the couple. The thermo-couple is then inserted into the steel sample, and the sample is heated either in a small electric furnace or uniformly heated with a gas flame until the pyrometer shows a temperature of about 1700 degrees F. Without disturbing the couple, the sample and couple are removed from the fire and the sample allowed to cool. Readings on the pyrometer are now taken every 10 seconds, putting the readings down in one column for time and in another for temperature. The temperature as indicated by the pyrometer will be less for every 10-second reading, until the recalescence point occurs, when the temperature will remain constant for 20 or 30 seconds, and sometimes as long as 1 minute, depending on the size of the sample. This steady point is, of course, the recalescence point of the steel. If the absorption point is wanted, the temperature and time are taken every 10 seconds while heating the sample, although the absorption point will not stay steady as long on the pyrometer as the recalescence point. Of course if a recording instrument is at hand, simply by reducing the diameter of the couple as previously described, the recorder will record the absorption and recalescence points. If the sample is made ½ inch in diameter and 2 inches long, it is amply big for obtaining these points. The hole should not be too large, but the thermo-couple should fit rather snugly in it.

MAKING SECTIONAL MOLDS FOR DIE-CAST NAMEPLATES

METHOD OF ASSEMBLING THE SAME MOLD SECTIONS IN VARIOUS COMBINATIONS

BY EDWARD K. HAMMOND*

THE method of manufacturing nameplates for machinery developed by the Federal Nameplate & Novelty Co., 732 Federal St., Chicago, has two noteworthy advantages. Of primary importance is the fact that the letters, numbers and decorations are made to stand out in bold relief, so that the nameplate possesses the maximum publicity value and will not become worn smooth and illegible during the life of the machine to which it is attached. The nameplates are die-cast, and by means of a patented method by which the molds are made, each letter, figure, or unit of decoration or background is contained in a separate block of steel. These blocks are carefully ground on all sides so that they fit accurately together, and can be locked up in a frame to form the mold matrix. Then after the required number of nameplates has been cast, the mold is broken up and the sections distributed to the different "fonts" or cases in which they are kept. As the same mold sections can be used over and over again in casting nameplates requiring any combination of letters, figures and decoration, they constitute a stock in trade for the nameplate manufacturer, and as a result the purchaser only has to pay for the actual plates which he receives, no charge being made for making the letters, numbers or background sections of any size required to fill an order, if they are not in stock at the time the order is received.

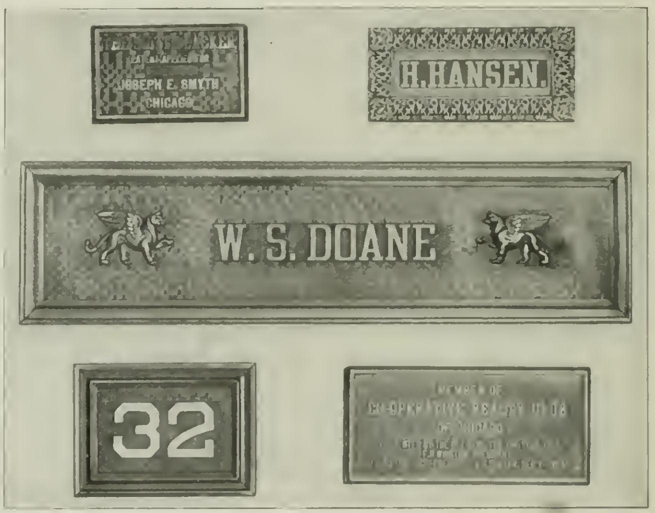

Fig. 1. Examples of Federal Nameplates, showing Variety of Letters, Numbers, Backgrounds, Decorations and Borders that can be employed

It is the purpose of this article to describe the method of making the mold sections and the manner in which these sections are combined to form the complete mold for casting any given nameplate. For the purpose of description, it will be assumed that an order is received which requires different mold sections from those already in stock. Such being the case, it would be necessary to make up these sections before proceeding to fill the order; but if they are standard letters, numbers, etc., which there is a reasonable chance of using over again, no charge would be made for this part of the work. The method of procedure is as follows: A master punch or "hub" is first made for each letter or figure in the required nameplate, and after these have been completed the mold sections are produced by forcing the master punches into the ends of accurately finished steel blocks by means of hydraulic pressure. The tool steel blocks from which the mold sections are made are finished to approximately the required size before the impressions are made in them, and after this operation has been performed, all sides of the blocks are accurately ground to size so that they will fit together properly. After this work has been done the mold sections are locked up in a frame, as shown in Fig. 2, which is closed in by a plain plate at the back, this plate being at the proper distance from the faces of the mold sections to give the required thickness to the nameplate. The mold is then ready to be sent to the die-casting room, where it is set up in the machine ready for casting the required number of nameplates. Having made this preliminary statement, we can proceed with a detailed description of the different operations involved in making the mold.

Engraving the Hubs or Master Punches

In making the hubs or master punches, the first step is to prepare the tool steel blanks; and for the purpose of reference, a drawing has been made of the master punch for the letter Z as shown in Fig. 4. The blank is first accurately ground so that the sides *A* and *B* are exactly at right angles to each other, these sides being used for the purpose of locating the blank in the different fixtures in which it is held while engraving. After the sides have been ground in this way, the face of the blank in which the letter is to be engraved is first ground perfectly smooth and square with the sides *A* and *B*, after which it is polished on a lapping plate charged with flour of emery so that a very smooth surface is obtained on which the letter is laid out.

In laying out the work there are two alternatives: The engraver may be called upon to reproduce a master punch which has been damaged, or he may be required to lay out a new letter or letters of a specified size; and the method of procedure will be different in these two cases. The method of reproducing a master punch which has been damaged is as follows: The block which has been finished according to the preceding description is clamped in one socket of the double jointer which is shown at *A* in Fig. 5, and the block on which the letter is to be laid out is secured in the other socket of this tool. The double jointer is merely a duplex clamp which provides for holding the work and the master which it is desired to reproduce. The socket in which the work is held may be adjusted by means of two screws, one of which regulates its lateral position and the other its angular position, so that the block is lined up with the master that is being worked from. After these adjustments have been made, the engraver uses his square *B*, angle gage *C*, etc., to locate the required points on the work from the master which is held in the other socket of the double jointer. When these points have been located, the letter is laid out and the work is then ready to be engraved.

For this purpose, a special routing machine is used, which is shown at the right-hand side of Fig. 3. The head of this machine is provided with the usual form of micrometer stop for regulating the depth to which the work is engraved, and the vise is provided with a special form of micrometer collar for locating the work for engraving along angular lines, such as the cross bar of the letter Z. For making this setting, the engraver will use his micrometer gage to measure the distance *C* on the master shown in Fig. 4, from which he is working; or on the letter which he has laid out on the work, should he be laying out a letter from dimensions. He will

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* Associate Editor of MACHINERY.

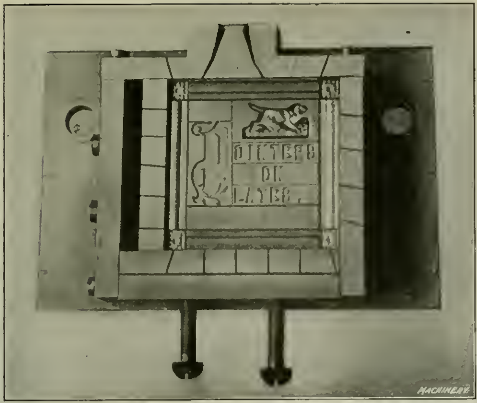


Fig. 2. Assembled Mold with Back Plate removed to show Matrix

then swivel the vise on the engraving machine through a corresponding distance. This results in bringing the cross bar on the letter parallel with the cross-slide on the engraving machine, and it is then an easy matter to run the routing tool along the required lines.

Testing the Accuracy of the Engraved Punches

After the routing operation has been completed, the engraving of the master punch or hub is finished by means of the hand gravers shown at *D* in Fig. 5, and as the engraver uses a watchmaker's glass, he is able to attain an extremely high degree of accuracy. When the engraving has been finished in this manner, it is necessary to prove the accuracy of the work, the tests consisting of measuring the "weight" or thickness of the lines, the depth to which the letter has been engraved, and the size of the letter. For measuring the thickness of the lines, "ceriph" gages are employed, which are shown at *E* in Fig. 5. These gages consist of two semi-cylindrical members which are sharply pointed at the ends. The two parts of the gage are pinned together in such a way that the two halves may be moved longitudinally in relation to each other. In using the ceriph gage, the engraver first sets it so that the two points lie on opposite sides of the line on the master letter, which is to be compared with the line on the letter that has been engraved. This setting can be made with extreme accuracy, as the points are quite sharp and the watchmaker's glass magnifies an error in setting which would be invisible to the naked eye. After the ceriph gage has been set from the master punch, it is used to measure the accuracy of the corresponding line on the work. All of the lines are gone over in this way and any errors are corrected.

The next step consists in measuring the accuracy of the "counter" of the letter, the micrometer counter-gage shown at *F* in Fig. 5 being used for this purpose. In this connection it will not be out of place to explain that the "counter" of a letter is its inside width, the counter of the letter Z being the distance indicated by *D* in Fig. 4. It will be seen that the micrometer counter gage is a special micrometer caliper made with parallel knife-edges which are accurately set on the opposite sides of the "counter" by the aid of the watchmaker's glass. After the accuracy of the counter of the letter has been determined, a lining gage is employed to determine the accuracy of the positions of the "cap" line, the "descender" line and the "side" or "set" line of the letter. The lining gage is shown at *G* in Fig. 5, and it will be seen that this tool is provided with three knife-edge blades which may be set independently of each other for determining the three dimensions of the letter that have been referred to. A shoulder on the lining gage bears against the finished sides of the jointer in which the work is held. In working from a master letter, micrometer collars on the tool are not necessary, as the working edges of the three blades are brought into coincidence with the corresponding lines on the master, these positions being determined with the aid of the watchmaker's glass. After the settings of the gage have been made, the tool is used in proving the accuracy of the punch which has just been engraved. But where the engraver is working from specified dimensions instead of a sample letter, the micrometer lining gage shown at *H* is used to check up the "cap," "descender" and "set" lines.

Fig. 3. Engraver's Bench, with Special Routing Machine at Right and Vise Stand at Left

In this connection, it may be mentioned that the "cap" line is the bottom line of the capital letter or the line on which all of the letters rest. The "descender" line is the line marking the distance which the lower case letters g, j, p, q and y extend below the "cap" line. The "side" or "set" line is the distance of the right-hand side of the letter from the side *B*, Fig. 4, of the block on which it is engraved. The accuracy of this dimension is a point of vital importance, as all letters are located on their blocks from the side *B*, and the proper spacing of the letters is determined in this way. All of the required dimensions have now been determined with the exception of the depth to which the letter has been engraved, and for this purpose the depth gage shown at *J* in Fig. 5 is employed. This is simply a refinement of the machinists' depth gage, and is used in about the same way, except that there is a sharp knife-edge which comes into contact with the finished face of the work, and accuracy is proved by noting whether the knife-edge is raised sufficiently from the work to permit light to pass underneath it.

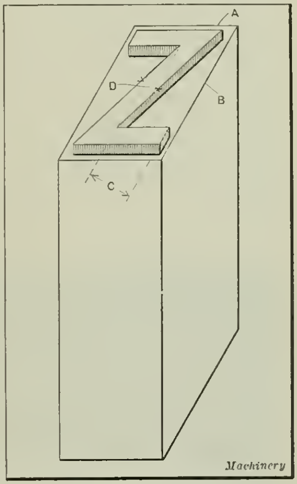


Fig. 4. Master Punch or "Hub" for Letter Z

The preceding description applies to the laying out of a master punch or hub from an existing master punch. When it is required to lay out a letter without the use of a master, the location of each point must be determined by the micrometer screws on the engraver's gages. The required size of the letter and weight of the lines will also be determined with these micrometer gages, and after the letter has been engraved its accuracy will be proved as described in the preceding paragraph, except that the gages will be set by means of the micrometer screws instead of setting the edges of the gages to the required faces on the master from which the work was laid out.

Making the Mold Sections

After the accuracy of the engraving operation has been proved in this manner, the punch is transferred to the hardening department where the steel is hardened in accordance

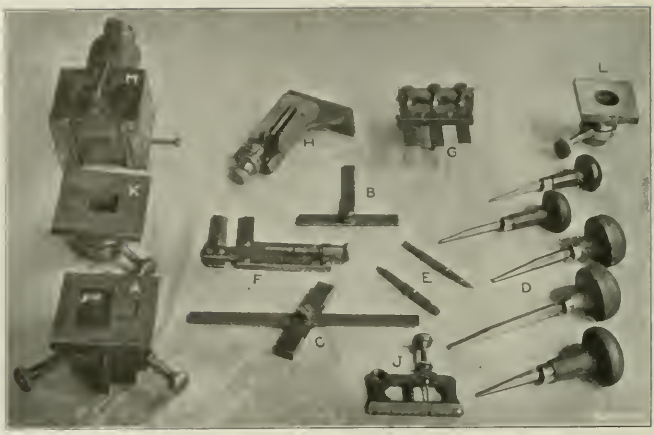


Fig. 5. A, Double Jointer; B, Square; C, Angle Gage; D, Gravers; E, Ceriph Gages; F, Micrometer Counter Gage; G, Lining Gage; H, Micrometer Lining Gage; J, Depth Gage; K and L, Single Jointers; M, Bevel Jointer used to get Uniform Bevel on Hubs

with the standard practice followed in the heat-treatment of tool steel; and after this has been done, the punch is ready for use in making the mold sections. In making the mold sections, commercial annealed tool steel is used, from which blanks of the required size are machined up and ground to the approximate size. These blanks are then mounted in the fixture shown in Fig. 8, which is carried on the bed of a hydraulic press that is used to drive the hub down into the face of the blank to produce the required impression for the mold section. Reference to Fig. 8 will show that this fixture is provided with two slides *A* and *B* which enable the longitudinal and transverse adjustments to be made, in order to locate the work in the proper position under the punch. The longitudinal movement of the fixture obtained by the slide *A* is regulated by the screws *C*, while the transverse movement of the slide *B* is governed by a pair of screws carried by a plate secured to the bed of the press.

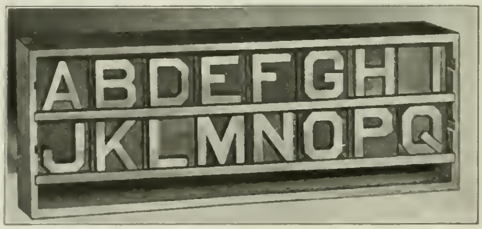


Fig. 6. Set of "Hubs" or Master Punches for Large Letters

In addition to the means of making these adjustments, it will be seen that the fixture is provided with two backing-up screws *D* which hold hardened steel plates *E* against two sides of the work, and force the work against the two fixed sides of the socket in the fixture. In this way the blank is adequately supported on all sides so that it will not be distorted by the high pressure which is necessary to drive the punch down into the steel. But to guard against slight distortions which may occur, the blanks are transferred from the press to a Brown & Sharpe No. 2 surface grinder, where they are held on a Walker magnetic chuck and ground on all sides to reduce them to exactly the required size, and at the same time to eliminate any slight errors which might result from distortion during the formation of the depression under the hydraulic press. In this grinding operation, care must be taken to have the sides of the blank ground exactly parallel and to have all blanks of exactly the same size; otherwise, the different sections required for a finished mold would not fit together properly. Also, it is obviously necessary to have all of the mold sections of exactly the same height in order that they may be assembled with their working surfaces exactly level.

Assembling Finished Sections into Mold

After the necessary mold sections have been made, they are assembled and locked together to produce a mold of the general form shown in Fig. 2. The mold is shown with the back plate removed to show the matrix; but this plate is merely a flat piece of steel which fits closely against the rim and forms the plain back of the nameplate. It will be seen that the rim at the top of the mold is gated to provide the necessary space for the metal to flow into the mold. There is nothing of exceptional interest about the die-casting operation, and as the subject of die-casting has been quite thoroughly treated in articles published in MACHINERY, further treatment of this work is unnecessary.

The Distinctive Features of Federal Nameplates

It has been the purpose of this article to describe the method and operations involved in making sectional molds for die-casting the nameplates made by the Federal Nameplate & Novelty Co.; but as the means by which any desired end is attained is merely incidental to that end, this article would be incomplete without making some detailed reference to the class of work produced in the molds. The features of obtaining nameplates with the lettering and design in bold relief, and the possibility of obtaining these plates without the expense incident to engraving a special mold matrix for each different plate have already been referred to. This process of die-casting machinery nameplates is also well suited for application in the production of speed and feed plates for machine tools, door plates, and various other classes of work where letters, numbers and decorative effects are required in various combinations.

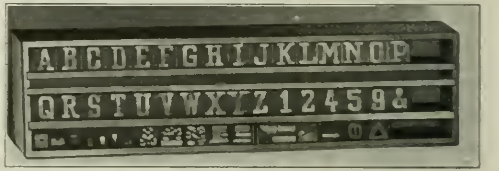


Fig. 7. "Hubs" for Small Letters, Figures, Backgrounds, Borders, Decorations, etc.

The plates are made from two classes of metal, depending on whether they are to be mounted on a flat surface or a curved surface. In cases where the finished plate is required to be bent to fit over a curved surface, white metal is used, as this metal is quite flexible and can be bent without danger of breaking. But where the finished plate is to be mounted on a flat surface, greater durability is obtained by

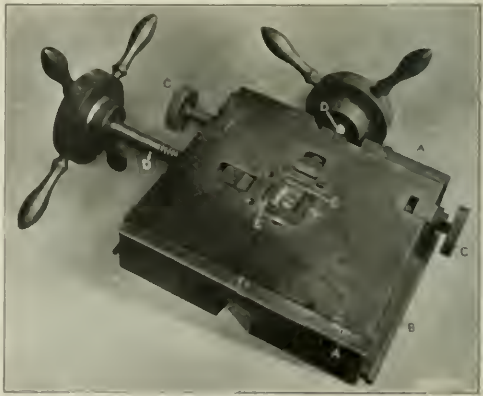


Fig. 8. Fixture used for holding Work while forcing "Hubs" into Mold Sections

casting the plates with a special brass mixture. Different methods of finishing are employed to add to the attractive appearance of the nameplates. In some cases, the Schoop process of spraying molten metal onto the surface of the plate is employed, and where this process is followed, the surface of the plate may be coated with copper, silver or other metals of distinctive color. In other cases, it is found desirable to electroplate the nameplates. After the metal coating has been applied, the plates are lacquered to give them the final finish.

It is often required to have the letters of one color and the background of another, and to secure this result the entire nameplate is sprayed with the colored lacquer which is required for the background. While the lacquer is still wet, the surface of the plate is wiped with a soft cloth which removes the lacquer from the faces of the raised letters, exposing the surface of the metal to give the letters the distinctive color of the metal from which the plate is made. Then after the first coat of lacquer is dry, the entire plate is again sprayed with white lacquer to give the final finish. The combination of different decorative effects, a border and an artistic background, in connection with the required lettering on a nameplate, naturally adds greatly to its appearance. The background may be of "basketwork" design, stippled, or of any other pattern required, or it may be left plain. When it is taken into consideration that these features are obtained by a method which enables nameplates to be made without any charge for engraving the mold, it will be evident that this process of die-casting in sectional molds is one which is destined to be of far-reaching importance to the mechanical public.

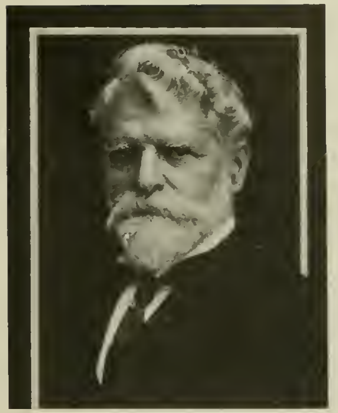
* * *

AMBROSE SWASEY

Ambrose Swasey, the donor of the initial fund of $200,000 for the Engineering Foundation, inaugurated at the Engineering Societies Building, January 27, as mentioned in the February number of MACHINERY, is widely known as a member of the firm of Warner & Swasey, builders of machine tools and telescopes, of Cleveland, Ohio. He was born in Exeter, N. H., his ancestors being among the early settlers of New England, having come to America in 1638. He received his education in the "little red school house" of the district. At the age of eighteen he entered upon the machinists' trade in Exeter, and in 1870 he entered, together with his present partner, W. R. Warner, into the employ of the Pratt & Whitney Co., Hartford, Conn. Here his energies and ability soon became manifest, and his aptness in the solution of mechanical problems was so thoroughly appreciated that the expression "send it up to Swasey" became a standing phrase in the factory. While in charge of the gear-cutting department of this company he invented and perfected an epicycloidal milling machine for producing true theoretical gear-tooth curves, and also developed an entirely new process for generating and cutting spur gears.

In 1880 Mr. Swasey resigned his position with the Pratt & Whitney Co., and together with Mr. Warner established the firm of Warner & Swasey, in Cleveland, Ohio. This business has grown to be one of the prominent machine tool plants in the country, and is also well known as the leading plant in the world for the building of telescopes. Among the instruments which have been designed by the firm of Warner & Swasey are the famous Lick, Yerkes, and United States Naval Observatory telescopes, as well as the great 72-inch reflecting telescope for the Canadian government, which is now under construction. The achievements in the machine tool building field are too well known to need comment.

Mr. Swasey is known also, in addition to his engineering achievements, for his practical efforts toward scientific education and the advancement of the engineering profession, and his gift for the establishment of the Engineering Foundation indicates clearly the deep interest and profound sincerity of his efforts. Nor is this Mr. Swasey's first gift for purposes of this kind. He gave a handsome observatory to the Denison University at Granville, Ohio, and the science building for the University of Nanking, China, as well as a Young Men's Christian Association building at Canton, China. He has also interested himself earnestly in the establishment and conduct of the Warner & Swasey apprentice school.


Ambrose Swasey

Mr. Swasey is the inventor of a number of instruments used by the government in its coast defense, including several improvements in the construction of range finders. Many honors have come to Mr. Swasey for his work and achievements. He is a past president of the American Society of Mechanical Engineers, a member of the Institution of Mechanical Engineers of Great Britain, and of the British Astronomical Society, a Fellow of the Royal Astronomical Society, and past president of the Cleveland Engineering Society. In 1900, he received from the French government the decoration of the Legion of Honor for his achievements in the design and construction of astronomical instruments, several of which are installed at the leading observatories in Europe. He was a member of the jury of awards at the Nashville, the Pan-American and the St. Louis expositions, and vice-president of the jury of awards at the Jamestown Exposition. He has also been president of the Cleveland Chamber of Commerce, and the degree of Doctor of Engineering has been conferred upon him by the Case School of Applied Science at Cleveland.

* * *

CLASSIFICATION OF ALLOYS

A number of different societies and commercial bodies interested in metal alloys have, of late, made attempts at classifications and nomenclatures for metal alloys. There are a few general principles with relation to the names of alloys which are quite generally recognized and which, if adhered to, would avoid much confusion. Of course there is a clear distinction between ferrous and non-ferrous alloys. The former contain iron as their chief component, while the latter do not. The most important of the ferrous alloys are generally known as alloy steels. Of the non-ferrous alloys, bronze and brass are the most important. Bronze, properly defined, is an alloy consisting of copper and tin in variable proportions in which, however, the copper is the chief component. Brass is an alloy consisting of copper and zinc in variable proportions in which the copper also is the chief component. Many authorities claim that when a third metal is added to brass or bronze, the alloy should be termed a composition; thus a bronze composition would be an alloy of copper and tin with one or more variable components, but in which tin is the chief minor component. A brass composition would be an alloy of copper and zinc combined with one or more other components, but in which the zinc is the chief minor ingredient. In general usage, however, brass and bronze compositions are frequently known simply as brasses and bronzes. Of other alloys generally used, the white metal alloys occupy an important position. These are combinations of any two white metals. If a combination of two white metals is combined with one or more other variable minor components, the alloy is known as a white metal composition. Amalgam is an alloy of mercury with other metals.

* * *

CORRECTION

Through an error it was stated in the February number of MACHINERY that T. B. Pierce, who died December 19, was superintendent of the Boston Gear Works, Boston, Mass. Mr. Pierce was superintendent of the Grant Gear Works, Boston.

WIRE SPRINGS[*]

DATA FOR DETERMINING THE PROPERTIES OF WIRE SPRINGS

BY EGBERT R. MORRISON[†]

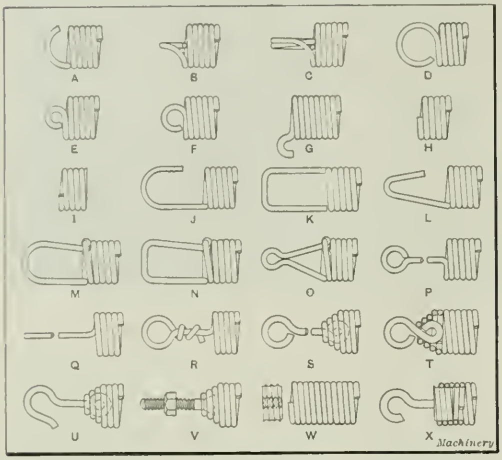


Fig. 1. The Spring A has a Regular Machine Hook over Center; B, Regular Hand Loop over Center; C, Double-coil Hand Loop over Center; D, Regular Hand Loop at Side; E, Small Eye at one Side; F, Small Eye over Center; G, Small Hook at one Side; H, Plain End; I, Ground End; J, Long Hook; K, Long Square Hook; L, V-hook; M, Loop knotted or secured to Spring; N, Square Loop knotted or secured to Spring; O, Knotted Eye; P, Extended Eye; Q, Straight End (usually annealed so that it can be twisted); R, Annealed End, eyed and twisted; S, Tapered End with Extended Swivel Eye; T, Tapered End with Regular Swivel Eye; U, Tapered End with Swivel Hook; V, Tapered End with Swivel Bolt; W, Plain End with Plug to screw into Place; and X, Plain End with Hooked Plug.

WIRE is classified by gage, a certain gage meaning a wire that will pass through a standard sized hole or slot. These holes or slots are numbered; thus a No. 10 wire will pass through the No. 10 hole in the gage. From this it will be clear that wires are not identified by their actual diameters as in the case of round bar stock. If there were only one wire gage in general use, this method of specifying wire sizes would be less confusing; but unfortunately there are several gage systems which were originally developed by workers in different trades or shops, and each of these is in more or less general use. The more common of these wire gages are: (1) American, or Brown & Sharpe; (2) Birmingham, or Stubb's iron wire; (3) Washburn & Moen; (4) Stubb's steel wire; (5) American screw gage; and (6) steel music wire. As a complete series of wire sizes are made in accordance with each of these systems, and as only the more widely used systems are mentioned in the preceding list, it will be evident that the different sizes of wire are numerous and that these sizes over-lap each other.

Impracticability of a Complete Table

In arranging a table of springs which are made from rods, the table may be laid out according to the sizes of the rods, *i.e.*, 1/4, 5/16, 3/8 inch in diameter, etc. Then the properties of the springs may be tabulated under each size of rod, according to the outside diameter of the spring, *i. e.*, 4 inches, 4 1/16 inches, 4 1/8 inches, etc. In such cases intervals of 1/16 inch in the outside diameter of the spring or in the diameter of the bar from which the spring is made, is the smallest variation required for all ordinary cases. No such method can be followed in working out a table of wire springs, however, because the different wire gages in common use are too numerous and the variations in the diameters of the springs are infinite, the spaces being very erratic and often consisting of infinitesimally small differences. Moreover, the variation of any dimension by even 1/32 inch may be entirely too great when compared with the size of the spring, as some wire springs are so small that it requires several thousand of them to weigh one ounce. The best that can be done is to resort to a makeshift and develop an approximate table which will give a good idea of the properties of any given spring. In addition to the trouble resulting from different wire gages in common use, a further difficulty is encountered owing to the fact that springs are made of all kinds of material—such as aluminum, brass, bronze, steel, etc.—and there are no standard grades of wire for this purpose, as in the case of rods where the Pennsylvania Railroad specifications for spring steel are recognized as a standard. On this account we can only base the data in a wire spring table on a certain specified fiber stress and leave it to the engineer to use that as a basis where a different fiber stress must be used.

The Spring Index

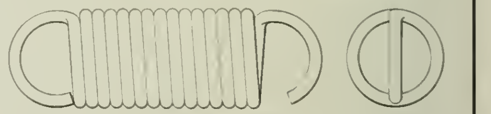
No matter what the size of the wire or the diameter of the spring may be, it is always possible to arrive at the value of a ratio which is known as the "spring index." This ratio is given by the following:

$$\text{Spring index} = \frac{D}{d}$$

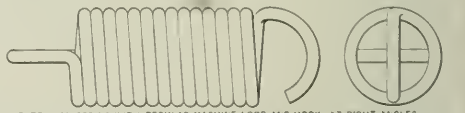
where D = outside diameter of spring;

d = diameter of wire.

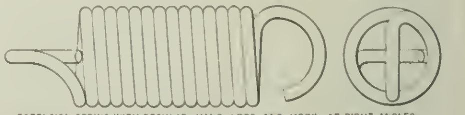
A wire spring table containing all values of the spring index $\frac{D}{d}$ would, of course, be infinitely long and include infinitely small differences, so that any practical table must omit many possible values. Consequently, reference to the table will often result in failure to find the exact value of the spring index $\frac{D}{d}$ that is wanted. In such cases the nearest value will serve to give a fair idea of the actual spring properties, and



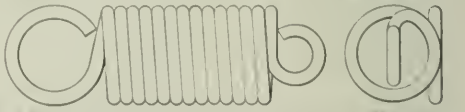
EXTENSION SPRING WITH REGULAR MACHINE LOOP AND HOOK, IN LINE OR IN SAME PLANE.



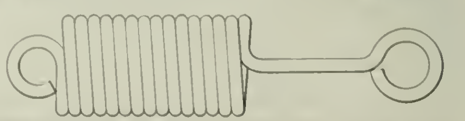
EXTENSION SPRING WITH REGULAR MACHINE LOOP AND HOOK, AT RIGHT ANGLES.



EXTENSION SPRING WITH REGULAR HAND LOOP AND HOOK, AT RIGHT ANGLES.



EXTENSION SPRING WITH REGULAR LOOP OF ONE COIL ON SIDE AND SPECIAL CROSSOVER EYE.



EXTENSION SPRING WITH SPECIAL CROSSOVER EYE AND AN EXTENDED EYE FROM CENTER OF COIL.

Machinery

Fig. 2. Further Examples of Spring Ends

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[*] For additional information on spring design and allied subjects published in MACHINERY see: "Slide-rule for Spring Calculations," July, 1913, "Winding Piano Wire Tension Springs," April, 1913; "The Design of Conical Helical Springs," May, 1912, "The Design of Grouped Helical Springs," March, 1911; "The Design of Flat Spiral Springs," July, 1910; "Slide-rule for Helical Spring Calculations," March, 1910; "Helical Springs," January, 1909. "The Design of Springs for Gas Engine Valves," May, 1908; and "Hardening and Tempering Coil Springs," May, 1902.

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will generally be close enough to answer all practical purposes. In order to use the spring table which is presented in this connection, the first step is to calculate the value of $\frac{D}{d}$ for the required spring, and also the value of d^2. The second and fourth columns of the table contain constants which are multiplied directly by the solid height of the spring, but the values in the third and fifth columns of the table must be multiplied by d^2. If the weight of the spring is required, it is also necessary to multiply by the solid height of the spring. The results presented in the table are based upon a value of 80,000 pounds per square inch for the fiber stress and a torsional modulus of 12,600,000.

To make the method of procedure quite clear, we will calculate the properties of a wire spring to be made of spring steel which has a safe fiber stress of 80,000 pounds per square inch, the diameter d of the wire being 1/16 inch and the outside diameter D of the spring, 3/16 inch. The solid height of the spring is to be 1¼ inch. It is required to know: (1) the length of wire necessary to make the spring; (2) the weight of the wire in the spring; (3) the free height of the spring; and (4) capacity of spring. With this, we find,

$$\text{Spring index } \frac{D}{d} = \frac{3/16}{1/16} = 3$$

$$d^2 = [1/16]^2 = \frac{1}{256}.$$

Now referring to the table for a value of 3 for the spring index $\frac{D}{d}$, the required length of wire to make the spring is found to be (from the second column of the table):

$$1\tfrac{1}{4} \times 9.4248 = 11.78 \text{ inches.}$$

From the third column, the weight of this wire is found to be:

$$\frac{1}{256} \times 2.0973 \times 1\tfrac{1}{4} = 0.0102 \text{ pound.}$$

From the fourth column, the free height of the spring is found to be:

$$1\tfrac{1}{4} \times 1.1795 = 1.47 \text{ inch.}$$

From the fifth column, the capacity of the spring is found to be:

$$\text{Capacity } \frac{1}{256} \times 10{,}472 = 41 \text{ pounds per coil.}$$

WIRE SPRING TABLE

Weight per inch of solid height equals $A \times d^2$. Capacity of coil equals $B \times d^2$, where d is the diameter of wire in inches.

$\frac{D}{d}$	Length per Inch of Solid Height	Weight per Inch of Solid Height A	Free Height per Inch of Solid Height	Capacity B
3	9.4248	2.0973	1.1795	10,472
$3\frac{1}{16}$	9.6212	2.1410	1.1871	10,258
$3\frac{1}{8}$	9.8175	2.1847	1.1948	10,053
$3\frac{3}{16}$	10.0138	2.2284	1.2027	9,856
$3\frac{1}{4}$	10.2102	2.2721	1.2107	9,666
$3\frac{5}{16}$	10.4066	2.3158	1.2189	9,484
$3\frac{3}{8}$	10.6029	2.3595	1.2272	9,308
$3\frac{7}{16}$	10.7992	2.4031	1.2357	9,139
$3\frac{1}{2}$	10.9956	2.4468	1.2443	8,976
$3\frac{9}{16}$	11.1920	2.4905	1.2531	8,819
$3\frac{5}{8}$	11.3883	2.5342	1.2621	8,666
$3\frac{11}{16}$	11.5846	2.5779	1.2712	8,520
$3\frac{3}{4}$	11.7810	2.6216	1.2805	8,378
$3\frac{13}{16}$	11.9774	2.6653	1.2899	8,240
$3\frac{7}{8}$	12.1737	2.7090	1.2995	8,107
$3\frac{15}{16}$	12.3700	2.7527	1.3092	7,979
4	12.5664	2.7964	1.3191	7,854
$4\frac{1}{16}$	12.7628	2.8401	1.3292	7,733
$4\frac{1}{8}$	12.9591	2.8838	1.3394	7,616
$4\frac{3}{16}$	13.1554	2.9275	1.3498	7,502
$4\frac{1}{4}$	13.3518	2.9712	1.3603	7,392
$4\frac{5}{16}$	13.5482	3.0149	1.3709	7,285
$4\frac{3}{8}$	13.7445	3.0586	1.3818	7,181
$4\frac{7}{16}$	13.9408	3.1022	1.3928	7,080
$4\frac{1}{2}$	14.1372	3.1459	1.4039	6,981
$4\frac{9}{16}$	14.3336	3.1896	1.4152	6,886
$4\frac{5}{8}$	14.5299	3.2333	1.4267	6,793
$4\frac{11}{16}$	14.7262	3.2770	1.4383	6,702
$4\frac{3}{4}$	14.9226	3.3207	1.4500	6,614
$4\frac{13}{16}$	15.1190	3.3644	1.4620	6,528
$4\frac{7}{8}$	15.3153	3.4081	1.4740	6,444
$4\frac{15}{16}$	15.5116	3.4518	1.4863	6,363
5	15.7080	3.4955	1.4987	6,283
$5\frac{1}{16}$	15.9044	3.5392	1.5112	6,206
$5\frac{1}{8}$	16.1007	3.5829	1.5239	6,130
$5\frac{3}{16}$	16.2970	3.6266	1.5367	6,056
$5\frac{1}{4}$	16.4934	3.6703	1.5498	5,984
$5\frac{5}{16}$	16.6898	3.7140	1.5629	5,916
$5\frac{3}{8}$	16.8861	3.7576	1.5763	5,845
$5\frac{7}{16}$	17.0824	3.8013	1.5897	5,748
$5\frac{1}{2}$	17.2788	3.8450	1.6034	5,712
$5\frac{9}{16}$	17.4752	3.8887	1.6171	5,648
$5\frac{5}{8}$	17.6715	3.9324	1.6311	5,585
$5\frac{11}{16}$	17.8678	3.9761	1.6452	5,524
$5\frac{3}{4}$	18.0642	4.0198	1.6595	5,464
$5\frac{13}{16}$	18.2606	4.0635	1.6739	5,405
$5\frac{7}{8}$	18.4569	4.1072	1.6884	5,347
$5\frac{15}{16}$	18.6532	4.1509	1.7032	5,291
6	18.8496	4.1946	1.7187	5,236
$6\frac{1}{16}$	19.0460	4.2383	1.7331	5182
$6\frac{1}{8}$	19.2423	4.2820	1.7483	5129
$6\frac{3}{16}$	19.4386	4.3257	1.7636	5077
$6\frac{1}{4}$	19.6350	4.3694	1.7791	5027
$6\frac{5}{16}$	19.8314	4.4131	1.7948	4977
$6\frac{3}{8}$	20.0277	4.4567	1.8106	4928
$6\frac{7}{16}$	20.2240	4.5004	1.8266	4880
$6\frac{1}{2}$	20.4204	4.5441	1.8427	4833
$6\frac{9}{16}$	20.6168	4.5878	1.8590	4787
$6\frac{5}{8}$	20.8131	4.6315	1.8754	4742
$6\frac{11}{16}$	21.0094	4.6752	1.8920	4698
$6\frac{3}{4}$	21.2058	4.7189	1.9088	4654
$6\frac{13}{16}$	21.4022	4.7626	1.9257	4612
$6\frac{7}{8}$	21.5985	4.8063	1.9428	4570
$6\frac{15}{16}$	21.7948	4.8500	1.9600	4528
7	21.9912	4.8937	1.9774	4488
$7\frac{1}{16}$	22.1876	4.9374	1.9949	4448
$7\frac{1}{8}$	22.3839	4.9811	2.0126	4409
$7\frac{3}{16}$	22.5802	5.0248	2.0304	4371
$7\frac{1}{4}$	22.7766	5.0685	2.0484	4333
$7\frac{5}{16}$	22.9730	5.1122	2.0666	4296
$7\frac{3}{8}$	23.1693	5.1558	2.0849	4260
$7\frac{7}{16}$	23.3656	5.1995	2.1033	4224
$7\frac{1}{2}$	23.5620	5.2432	2.1220	4189
$7\frac{9}{16}$	23.7584	5.2869	2.1407	4154
$7\frac{5}{8}$	23.9547	5.3306	2.1597	4120
$7\frac{11}{16}$	24.1510	5.3743	2.1788	4087
$7\frac{3}{4}$	24.3474	5.4180	2.1980	4054
$7\frac{13}{16}$	24.5438	5.4617	2.2174	4021
$7\frac{7}{8}$	24.7401	5.5054	2.2370	3938
$7\frac{15}{16}$	24.9364	5.5491	2.2567	3958
8	25.1328	5.5928	2.2765	3927
$8\frac{1}{16}$	25.3292	5.6365	2.2966	3897
$8\frac{1}{8}$	25.5255	5.6802	2.3167	3867
$8\frac{3}{16}$	25.7218	5.7239	2.3371	3837
$8\frac{1}{4}$	25.9182	5.7676	2.3576	3808
$8\frac{5}{16}$	26.1146	5.8112	2.3782	3779
$8\frac{3}{8}$	26.3109	5.8549	2.3990	3751
$8\frac{7}{16}$	26.5072	5.8986	2.4200	3723
$8\frac{1}{2}$	26.7036	5.9423	2.4411	3696
$8\frac{9}{16}$	26.9000	5.9860	2.4624	3669
$8\frac{5}{8}$	27.0963	6.0297	2.4838	3642
$8\frac{11}{16}$	27.2926	6.0734	2.5054	3616
$8\frac{3}{4}$	27.4890	6.1171	2.5271	3590
$8\frac{13}{16}$	27.6854	6.1608	2.5490	3565
$8\frac{7}{8}$	27.8817	6.2045	2.5711	3540
$8\frac{15}{16}$	28.0780	6.2482	2.5933	3515
9	28.2744	6.2919	2.6156	3491
...	....	......	......	....

Machinery

Wire springs are likely to be very small; for instance, the writer has one particular spring in mind which was so small that 38,000 were required to weigh one pound. For measuring wire of any kind, it is better to use a micrometer caliper, thus recording the dimensions in decimal parts of an inch, instead of attempting to use gages of any kind.

Initial Tension

Springs are often made with an "initial tension" which causes the coils to be drawn tightly together. This result is secured by twisting the wire, a common example of a spring of this type being the ordinary screen door spring. Such springs will not begin to deflect as soon as the load is applied, it being necessary to first overcome the initial tension already in the spring. With springs of this type it is possible to load to the maximum capacity without obtaining a corresponding deflection of the spring.

Methods Used in Spring Manufacture

Wire springs are made of a great variety of materials, and the wire is generally sold under a trade name. The manufacturer is very willing to guarantee his wire of certain grades, but equally unwilling to guarantee other grades of wire which he makes. In all cases, however, he either cannot or will not state any of the physical properties of his product, contenting himself by saying that it is "extremely uniform." Some manufacturers actually disclaim the possession of such knowledge, while others are frank in stating that exact analyses and corresponding characteristics are regarded as valuable trade secrets. Some manufacturers of both wire and wire springs, even go so far as to state that they make certain grades of wire for their own use and that they will not sell such wire to other spring manufacturers. In such cases it is necessary for the spring manufacturer and his engineer to ascertain by experiment just what any grade of wire will do. In this way an exact average of the physical properties of the wire is obtained.

Spring Ends

Extension springs are furnished with an infinite number of different kinds of ends, many of which have become so commonly known in the trade that they are regarded as standard. The two hooks at opposite ends of a spring may be made in line and in the same or different planes; and they may be located at the center of the spring or on one side. A further variation may be obtained by arranging the ends out of line and they may even be located at right angles to each other. Some common forms of spring ends are illustrated in Figs. 1 and 2, and in referring to these illustrations it will be well to remember that the direction in which the springs should be wound ought always to be specified when giving an order. It must also be borne in mind that tables and calculations of the form presented in this article apply only to the flexible part of the spring. Ends of various kinds, such as hooks, plugs, etc., are really not part of the spring proper, such ends being merely mechanical appliances for attaching the spring to other machine elements.

* * *

A patent has recently been granted to S. W. Parr, Urbana, Ill., for a new alloy claimed to resist the corrosive action of moist oxygen or of ordinary acids. Hence, it can be used in calorimeters and exposed directly to the calorimeter charge. Bomb calorimeters ordinarily used are made of steel with the inner faces lined with platinum or gold plated copper, having the disadvantages of high cost and being easily damaged. The new alloy has a composition of 63 parts nickel, 5 parts copper, 20 parts chromium, 5 parts molybdenum, 2 parts tungsten and less than 2 parts each of aluminum, boron and manganese. It is claimed to have a very high electrical resistance, and to have a tensile strength for unworked metal of about 60,000 pounds per square inch. It may be used for valve seats and for the construction of chemical vessels, taking the place of platinum for certain purposes.

* * *

An error of statement was made in the article, "The Story of the Combination Square," which appeared in the January number in regard to the interview of Mr. Starrett with Samuel Colt. The interview was not with Mr. Colt, but with a representative of Colt's Armory. Mr Colt had been dead a number of years at the time of the interview.

ANNEALING BRASS FOR FORMING AND DRAWING OPERATIONS

BY HOWARD W. DUNBAR*

Difficult forming and bending operations as performed under a punch press have and always will cause considerable trouble, especially when a large number of successive operations must be performed. A lot of time must be spent in producing the exact shape on the dies, fussing with corners and removing a thousandth here and a thousandth there. The material next comes in for its criticism, and we finally select a grade which is correct in composition and whose physical properties should insure satisfactory results. We anneal the parts—a number of times perhaps—and sometimes we have them annealed after each operation, but still we fail either to succeed in producing any parts at all, or the majority of these parts develop cracks in making some of the bends or forming operations. The fact I wish to bring out is that we are very particular with most of the variables which enter into difficult forming and drawing operations, and then promptly proceed to neglect a most important one—annealing. Frequently very little thought is given to the effect annealing can have upon the forming and drawing operations. We permit the annealing foreman to establish the temperature, and then are content to let the man at the fire gage the temperature with his eye (and it is admitted that an annealing expert becomes skilled in this respect) and use his own judgment as to the length of time the parts are left in the furnace. How do we qualify him to do this? He seldom has an opportunity to gain experience with the actual operations on the parts he is treating, nor in many cases does he know the results which are to be accomplished through the medium of the annealing operation. He seldom, if ever, knows the exact composition of the material which he is handling; it is brass and brass alone to him.

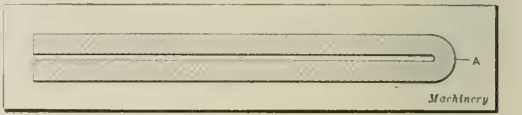

Fig. 1. Piece of Work which gave Trouble at Bend A

Now there are many variables, both of a personal nature and of a tangible nature, and all should be given proper consideration before the most desirable results can be expected. Let us consider some of those which have a bearing upon the requirements of an efficient annealing operation. (1) The composition of the brass, i. e., whether it be high or low in lead, and the amount of zinc which plays an important part in determining the temperature at which this material should be annealed to produce good uniform results in a bending or forming die. As the lead and zinc melt at a low temperature, they naturally are more quickly affected by overheating, and the higher the percentage of these two metals in the mixture, the more is the brass structure changed by variations in temperature. (2) The length of time that these parts are left in the furnace under this temperature. Of course the temperature can be higher or lower (within reason) if the time the parts are left in the furnace is varied to suit such differences. Still, with a given temperature, observations have shown that the time cannot vary more than 5 per cent. (3) The manner of cooling. (4) The varia-

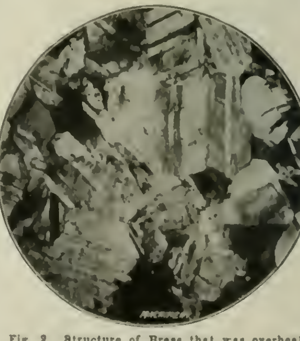

Fig. 2. Structure of Brass that was overheated in annealing by the "Hit or Miss" Method

tions in temperature throughout the heat. In most difficult forming operations, especially where there are a large number of successive drawing or bending operations to be performed, the temperature during the annealing operations cannot vary materially. Thirty degrees in some cases is the limit. (5) The nature of the bend, *i. e.*, whether it be a severe one or one more readily accomplished. This naturally affects the number of annealing operations, which should be held down to a minimum, as the more annealings introduced the more chances there are for changing the structure of the brass by overheating.

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How can these variables be controlled, and what advantages can be obtained by such control? To emphasize this point, and incidentally to illustrate the importance of attention to that part of the work connected with difficult forming operations, which is now so sadly neglected in many cases, let me give an illustration of an actual experience which came under my observation. A small brass part made from sheet stock approximately 3/32 inch thick was to be formed by perhaps fifteen or sixteen different operations to a very irregular and difficult shape, and the particular operation with which considerable trouble was experienced is illustrated in Fig. 1. The brass had to be bent back on itself, leaving a very small space between the parts; two operations at this particular point had preceded the one in question. The material from which the part was made was what is known to the trade as "soft draw" brass, and contained a minimum amount of lead (about 0.5 per cent) with the general mixture for zinc and copper, the impurities being reduced to a minimum. It was the best material known to makers of brass, for the purpose for which it was to be used, but still the parts could not be formed so that point *A* did not show cracks.

Considerable time, thought and worry were put into the many troubles as they came up. The cost of the investigation ran up to thousands of dollars in wasted material and changes in tools and fixtures, every change seeming to point toward a solution of the difficulties, but little actual improvement was noticed until one day it occurred to me that perhaps our trouble did not lie in what seemed to be the apparent cause—the mechanical operation. Perhaps there was some other reason for the difficulty, and we naturally turned to the only other possible source of trouble, *i.e.*, the annealing department, after having exhausted all imaginary experiments in materials and tools. I discovered in the annealing department, and no doubt similar discoveries can be made in practically all such departments, a sadly neglected state of affairs. Temperatures ranging from 1000 to 1650 degrees were commonly used. Sometimes the part remained in the furnace a very short time, and at other times for a longer period. It is true that occasionally parts were properly annealed, and when properly annealed no trouble resulted. This constituted that percentage which had been all right.

A systematic study was made of the conditions pertaining to the particular operation in question. A pyrometer was installed to indicate the temperature, which helped to maintain it at a given figure, and hold it within a limit of twenty degrees. This instrument was of the recording type, so that any fluctuations in temperature could be traced, and if trouble resulted from parts annealed at any particular time, the cause could be traced and corrected. A mechanical device was installed which carried the parts into the furnace, allowed them to remain there for a certain length of time, and then automatically carried them out and dropped them into the water tank for cooling. This insured that the parts only remained in the furnace for the time desired; and the speed of this mechanical device could be regulated within a range which was considered sufficient to cover the case. Of course a great number of experiments had to be performed, but the results were that after the temperature was once determined, the length of time the parts were allowed to remain in the furnace was fixed, and all parts that came to the dies in this state were formed to their proper shapes without defect.

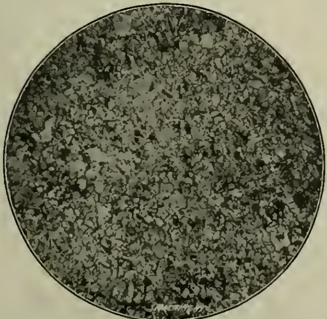

Fig. 3. Same Brass shown in Fig. 2, illustrating Improved Structure obtained by Proper Annealing Conditions

Figs. 2 and 3 show reproductions of micro-photographs of the surface of a piece of brass after the annealing operation. In both illustrations the same grade of brass was photographed, and these photographs were taken at the same time, the magnification being 80 diameters in each case. Fig. 2 illustrates the surface of the brass as seen under the microscope when annealed by the hit or miss process that was in vogue previous to the investigation. The temperature of the furnace during the annealing operation was stated to be 1500 degrees and the parts remained in the furnace at this temperature for a length of time varying from two to seven or eight minutes. An examination of the manner in which the material has crystallized will readily reveal the fact that the stock was very much overheated, and that the materials are separated, leaving large crevices, which, it is obvious, would cause cracks or breaks in the bending operation. A glance at Fig. 3 will at once show the improvement accomplished when proper attention was given the annealing operation. The closeness of the grain, as compared with Fig. 2, immediately impresses upon one the importance of the annealing operation. The temperature as indicated by the recording pyrometer, was held from 1150 to 1180 degrees, and the parts remained in the furnace at this temperature for a period of three minutes, thirty seconds, when they were plunged into lukewarm water and accordingly cooled. The brass in both cases analyzed the same, and an interesting point is that when tested with the scleroscope, both showed the same hardness, indicating that the mere softening of the brass is not the only object sought.

This example serves only as one illustration of many similar cases which were at once revealed in succeeding experiments on other bending and forming operations which were giving similar trouble. After once establishing a uniform condition of annealing, and arranging it in such a manner that when parts were not annealed according to instruction, this fact was revealed through the recording pyrometer and recording time indicator, bending troubles at once vanished. Dies which formerly were condemned as not being capable of producing correct shapes were pressed into service and proved not only useful but satisfactory. Operations which were a variable quantity on the production sheet, because of large percentage in loss, at once became normal and ceased to be a trouble. Four marked improvements were noticeable as a result of this investigation: (1) Tool wear (within reasonable limits) ceased to be a factor. (2) Output immediately increased. (3) A wider variation in the composition of the stock was permissible. (4) Percentage of scrap pieces due to cracks or breaks was reduced to 0.5 per cent.

Are not these results of sufficient importance to make the subject of annealing brass worthy of serious consideration?

* * *

Engineering science, which has done probably more than any other material agency to build up and make possible our present civilization, is also used as the main agency in destroying it, because war has become mainly a skillful use of the devices provided by the engineer. The part that the mechanical, electrical, civil and naval engineer plays is easy to recognize, but even the mining engineer comes in for his share. We are told that at one point in France, where the opposing trenches were very close together, and where the French were "much annoyed" by the fire of German machine guns, which were inaccessible to the French fire, some mining engineers and coal miners drove a tunnel to the spot where the machine guns were located and succeeded in blowing up the cause of the "annoyance."

ELECTRIC BUTT-WELDING PRACTICE*—1

APPLICATION AND PRACTICE OF JOINING METALS BY ELECTRIC WELDING MACHINES

BY DOUGLAS T. HAMILTON†

While practically all metals and alloys can be electrically butt-welded, it is necessary to adopt different methods of clamping the work and applying the current to make a perfect union with metals of relatively low resistance. Copper, for instance, requires a large amount of electric current for a short period of time, whereas aluminum can only be satisfactorily welded with a current that is under perfect control and is cut off at the precise moment that the metals are homogeneously united. The protrusion of the metals from the clamping jaws also governs, to a certain extent, the effectiveness of the electric welding machine.

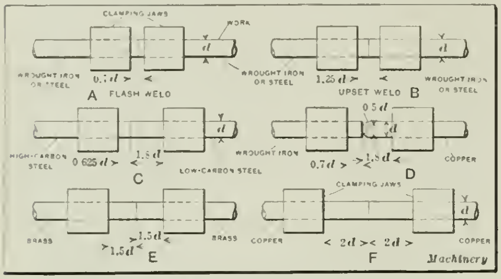

Fig. 1. Diagram showing Projection of Work from Clamping Jaws for welding Different Kinds of Material and for making Various Types of Welds (Toledo Electric Welding Co.)

Projection of Work from Clamping Jaws

In butt-welding, the work is allowed to project a certain distance out from the faces of the clamping jaws, and then when it has become heated to the proper temperature the jaws are forced together until, in some cases, they practically contact. The amount of metal left projecting is determined largely by the material to be welded and the type of weld desired.

Fig. 1 shows the relative positions of the clamping jaws and the amount that the work should project from them for welding various materials. At *A* is shown the amount that the stock should project from the clamping jaws when making a flash weld on round or bar stock. This applies to the welding of wrought iron or steel. The space between the two jaws should equal about 0.7 times the diameter of the work. The distance is never greater than the diameter of the stock for making a flash weld. A flash weld is generally used on stock that is wide and thin, and is sometimes advisable when the welding faces are not cut square and true. It is also used in welding tubing to tubing; in fact, in all cases where a small amount of stock is to be taken up in the weld, or when it is desired to shear or grind off the fin.

For making an upset weld, the stock should project from the jaws about the distance shown at *B* in Fig. 1. The amount of metal generally left extending from the jaws for making an upset weld of wrought iron or steel is about $1\frac{1}{4}$ times the diameter of the work. Upset-welding is used in all cases where the weld is to be hammered, using the heat generated in welding; also in some cases on small rods or rings where it is not necessary to have a uniform thickness of stock. In welding materials such as copper, brass, tool steel and other metals that are deteriorated by high temperatures, they must be heated quickly and pressed together with sufficient force to push out all the burnt metal from the weld.

When welding high-carbon steel to low-carbon steel, the stock should extend from the jaws about as indicated at *C*, Fig. 1. The low-carbon stock should extend considerably farther than the high-carbon stock, the high-carbon stock generally extending about 0.62 times the diameter of the work, and the low-carbon stock about 1.8 times the diameter of the stock. The reason for this is that the high-carbon stock offers much greater resistance to the passage of the electric current than the low-carbon stock does and hence heats up quicker.

When welding wrought iron to copper, it is necessary for the work to be held as shown at *D* in Fig. 1. The wrought iron should project from the jaws about 0.7 times the diameter of the work, and the copper about 1.8 times the diameter. The copper should preferably be reduced on the end to about 0.5 times the diameter of the bar. In this case, the copper is a better conductor of the electric current than the wrought iron and, consequently, does not heat up as quickly. The cross-section of the copper is therefore reduced to increase its resistance to the passage of the electric current and cause it to heat up quicker or at about the same rate as the wrought iron.

In welding one brass rod to another brass rod, the clamping jaws should be set apart about three times the diameter of the rod, as indicated at *E* in Fig. 1. The weld, however, only takes up about one times the diameter of the bar, when the bar is over $\frac{1}{4}$ inch in diameter. In welding copper to copper, the work should project, as shown at *F* in Fig. 1, about four times the diameter of the rod. Here again only about one times the diameter of the stock is utilized in making the weld, unless the stock is less than $\frac{1}{4}$ inch in diameter.

Various Arrangements of the Clamping Jaws

In order to make different types of welds, various arrangements of the clamping jaws are necessary. Fig. 2 shows diagrammatically a number of different arrangements. The views shown are plan views, looking down on the top faces of the jaws. At *A* is shown the typical arrangement of the jaws for making an ordinary butt-welded joint, the work being clamped centrally between the upper and lower clamping jaws and projecting the required amount, as previously described, for various materials.

Sheet or flat stock is usually welded with a machine called a spot-welder, provided with vertical clamping points or electrodes. This process will be fully described in a succeeding article. When the size and shape of the work will permit, however, spot-welding operations can be accomplished on certain materials in a butt-welding machine by employing special arrangements of the clamping jaws as shown at *B* and *C* in Fig. 2. In practice, however, it is found that in some cases the necessary form of jaws on butt-welding machines render them impractical on account of the impossibility of getting the work to be spot-welded into them. For spot-welding in an electric butt-welding machine, the two upper clamping jaws are not used, and one of the lower jaws is pointed as shown at *B*, the other being provided with a flat face. The material having the least resistance to the electric current is placed in contact with the pointed jaw. This form of jaw is used in welding sheet steel, copper and brass, but when galvanized iron is to be spot-welded the faces of both clamping jaws must be pointed.

The arrangement of the clamping jaws shown at *C* in Fig. 2 can also be used in an emergency for performing spot-welding operations on a butt-welding machine. Instead of using the jaws as electrodes, two round copper rods, as shown, are held in them, one of which is pointed for welding steel, brass and copper; both of these must be pointed for welding galvanized iron.

For performing jump-welding operations on light stock, the arrangement shown at *D* in Fig. 2 is used. One piece of work is held parallel with the front faces of the clamping jaws as illustrated, and the other located at right angles to it. The piece of work located at right angles is generally pointed to reduce the cross-sectional area in order to enable it to heat up at the same time as the other piece, allowing a perfect junction to be made. This arrangement of the jaws is also used for the welding of tubing.

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* See also "Electric Butt Welding Development" in the February, 1915, number of MACHINERY.

† Associate Editor of MACHINERY.

A rather unusual arrangement of the clamping jaws is shown at *E* in Fig. 2. This requires a specially constructed machine provided with two pairs of self-equalizing clamping jaws mounted on the left-hand head and insulated from each other. These two jaws are operated by one vertical lever and are used for gripping the upper part of the "T bar" that is to be welded. The machine is provided with a double-throw switch operated by a foot lever. The making of a tee-weld is accomplished by first heating the stock between the two auxiliary clamping jaws *a* for a distance of about one or two inches. When it is red-hot, the double-throw switch is turned to the left, which changes the flow of the current. The current then travels from the right-hand clamping jaw *b* in which the lower part of the tee is held to the left-hand preheating jaws. When the lower part of the tee is brought into contact with the preheated bar and the current turned on, the two pieces quickly reach the welding temperature; a slight pull on the lever handle forces them together and the job is done.

The diagram at *F*, Fig. 2, shows the arrangement of the clamping jaws and work for forming a square-corner weld. One piece of work is held parallel with the traveling slide of the jaws, and the other at right angles to it. In this case the sectional area of the two pieces is practically equal, so that no preheating of the bars is necessary. It is strictly a straight welding proposition. The flat bar in the right-hand jaw, however, should project out farther from the face of the jaw than the other piece, generally about twice the distance. At *G* another arrangement of the clamping jaws is shown for making a corner weld, but in this case the weld is made at an angle of about 45 degrees, making a right-angle joint. In this arrangement the work is presented differently because of the angles on the work. The jaws are machined out so that they act as a guide to present the two pieces at right angles to each other, and then the welding operation is a comparatively simple process, no preheating of the work being necessary.

The butt-welding of hoops or rings, as shown at *H*, can also be accomplished on a regular butt-welding machine in which the clamping jaws are so arranged as to allow the stock to be presented to them without coming in contact with the frame of the machine. The operation of welding is carried on in the same way as an ordinary butt-welding job.

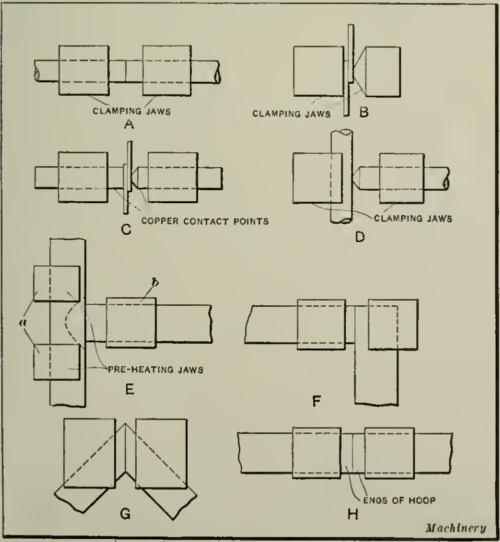


Fig. 2. Diagram illustrating Arrangement of Clamping Jaws for performing Various Types of Welds (Toledo Electric Welding Co.)

A special arrangement of the clamping jaws (patented by the Thomson Electric Welding Co.) for butt-welding thin wide strip stock in a butt-welding machine is shown in Fig. 3. This type of welding would be particularly difficult of accomplishment with clamping jaws of the ordinary shape, as it would be impossible to hold the thin stock close enough to the edge to keep the two edges in alignment and distribute the heat evenly. By constructing the jaws with toothed or intermeshing edges, as shown in Fig. 3, the stock can be supported practically to the edge, as shown at *A*, and still allow space for a burr to be formed at the weld when the jaws come together as shown at *B*.

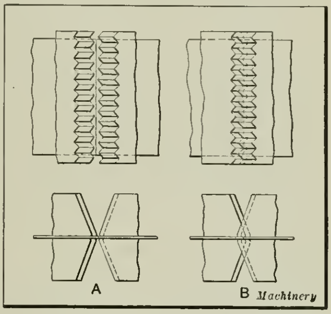


Fig. 3. Method of arranging Clamping Jaws for butt-welding Thin Strip Stock (Patented by the Thomson Electric Welding Co.)

Welding Pieces of Unequal Cross-sectional Area

Fig. 4 shows a machine embodying the necessary apparatus for welding pieces of unequal cross-sectional area, which has been designed and patented by the Thomson Electric Welding Co. This is accomplished by using two transformers, one for heating the thick piece and the other for making the weld. In the illustration, the heating transformer is indicated by *A* and the welding transformer by *B*. *C* is the secondary circuit of the heating transformer; it consists of a metal yoke recessed to receive the primary coil *D* and is bolted to the table top as shown. On one terminal is secured a slide *E* and on the other a slide *F*; these slides carry at their forward ends the lower jaws or work-holding members *G* and *H*. Mounted on slides *E* and *F*, but insulated from them, is an arm *I* on which the other work-holding members *J* and *K* are mounted. These upper clamping jaws are insulated and seated in the free end of the lever *L* which is pivoted to the arm *I*. This lever is depressed by the cam lever *M*.

The welding transformer has its secondary in the plane intersecting that of the heating transformer. It is secured to the table and has one of its terminals projecting and seated between the terminals of the heating transformer from which it is insulated. The other terminal of this secondary has mounted on it a slide *O* which carries at its forward end the lower jaw or work-holder *P*. The upper jaw or work-holder *Q* is carried on the end of lever *R*, which is pivoted to the curved arm *S*, mounted on the slide *O*. A cam lever *T* serves to depress the lever *R*, and a spring returns it substantially to its former position. Anti-friction rollers are located between the base of the machine and the movable arm *S* to facilitate its movement. The work-holders are constructed so that the clamping bases may be readily removed, and are made as small as practical with sufficient contact area to concentrate the lines of force between the terminals of the secondary. The work-holders are also kept cool by circulating water through them. The primaries of the transformers *A* and *B* are connected to a source of electric current in parallel, and each is provided with a switch so that it can be operated independently.

In using this apparatus for welding a thin piece to the side of a thick piece, the latter is clamped between the jaws *G* and *H* and *J* and *K* and the current turned on, thereby heating the portion of the thick piece which lies between the clamps. The abutment *U* and the thin piece can touch the work if desired. The current flows from one terminal *G* to the other terminal *H* and through the work, which is clamped in position by means of the jaws *J* and *K*. When the thick piece is sufficiently heated, it is moved back, together with its clamp, until it bears snugly against the abutment *U*, and at the same time the slide *O* is moved to bring the thin piece of work held in jaws *P* and *Q* up against the thick one.

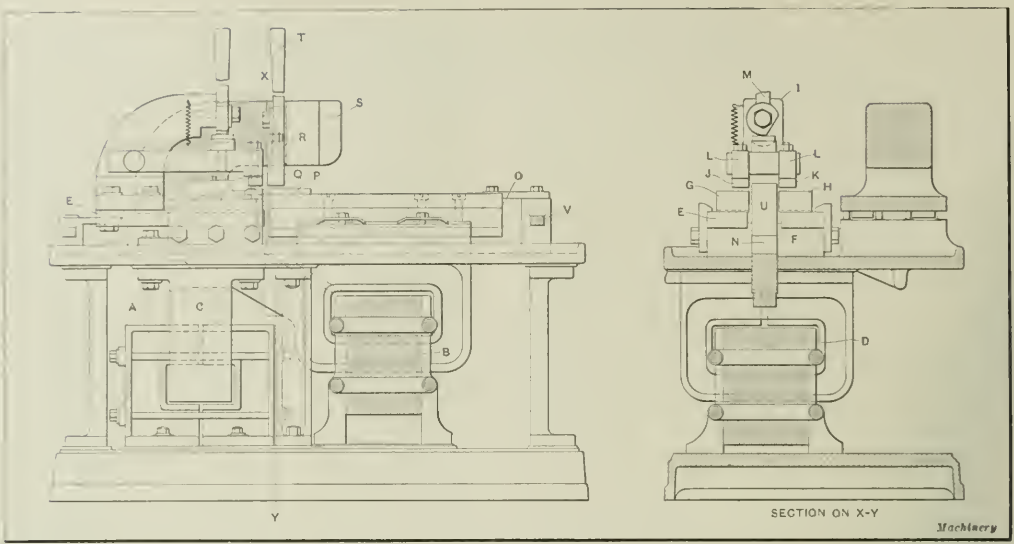


Fig. 4. Special Type of Electric Butt-welding Machine patented by the Thomson Electric Welding Co. for welding Pieces of Unequal Cross-sectional Area. This Machine comprises Two Transformers. (Thomson Electric Welding Co.)

The current is then turned on to the welding transformer *B* and, if necessary, can be turned off from the heating transformer *A*. When the current is turned on to the welding transformer, it flows from the jaw *R* through the abutting pieces of work to the abutment *U*. As the pieces of work soften, suitable pressure is applied to the lever *V* to produce the necessary upset and effect the weld. The current is then turned off and the levers released to free the work.

Tee-welding Thin Strip Stock

In the butt-welding of thin strip stock, it is evident that the top of the tee has much more volume than the end of the lower portion of the tee that is to be welded to it, as is clearly illustrated by the pieces *a* and *b* in Fig. 5. It is desirable to provide a means for localizing the current so that the piece *a* will heat up equally with the piece *b*. The method of accomplishing this is to first heat the piece *a* and then subject it to end pressure to upset it and form a burr or projection as shown. This provides means for localizing the current at the point of welding in the subsequent stages of the operation. The piece *b* is then welded to the piece *a* by bringing the former into engagement with the upset and subjecting it to both heat and pressure. With this type of apparatus it is evident that three sets of clamping jaws are necessary, as has already been described for this work. The condition of the work before and after welding is shown at *A* and *B*. This process of electric welding was patented by the Thomson Electric Welding Co. in November, 1913.

Tee-welding without Changing Original Dimensions of Work

A special application of the electric welding machine, patented by the Thomson Electric Welding Co., to tee- and angular-welding without changing the original dimensions of the work is shown diagrammatically in Fig. 5. This method can be used advantageously in the construction of articles such as metal grills, grids or frames employing a number of cross pieces united to end pieces or pieces common to such cross pieces. In the usual practice of uniting pieces by a butt-welding process, there is, of necessity, a shortening of the piece attendant upon the upsetting of the plastic metal at the joint under endwise pressure. This involves a change in the dimensions of the completed structure, or in other words an alteration in the relative positions of two pieces due to the movement of one toward the other in forming the joint. Hence, in the welding of a frame or grid having two or more cross pieces of definite dimensions, it is evident that, by the ordinary method of butt-welding, a certain amount of the metal is taken up in the upset and hence the pieces would be shortened. The methods illustrated in Fig. 5 consist in holding the pieces to be welded rigidly in their ultimate relative positions and crowding in a uniting material which is made plastic by the passage of an electric current through it. The metal is crowded into the space between the two pieces and fills up the joint, welding the members together.

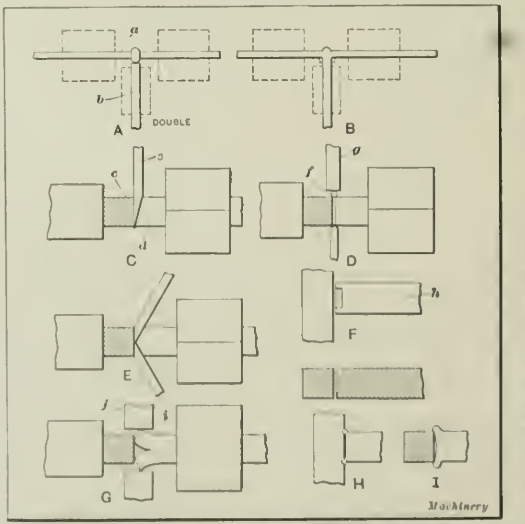


Fig 5. Method of making a Tee-weld on Thin Stock, also Method of making Tee-welds without reducing Original Dimensions of Parts being welded (Thomson Electric Welding Co.)

One method of uniting two members in this manner is shown at *C* in Fig. 5. Here it will be seen that the pieces c and *d* to be joined are separated by a wedge *e* which is forced in sideways in the space between the two pieces. This metal may be of the same character as that of c or *d* or different according to the kind of joint required. By passing a current through these pieces, the metal wedge becomes plastic and adheres to the pieces, joining them without change of dimensions in the structure or shortening of either of the component parts. Any part that is left projecting from the wedge-shaped piece *e* is cut off after the welding of the joint is completed.

Another method of making the same joint where only moderate strength is required is shown at *D*. In this case a small piece of metal *f* is being crowded into the intervening space between the two pieces by means of the crowding tool *g*. A slightly different application from that shown at *C* is shown at *E* where two pieces instead of one are being used to form the junction. At *F* is shown another method. In this case, it will be seen that a bevel groove is cut in the piece *h*, providing it with a seat for the metal which is inserted to form the junction. Still another method of effecting a tee-weld without any change in the original dimensions of the pieces is shown at *G*, in which the end piece *i* is flared out to provide material which is forced back by means of the crowding tool *j*. In this case, however, it is obvious that the plastic material is not a separate piece, but consists of one of the parts itself. The flare instead of being as shown at *G* can be as shown at *I* and will engage the other piece on the corner instead of in the center, so that the action of the crowding tool will force the metal down into the center when making the junction. Another method of accomplishing the weld is shown at *H* in which the joining metal is applied in small pieces or spots at the corner, this method being especially adapted to the tee-welding of parts where a strong joint is not essential.

* * *

RECENT LEGAL DECISIONS INVOLVING MACHINERY

Of Interest to Exhibitors at San Francisco

(Wisconsin.) Where a manufacturer of machinery places one of his machines on exhibit at an exposition or fair, and the same is installed on a platform, it is the duty of the manufacturer to anticipate that injury might probably result to some person exercising ordinary care, if guard rails are not provided on the steps leading to the viewing platform. Failure to provide such rails is negligence for which he is liable in the case of accident.

The Wisconsin Supreme Court has held the foregoing to be the law in Pennell v. Rumely Products Co. The action was brought to recover damages for an injury received by plaintiff in having his arm caught between a pulley attached to the cylinder shaft of a threshing machine, such machine being exhibited at the La Crosse county fair in September, 1912. The platform upon which the machine stood was not properly guarded with a hand rail. In the trial court, a jury returned a verdict of $3500. The judge deemed such amount excessive and gave the plaintiff an option to take judgment for $2000 or a new trial. Judgment was entered for $2000 and the defendant Rumely Co. appealed. The Supreme Court affirmed the judgment. *(Pennell v. Rumely Products Co., 149 N. W. 769.)*

Injured by Gears

(Massachusetts.) In an action for injuries to a boy fourteen years old, whose fingers were caught in the gears of a machine, of the existence of which gears he did not know, when the cover enclosing the gears slipped off, evidence to the effect that his employer had not instructed him as to the dangerous character of the machine was held sufficient to warrant a jury in a finding of negligence in exposing plaintiff to a hidden peril in work that apparently was not dangerous, without instructions or warning. *(Moloney v. Pemberton Co., 107 N. E. 388.)*

Excessive Charge for Machinery

(Washington.) Where machinery had been manufactured upon defendant's order and accepted by the defendant, the manufacturer, in the absence of an agreement as to the price, can recover the reasonable value of the machinery, though he charged the defendant with a price in excess of the reasonable value.

Where defendants purchased certain machinery without any agreement as to the price, an instruction that, if the jury found that defendants could have purchased the machinery in the open market at a price considerably less than plaintiff asked, that fact might be considered in determining whether there was a contract between the plaintiff and defendants, was erroneous, misleading, and confusing. *(Nordeen Iron Works v. Rucker et al., 145 P. 219.)*

Conditional Sale of Machinery

(Georgia.) A purchaser of machinery in a conditional sale contract was adjudicated a bankrupt. In his schedule he listed this machinery as part of his assets. The seller of the machinery, in reclamation proceedings, obtained an order of court to repossess himself of the property. Later the seller brought suit against the sureties on the bankrupt's conditional sale note and obtained judgment. The machinery had not been removed from the bankrupt's premises. Under such circumstances it is only proper that the seller should not have the right to take possession of the machinery, since judgment had been secured against the sureties on the conditional sale note. *(Mallary Bros. Machinery Co. v. Thomas et al., 83 S. E. 783.)*

Assumption of Risk

(Maine.) A servant assumes the risks of dangers known to him, as well as those incident to his work and apparent to one of his intelligence, and is chargeable with knowledge of the things and conditions which he sees, or by the exercise of reasonable care ought to see, and his failure in that respect is negligence, and the master may assume that he will see and guard against apparent dangers. *(Monk v. Bangor Power Co., 92 A. 617.)*

Foreclosure of Chattel Mortgage

(North Dakota.) Where property is sold on the foreclosure of a usurious mortgage, one who purchases at the foreclosure sale and pays his money without notice of the usurious character of the mortgage is protected as a *bona fide* purchaser of the property, and the same is true where, after the foreclosure sale and before the expiration of the time of redemption, a person buys the interest or estate of the mortgagee who bids in the property at the sale. *(Heitsch et al. v. Minneapolis Threshing Machine Co. et al., 150 N. W. 457.)*

Master's Liability for Injury to Servant

(Federal.) Plaintiff for four years had operated a machine in defendant's shoe factory, above which was an electric light. She arrived one morning five minutes before time to commence work, when it was quite dark, and was unable to turn on her light, because the current had not been switched on from below, which was done, however, in two or three minutes. In the meantime she undertook to hang up her coat in the place provided, which required her to step upon a chair and from there on a bench, and in doing so she placed the chair on some shoe uppers which had been left on the floor by a fellow servant, and the chair tilting, she fell and was injured. Held that, in so far as there may have been negligence in so placing the coat hangers as to make it necessary to climb upon the bench, the risk was an obvious one, which she knew and assumed; that she also assumed the risk involved in moving around and placing the chair in the dark, which was not required by her employment or properly incident thereto. *(W. H. McElwain Co. v. Bullock, 217 Fed. 962.)*

* * *

An alleged new method for producing electricity commercially (?) consists in placing thermo-electric couples around heated flues. The thermo-electric elements are separated by a layer of mica insulation and are joined at their hot ends by a band of electrolytically deposited copper. Five of these elements are connected in a series to form a unit and a suitable number of units are formed into a ring that surrounds the heated flue. The unheated ends of the elements are kept cool by circulating cooled air around them. The cost of installing such a system, as compared with the cost of gas, oil and steam operated engines, is stated to be less than half, while the cost of producing electricity by this means is from one-third to one-fourth of the cost when produced by steam, gas or oil plants. Unfortunately it is not possible to go right ahead and install such a system, and thus save so great a percentage of the present cost of producing electricity, because the couples are composed of an element made of a *special secret alloy*. Experience teaches that when secret alloys or processes form part of a new development like the one mentioned, the most important secret of all is to gather in the proceeds from unsophisticated investors.

SNAPSHOTS ON THE ROAD

SOME NOTES PICKED UP AT RANDOM BY MACHINERY'S FIELD SERVICE EDITORS

—"there are hardly enough patterns to warrant the employment of a stock-keeper and a regular system for keeping track of the patterns."

THE simplicity of an idea is often its saving point. There is a small concern right in New York City that has a set of patterns almost in constant use. As yet there are only about two hundred patterns in all, but to lay your hand on any one of them is a hard job, because there are so many places where they might be. For instance, there are two different brass foundries and two iron foundries patronized by this concern, all located at a considerable distance from the shop, and the pattern may be at any one of these; or it may be in the storage or in the pattern-room. The difficulty is that there are hardly enough patterns to warrant the employment of a stock-keeper and a regular system for keeping track of the patterns, but there are too many to depend on memory alone.

The superintendent of this little concern, however, is a common-sense sort of a chap, and the way he handles the matter is as follows: He had the patternmakers saw out two hundred wooden cubes, ¾ inch square. He painted the faces of the cubes different colors and then made a special box to hold them all in one layer. On the cover of the box he inscribed "tracers" for the different colors; thus, red meant that the pattern was in one of the iron foundries, blue that it was in one of the brass foundries, and so on. The faces of the cubes were all numbered (over the color) with a pattern number, and the cubes were then arranged in numerical order in the box. Now, when a pattern goes to any of the foundries or to the pattern-room, the cube is turned with the color corresponding with that location uppermost. Thus, at a glance, the superintendent can tell from the color of the cube face that is turned up just where the pattern is.

Down in the Nutmeg state, a little while ago, the traveling editor went into a shop where the man in charge had difficulty in punching a lug from thick stock, raising it from the opposite side of the metal. The trouble was that in obtaining sharp sides on the lug, the metal was sheared and weakened. Now it happened that the traveling editor had seen a similar job done in a shop in New York state, so he sat down, and on the back of an old time-card, made a sketch of a die that would do the trick without weakening the lug. The idea consisted in driving the stock down around the lug, leaving the metal in the lug in its original condition while the rest of the metal was depressed. Simple, sure it was simple—but the man who had trouble certainly was glad to receive the suggestion, as it saved the day; and the next time the traveling editor visited the shop he had the pleasure of seeing the tools in operation. It is not far from the truth to say that the owner of this little shop appreciates a mechanical visitor when he sees him.

It is not always in the shop that a suggestion from a visitor is most appreciated, but oftentimes it is the man who is trying to sell the product of the machine shop who is looking for tips. One of the most frequent calls for assistance is from the head of the young concern which is just starting to market its product. He usually knows a great deal about the product, but little or nothing about publicity or circularizing. What troubles him most of all is to get a good mailing list. He has been asked to buy all kinds of mailing lists, but he does not know their value; sometimes they are valueless. The best mailing lists, like the best of all other things, are made by hard digging, taking the names from here, there and everywhere—from trade journals, directories, correspondence, talks with salesmen, etc. After the list is started, constant pruning and revising is necessary to keep it up-to-date, and constant adding is required to make it complete.

"He has been asked to buy all kinds of mailing lists."

Keeping the sales and engineering forces and department foremen in touch with the developments in their field is handled in a very satisfactory manner by a large manufacturing concern in New England. As soon as a technical magazine comes into the office, it is turned over to the publicity department and carefully looked over, and the articles pertaining to the subjects that are of interest to the manufacturing plant are marked. Typewritten copies are then made out, giving the title of the article, the contributor, the name of the magazine and the date of publication. These lists are compiled each month, and are distributed as follows: sales department, engineering department, salesmen on the road, advertising department, and department foremen. As soon as these lists are placed in the hands of the various men receiving them, they are quickly gone over, and the article that the man is interested in is marked. This insures him that a copy of the magazine containing this article will be furnished from the library. He reads the article, and the magazine is returned. It might be mentioned that several copies of each magazine are kept in the library, so that there is little, if any, difficulty in meeting the demand when more than one man is interested in any particular subject. This method has the advantage of keeping the responsible men informed on what is going on in their particular field without the necessity of looking over a great many technical publications, etc.

Recently the traveling editor went into a little shop in a Massachusetts town in the dusk of a winter's afternoon. He found the oil-soaked stairway pitch-dark, the box-like office littered with pieces of scrap steel and other junk, and on the proprietor's desk there was just room enough to squeeze in the telephone after pushing back correspondence of the past decade. The trained mechanic does not have to spend an hour in consultation with a shop superintendent to find out if things are up-to-date or not. He gets to be a sort of Sherlock Holmes on such matters, and when he finds a tumbled down plant, a worn-out sign, a disorderly office and a dark and dingy shop, he knows that it is not often that the work done there is up-to-date. So, he knew at once that there was not much hope of seeing any-

—"on the proprietor's desk there was just room enough to squeeze in the telephone after pushing back correspondence of the past decade."

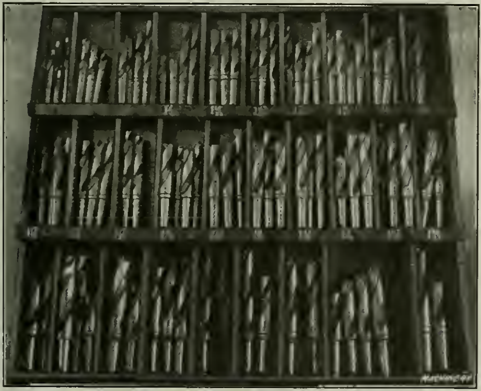
thing of particular mechanical interest in this place.

And the proprietor backed up his conclusion. He was of the old school and had built up a small business by working fourteen hours a day and cutting prices down to the last mill. "No, I will not consider having any of our ideas published, because I want to keep them right under my hat. What is the use of giving to the other fellow what you have worked hard to find out yourself?" he replied, when the subject of publicity was broached to him; but this fellow was ready to reap the benefit of mechanical information published by others just the same. "Say, you fellows published a table showing just how far to set a circular forming tool above or below center, didn't you? If you did, I wish you would send me a copy." Then came the psychological moment for preaching a sermon of publicity to this man, and he got it, too. But, after all, fear of publicity is a state of mind, and you can't cure it by arguments.

* * *

VERTICAL DRILL RACK FOR STOCKROOM USE

Many machine shop stockrooms use the same style of rack for holding drills, reamers, taps, etc. This is often in the form of a drawer or horizontal rack with pockets or partitions for the different sizes of drills. As, however, one of the points a workman considers in picking out a drill is its length, the horizontal method of storing is not conducive to picking out a long or short drill quickly.



Rack for holding Drills in Vertical Position

The Watson-Stillman Co. of Aldene, N. J., employs a very simple modification of the drill rack that overcomes this drawback. The illustration shows the Watson-Stillman drill rack which is placed in an inclined position slightly away from the vertical. Thus all the drills are supported by their ends, and the long ones or short ones are readily picked out. In addition, the points of the drills may be more easily inspected than when lying in a horizontal position.

C. L. L.

* * *

GOVERNMENT INSURANCE RATES ON FOREIGN SHIPMENTS

Many inquiries have been received at Washington as to the rates charged by the Bureau of War Risk Insurance, Treasury Department, Washington, D. C., on shipments to foreign countries. The department, therefore, publishes the following schedule of charges now in force for freight shipments, the insurance, of course, being confined to vessels under American registry.

1. Rates from any ports in the United States to any port in the United States or its possessions, or to any non-belligerent port in the western hemisphere, ¼ per cent.
2. Between ports on the west coast of the United States and Japan or China, ¼ per cent.
3. To any non-belligerent port other than those included in paragraph 1, and not north of Havre, nor east of Sicily, ½ per cent.
4. To all other ports, ¾ per cent.

HOW THE CHISEL POINT OF A DRILL WEARS*

BY R. POLIAKOFF†

The results of experiments conducted by the writer show that the chisel point of a twist drill exerts a considerable influence on the work done by the tool, as it increases the end thrust by about 20 per cent. The illustrations Figs. 4 to 12 give a good idea of how the chisel point gradually wears away until the drill becomes so blunt that it is unable to cut. These photographs show a one-inch high-speed steel twist drill made in England. The material in which the drill worked during the test was a steel block containing 0.45 per cent carbon, with a hardness number of 138 as determined by the Shore scleroscope.

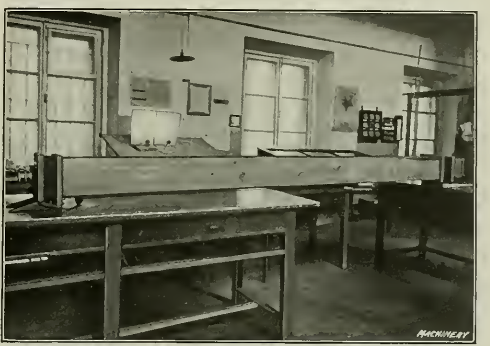


Fig. 1. General Arrangement of Camera used for taking the Photographs

Before starting the experiments proper, a few preliminary tests were made in order to determine the maximum cutting speed which could be used without burning the cutting edges of the drill. This was found to be about 50 feet per minute, and was adhered to as closely as possible in the subsequent experiments. The feed employed was 1/72 inch per revolution of the spindle. The drill was run for fifteen seconds at a cutting speed of 14 feet per minute, after which it was taken out and photographed. After making the photograph, the drill

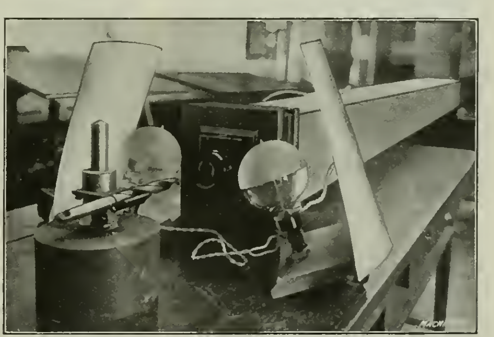


Fig. 2. Method of supporting Drill and securing Required Illumination

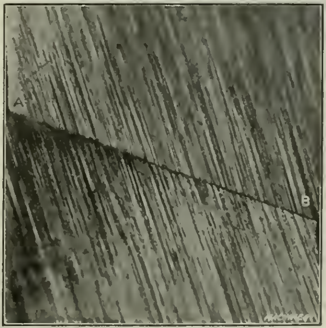


Fig. 3. Chisel Point of Drill to be tested

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[*] For further information on this subject see also "Experiments on Twist Drills," published in MACHINERY for May and June, 1909.

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was started again and run at the established cutting speed of 50 feet per minute for ten seconds, after which it was re-photographed, this procedure being continued at ten-second intervals, as long as the drill was able to cut. In order to show as clearly as possible how the chisel point of the drill wears, photographs were taken in such a way that the point of the drill is shown magnified to twenty-five times its actual size. For this purpose, the camera was arranged as shown in Figs. 1 and 2, the apparatus consisting of an ordinary camera attached to a long light-proof square tube made of wood and painted black on the inside. Two electric lamps were installed at each side of the drill.

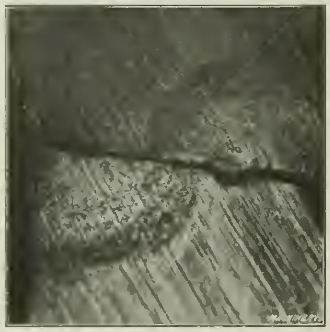
Fig. 4. Time, 15 Seconds; Depth drilled, 1/10 Inch; Speed, 14 Feet per Minute

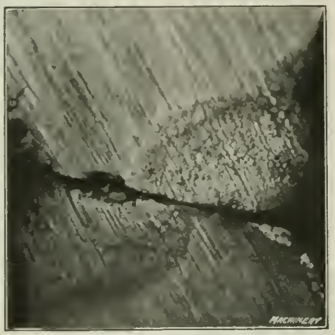
Fig. 5. Time, 25 Seconds; Depth drilled, ¾ Inch; Speed, 50 Feet per Minute

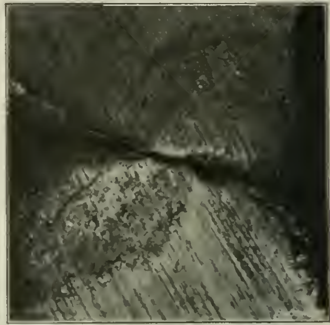
Fig. 6. Time, 35 Seconds; Depth drilled, 1 Inch; Speed, 50 Feet per Minute

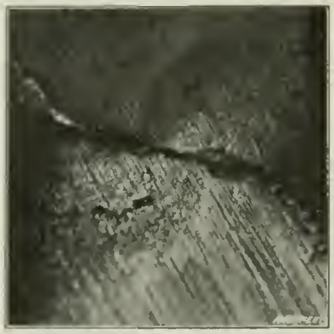
Fig. 7. Time, 45 Seconds; Depth drilled, 1¼ Inch; Speed, 50 Feet per Minute

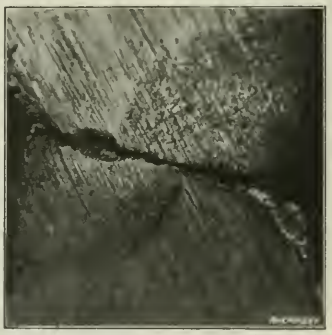
Fig. 8. Time, 55 Seconds; Depth drilled, 1½ Inch; Speed, 50 Feet per Minute

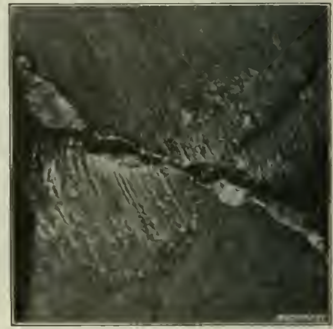
Fig. 9. Time, 65 Seconds; Depth drilled, 1⅞ Inch; Speed, 50 Feet per Minute

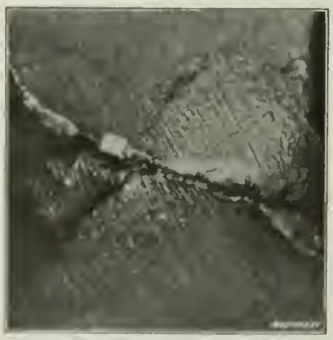
Fig. 10. Time, 75 Seconds, Depth drilled, 2 3/16 Inches; Speed, 49 Feet per Minute

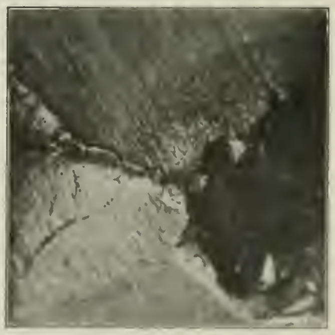
Fig. 11. Time, 85 Seconds; Depth drilled, 2⅛ Inches; Speed, 48 Feet per Minute

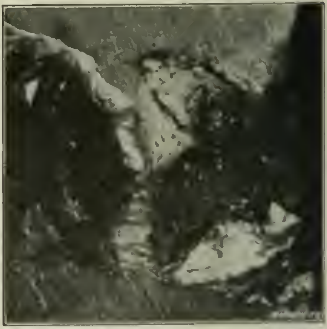
Fig. 12. Time, 95 Seconds; Depth drilled, 2¾ Inches; Speed, 48 Feet per Minute

Fig. 3 shows the chisel point of a fresh drill and Figs. 4 to 12 show the gradual deterioration of the chisel point. These illustrations are of value in showing the increasing influence of the chisel point on the magnitude of the end thrust of the drill, when it is considered that the speed at which the drill was driven did not result in burning the cutting edges. Experiments have also shown that the drill can work on the class of material on which the tests were made, without requiring regrinding, until it has been at work for about thirteen minutes, this figure being based upon a speed of 50 feet per minute for the cutting edges of the drill. Operating under these conditions, the drill will have cut through about 18 inches of metal and consumed about 6.3 horsepower.

* * *

At the beginning of the war it was feared that the effect would be disastrous to the industries in Austria, but at the present time many branches of trade have revived. Of course, factories of arms and ammunition and of all supplies necessary for warfare have been working with feverish energy to provide the armies in the field with supplies. This includes both government works and private firms. The shoe factories, which before the war were running on short time, have doubled their output. Wood-working machines are in demand, as the building of barracks and other military constructions has given new life to the lumber trade. Manufacturers of railway material are building new rolling stock, apparently to replace much of that which has been destroyed or rendered useless by the war. In industries which do not in any way cater to the demands furnished by the war, conditions, of course, are not flourishing.

SOME TYPES OF AUTOMOBILE CRANKSHAFT LATHES

BY J. C. SPENCE*

In the January number of MACHINERY, W. O. Strauss, under the title "Some Types of Automobile Crankshaft Lathes," states that "the economy of rough-turning crankpins preparatory to finish-grinding, as compared with rough-grinding, has been so thoroughly determined in the highly specialized shops that it needs but small mention here as a competitive proposition." This statement is rather a surprising one to those of us who have been connected with the grinding of crankshafts for the last ten years. To be sure, Mr. Strauss does not say that he refers to the automobile business, except in his title; but from the size of the crankshaft lathe described by him, the inference is that he is talking about that industry. If he had in mind the making of crankshafts for battleships or punch presses, then his statement would hold true, but on all crankshafts whose pins are not over 5 inches in length and whose webs do not need to be machined, exactly the opposite is true. The evidence of this does not, however, lie in theoretical study which worries about "the probable line of fracture" of the wheel, but in the fact that at least 85 per cent of all of the automobile crankshafts made annually in the United States are ground from the rough forging. The following is a partial list of firms who use the grinding method: Ford Motor Co., Willys-Overland Co., Buick Motor Co., Reo Motor Co., Mitchel Automobile Co., Hupp Co., Maxwell Motor Co., Dodge Bros. Co., J. I. Case Automobile Co., and Garford Automobile Co. In addition to the above, there are many jobbers and motor manufacturing firms who make crankshafts for sale, by the grinding method. It will be noted that those manufacturers who are producing a moderate priced car, and who are compelled by competition to produce good cars at a low labor cost, are the ones who have decided in favor of grinding crankshafts from the rough. The mechanics at these plants are hard-headed men and do not settle such important questions by theory. Rest assured that each one of them knows the gross cost of his particular crankshaft when made by both methods. The makers of grinding machines have been remarkably sane and conservative in this matter and have been very careful not to recommend grinding where experience tells that the lathe is better. Without question the lathe is better when the webs have to be machined for connecting-rod clearance, and whenever the end thrust collars of the pins or bearings are very deep beyond the fillet. A careful record of the manufacture of 12,000 crankshafts of various types in one season showed us that the wheels used per shaft, including all of the grinding on a shaft and not the pins alone, cost 4 cents per shaft; and that all of the diamonds worn out and lost cost 5 cents per shaft. This allowance is liberal, as some of the wheels and diamonds were also used on work of which no record was made. It will be seen from this that the grinding method has to save just 9 cents per shaft, or nine minutes, if time is rated at 60 cents per hour.

Up to date this has been an easy problem, especially when investigation of the crankshaft lathe reveals the fact that in every case, so far observed, the practice has been to leave from 1/16 to 1/8 inch on the diameter of each rough-turned pin, in order to insure all of the pins finally "cleaning." This large amount of stock, in most cases, calls for a rough-grinding operation anyway, and hence the lathe proves to be a hindrance rather than a help, as the rough-turning plus the rough-grinding costs more than if all the stock had been removed by grinding. This large amount of stock left by the turning operation is due to two causes: 1. A lathe tool releases all forging strains at one cut, whereas a grinding wheel releases them gradually and constantly corrects the error. 2. The heads of the lathe attachment get out of line and are not given the same care as is a grinding machine, simply because everybody has it in mind that the operation is a rough one anyway. At any rate, brushing the theory of drafting-rooms to one side, the fact remains that very few, if any, firms are turning crankshafts good enough to call for finish-grinding only.

Following the same article we read that "The rapid disintegration of the coarse grained wheel from contact with the fins left from the forging dies, and the necessity of frequent redressing to maintain fillets, is a big factor from the standpoint of wheel up-keep, besides causing frequent delays in the production chain." It may be of interest to know that, in at least one make of grinding machines, a 24 by 2 by 5 inch hole wheel will rough-grind 2000 pins 2 inches long by 1⅝ inch in diameter, removing 5/16 inch of stock from the diameter, and then the wheel will be 14 by 2 by 5 inches in size and can be used up on other work. If the machine is light, of course the wheel suffers, and in some makes of machines only about 1000 pins can be obtained per wheel. The right wheel on the right machine does not "disintegrate" any more than high-speed steel disintegrates. The grains wear out in doing useful work. The micro-photograph has proved this to the satisfaction of investigators. Now concerning the bugaboo of wheel "dressing," it seems too bad, at this late date, to have to say again that wheel "dressing" is a blessing and not a curse. Wheel dressing invariably increases output, just as frequent sharpening of lathe tools increases output. If you can increase output and reduce cost by throwing away abrasive grains, then you should be willing to throw them away.

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* Address: Care of Norton Grinding Co., Worcester, Mass.

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INTERNATIONAL ENGINEERING CONGRESS

The success of the International Engineering Congress to be held in San Francisco, Cal., September 20-25, is now well assured. Notwithstanding the difficulties arising as a result of the European war, the committee on papers is able to count on from two hundred to two hundred and fifty papers and reports, covering all phases of engineering work and contributed by authors representing eighteen different countries. Although the representation from the countries involved in the European war will be less than originally planned, the congress will still be truly international. The papers are now rapidly coming in and their character gives the fullest assurance that the proceedings will form a most important collection of engineering data, and a broad and detailed review of the progress of engineering art. Membership in the International Engineering Congress, with the privilege of purchasing any or all of the volumes of the proceedings, is open to all interested in engineering work. Further particulars relating to the congress may be obtained from the secretary, W. A. Cattell, 417 Foxcroft Bldg., San Francisco, Cal.

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TOLERANCES IN SCREW THREAD FITS

The Committee on Tolerances in Screw Thread Fits appointed by the American Society of Mechanical Engineers, of which L. D. Burlingame of the Brown & Sharpe Mfg. Co., Providence, R. I., is chairman, called a meeting at the Engineering Societies Building, in New York, February 5. At this meeting were present about forty men representing the tap and die industries, the screw-making industries, and the users of taps and screws. A number of valuable suggestions were given to the committee by the representatives of the various interests present, and it is believed that these suggestions will greatly aid the committee in formulating definite standards for screw thread tolerances. In a general way, the opinion was expressed that all taps should be above standard size, while all screws should be below standard size. The actual limits that would be necessary would vary in different industries, and the committee is inclined to believe that it will be necessary to establish a number of standards to apply (1) to ordinary commercial work; (2) to precision work; and (3) to work of a character that permits of greater limits than the general type of commercial work.

* * *

A British patent has recently been taken out covering a new composition for maintaining the brightness of polished steel parts. The ingredients contained are heavy white paraffine, starch and alum. The starch and alum are thoroughly mixed and the water evaporated from them, after which the compound is mixed with paraffine at about 110 degrees F.

EYE PROTECTION FOR GRINDERS AND MACHINISTS

BY H. W. DAVIE*

There are more risks of injuries to eyes in iron and steel plants than to any other single part of the body. The Pullman Co.'s accident charts show that 35 per cent of all injuries are eye injuries. Dust, flying particles, sparks and glare, unless guarded against by efficient eye protectors, offer constant and unavoidable danger to the men. This fact is being recognized by safety engineers, liability companies and industrial commissions in various states. Leading liability companies are requesting, and in some cases requiring, their subscribers to provide adequate protection for the eyes of their men. State officers are beginning to realize their responsibility in this matter and are issuing safety booklets describing dangers of accidents and recommending suitable safeguards for their prevention. This is notably so in California, Illinois, Iowa, Kansas, Massachusetts, Minnesota, New Jersey, New York, Ohio, Pennsylvania, Washington and Wisconsin.

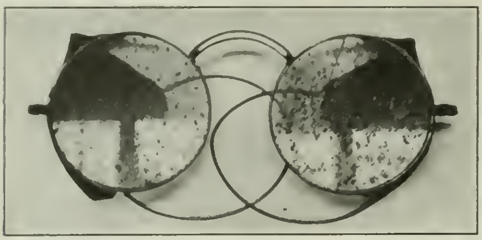

Fig. 1. Glasses after having been used Two Weeks by a Grinder

Many employers have sought to provide their men with eye protectors and have met with more or less prejudice on the part of the workmen. Many of the workmen believed that glasses would injure their eyes or that they could see better without them, and they have gone on squinting at their work, receiving more or less serious injuries to their eyes, and when actually supplied with eye protectors they have tucked them under their benches and gone on as before. A good deal of this is due to the often-met prejudice against anything new. Another cause is that the eye protectors are sometimes so uncomfortable and irritating as to render their constant use impossible. Those objections have been overcome, however, and improvements have been designed which yield perfect comfort as well as complete protection to the wearer. When improved eye protectors are demonstrated to the workmen and the great value of safety glasses is shown, they wear them gladly and constantly. A great deal of patient explanation is necessary to induce the men to try them, but once fairly tried they are fixtures. But it is not only the men who have to be shown the benefits of eye protection. Many foremen do not realize that the numberless minor accidents to men's eyes, causing not only the injured person to stop work to get grit, dust or other particles out of his eye, but a mate to help him, and perhaps one or two others to look on, may all be avoided by the provision of suitable safety goggles.

"Small particles are likely to become lodged in the cornea of a workman's eye. Close examination with a magnifying glass will usually show large numbers of minute scars, sometimes so numerous as to dull the cornea and affect the vision," says Dr. Mark D. Stevenson. In a grinding room there are countless injuries to men's eyes which are, in many cases, given little consideration at the time. With so much fine dust and grit flying about many particles imbed themselves in the cornea of the eye. When these particles are rather large they cause such immediate irritation that the grinder leaves his work and calls on the "shop doctor" or some fellow worker to get it out. This, of course, is a very dangerous procedure. The man's eyes may become infected from the use of a dirty toothpick or handkerchief, or the implement used may scratch the surface of the cornea so as to injure it permanently. Sometimes these particles may seem to have been taken out and, as in the case of the fine particles and dust which do not cause immediate irritation, they imbed themselves in the cornea so as to ultimately dull the vision and seriously affect the man's efficiency.

This matter has, up to the last year or two, been given little consideration generally and few people have realized how vitally necessary the protection of a grinder's eyes is. Without eye protectors he must squint and thus reduce his efficiency, and if he gets emery grit or bits of hot metal in his eye he will lose from five to twenty minutes in getting it out, if it is not bad, and if it is bad, he may lose days and weeks and ultimately his sight. With all of the fine dust flying about a grinding room where there are numbers of men working, protection at the side is just as important as protection at the front.

"Since the particles cut off by wheels are comparatively small, a heavy type of goggle is unnecessary. Goggles should have side guards of wire or leather as particles coming from the side frequently enter the eye," said R. G. Williams before the National Machine Tool Builders' convention at Worcester. It is readily seen that when there are a number of grinders working in a row it is impossible to prevent the sparks from one grinding wheel flying into another grinder's eyes. After most exhaustive tests as to the best way of protecting grinders' eyes, it has been proved beyond doubt that side guards should be provided on the glasses.

A man grinding high carbon or manganese steel looks constantly into a steady stream of sparks, the glare of which may cause *retinal asthenopia*. Retinal asthenopia is a condition from which the eye usually recovers after a suitable period of rest, but the loss of sight may be more lasting as the result of prolonged exposure to intense glare. In the industrial world retinal asthenopia is a dangerous condition, partly because of the insidious way in which it works.

A man grinding manganese or high-carbon steel should be protected from the harmful glare as well as from grit and dust. The desirability of light amber colored lenses for grinders' glasses has been proved in the research laboratories of one of the largest manufacturers of grinding wheels in the world. Grinders to whom glasses with white lenses have been given have complained of strain and irritation of the eye and blamed the glasses. The strain existed before, but was not noticed until something new brought it out. At once amber lenses were provided to cut out the harmful rays. There is an anti-sweat pencil on the market which will obviate sweating of the lenses. The effect of this pencil will last for from four to five hours.

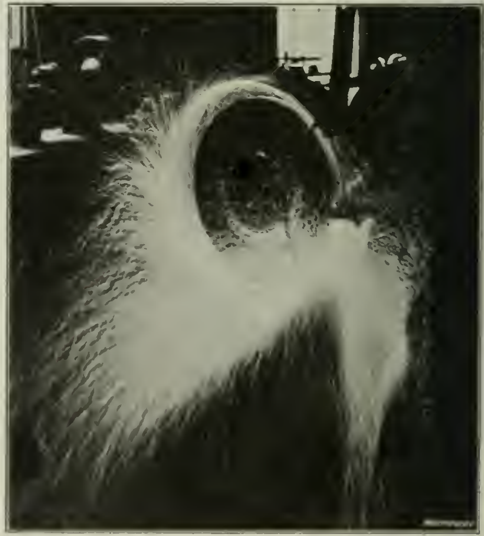

Fig. 2. The Dangerous Glare of a Stream of Sparks has injured Many a Worker's Eyes

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* Address: T. A. Willson & Co., Inc., Reading, Pa.

It is highly important that a heavy chippers' glass should not be given to grinders, machinists and others who do light work and who do not need such heavy protection. They will naturally object to the extra weight, and to get the maximum cooperation from workmen it is only wise to do away with all possible objections. Another thing which should be given careful attention is the matter of workmen who wear correction glasses. If these lenses are unprotected they quickly become scarred by emery grit and are soon so covered with spots that they are of little use. In the past it has been a frequent sight to see workmen wearing cheap leather goggles (such as are bought in 5 and 10 cent stores) over their regular glasses. Now, when the importance of good quality glasses is recognized by safety experts, eye protectors should be provided which can be worn over correction lenses even more easily than the old-style leather dust goggle. It seems unfair to burden a workman with placing high-priced correction lenses in his safety glasses and then having him pay for the many repairs which necessarily follow. In a good sanitary grinders' goggle which can be worn over other glasses and still provide protection from all angles, the workmen receive perfect protection and the cost of extra lenses for the eye protectors is small.

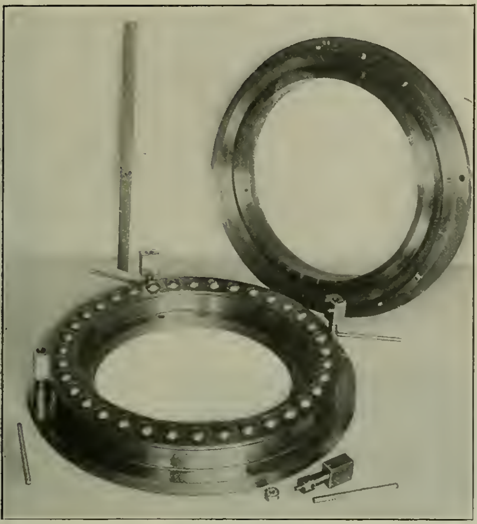

Fig. 1. Large Thrust Bearing for Lighthouse Use

It is surprising to note the number of foundries in which no protection is given to the eyes of such workers as molders, pourers, grinders, men slagging the cupola, etc. The idea that these dangers were "risks of the trade" has been so strong that neither employers nor employes awoke to the fact that not only can much pain and impairment of sight be avoided, but the efficiency of the workmen can be increased and much time and money saved for the employers.

Under the new workmen's compensation laws, employers are required to furnish certain safeguards, but there is nothing to require the men to wear them. After showing the men the advantages of eye protectors, corporations should absolutely require them to wear the glasses for mutual benefit. In some cases the management purchases supplies of eye protectors for different needs and sells them to the men at cost, while other plants distribute them to the men free of charge, recognizing that it is but a slight expense compared to the liability incurred if eye protectors are not worn. Since laws and insurance requirements force employers to furnish eye protectors where needed, it is but right that the employer should require his men to make actual use of them. This is an easy matter when they are shown the advantages.

* * *

A BALL BEARING FOR LIGHTHOUSE USE

The Auburn Ball Bearing Co., Rochester, N. Y., recently made a number of large ball bearings for use in government lighthouses to support the revolving lenses and mountings. One of these bearings is illustrated in Fig. 1, and this particular one was made for the Jupiter Inlet Light Station in Florida. From the illustration it will be seen that the bearing is of unusually large diameter and its general dimensions may be estimated by the two-foot rule shown beside it. The external diameter of the bearing is 24¾ inches and the 1¼-inch balls are spaced around a 20-inch circle.

The weight of the lens and mounting is only about 2000 pounds, although a bearing of this size is capable of carrying ten times that load. The timing of the "flashes" from a lighthouse must be uniformly constant year after year, in order that steamers at sea may always be able to identify the lighthouse from the duration of the flash and the interval between its flashes, and thus get their location. These intervals are often in seconds, so it is vitally important that no variation whatever occur. It is therefore necessary to reduce variations in frictional resistance to a minimum. Moreover, the driving mechanism for revolving the lenses is very delicate and of small power, so that by making the bearing of such large carrying capacity it is intended that the change in shape of the race grooves or balls from many years' use will be so slight as to practically make no perceptible difference in the driving resistance.

The details of the bearing are shown in Fig. 2. The ball races measure 22½ inches external diameter with an internal diameter of 17½ inches. These, of course, are of the best tool steel, hardened, accurately ground and highly finished. The race grooves are of the four-point cone principle which the Auburn Ball Bearing Co. employs on all its bearings. The balls are of hardened tool steel ground and polished to 0.0001 inch of size, and, as before stated, are 1¼ inch in diameter. The ball races are mounted in cast-iron flanges, being fitted in turned recesses. A ball separator 5/16 inch thick is placed between the two ball races to keep the balls equally spaced. A dust protector in the form of a metal ring is screwed to the upper ball race and extends down over the opening between the two races, effectually keeping dust and dirt from the bearing.

An interesting feature of these bearings, and one quite unusual, is the provision for raising the load so that the balls and races may be cleaned. Smooth running action was the principal feature to be desired in this bearing, and to insure this frequent cleaning is necessary. To raise the load from the balls and lower race four jacks are employed, being placed around the bearings equidistantly between the outer flanges. These are ball-bearing jacks, as may be seen from Fig. 1, and small pins are employed to turn them and raise the upper race clear of its contact with the balls. To put the bearing in commission after cleaning, it is only necessary to turn down the jacks until they are clear of the upper race, when the bearing again takes up the load.

C. L. L.

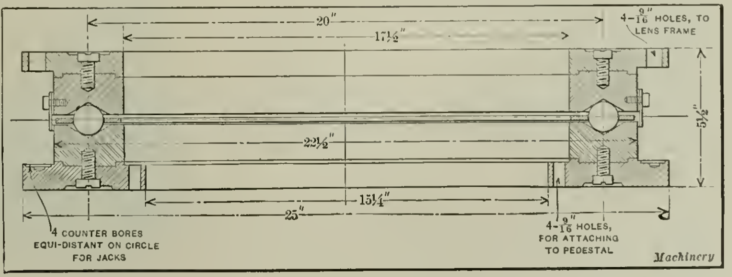
20"
17½"
4-9/16" HOLES, TO LENS FRAME
5½"
22½"
15¼"
25"
4 COUNTER BORES EQUI-DISTANT ON CIRCLE FOR JACKS
4-9/16" HOLES, FOR ATTACHING TO PEDESTAL
Machinery

Fig. 2. Sectional View of Bearing

MACHINING SHRAPNEL SHELLS*

TOOL EQUIPMENT USED ON THE POTTER & JOHNSTON AUTOMATIC CHUCKING AND TURNING MACHINE

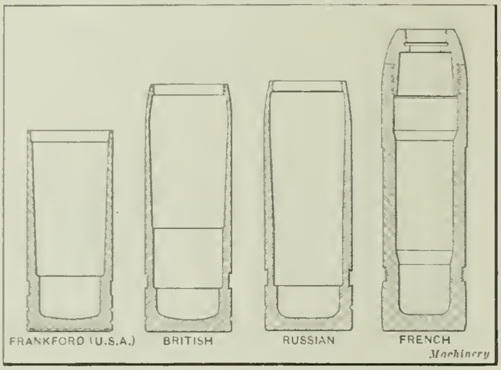

Fig. 1. Examples of Shrapnel Shells that can be economically machined on Potter & Johnston Automatic Chucking and Turning Machines

WITHIN the last few months the manufacture of shrapnel has become a great industry. There are at present a large number of firms engaged in this work and the number is constantly increasing. The ingenuity displayed by machine tool builders in adapting their machines to the requirements of this work is worthy of special notice. The shrapnel shells used by some of the principal governments vary slightly in construction, as is shown in Fig. 1, and consequently require slightly different tooling equipments. The principles involved in the machining of the different shells, however, are practically the same. The following article will describe the methods of manufacture followed in producing British shrapnel shells on the Potter & Johnston manufacturing automatic chucking and turning machine. Some of the tool equipment used for this work is unique and should, at the present time, be of special interest to manufacturers of shrapnel.

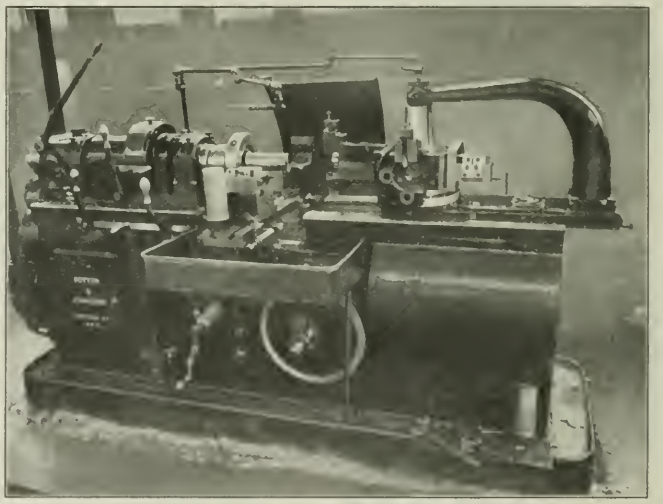

Fig. 2. First Operation on Shrapnel Shell, performed on a No. 6A Potter & Johnston Automatic Chucking and Turning Machine

Preliminary Operations in Producing a Shrapnel

Shrapnel shells are being produced from both bar stock and forgings, but it has been found that the forged shell is much superior to the bar shell because it is more homogeneous. It is therefore anticipated that, in the future, practically all shrapnel will be made from forgings instead of bar stock. In the making of forgings for shrapnel shells, the hydraulic press is used almost exclusively. In fact, until within the last few months this was the only method of manufacture. At the present time, however, power forging machines are being developed for this work. A shrapnel forging has its beginning in a rough billet, which is gradually forced into shape under hydraulic pressure and then finished in a draw-bench. As this article, however, is to deal with the machining of shrapnel and not the making of forgings, we will confine the description to the manufacturing steps after the forging has been completed. While the Potter & Johnston automatic chucking and turning machine is especially adapted to the production of all the different types of shrapnel shells and cases, this article will apply only to the machining of the British forged shrapnel shell.

Machining the British Forged Shell on Potter & Johnston Automatics

In making the British forged shell on the Potter & Johnston automatic chucking and turning machine, three operations complete the work. The first operation completes the outside of the shell, except for the extreme end which is covered by the gripping mechanism of the chuck. The second operation finishes the inside of the shell and at the same time finish-turns the extreme open end. After the second operation is performed the shell is "nosed in," which consists in heating it in a lead bath and then striking it under a light press to close in the end. The third operation then follows, and consists in taking light cuts from the inside and outside diameters and threading the open ends.

Method of Holding Shell for First Operation

For the first operation, the shell is held on an expanding arbor of the type shown in Fig. 4. The arbor *A* is tapered on its rear end and is held in the nose of the spindle of the machine. The shell is pushed onto this arbor until the end of the arbor strikes the bottom of the shell. The gripping mechanism which comprises six jaws *B* and a draw-in plunger *C* are contained inside the arbor. The external diameter of the arbor is machined to practically the same shape as the internal diameter of the shell, but is smaller. The jaws are held in slots which control their movement in every direction except radially. They are forced out radially by means of the draw-in bar *C* which is provided with tapered seats that engage the inward end of

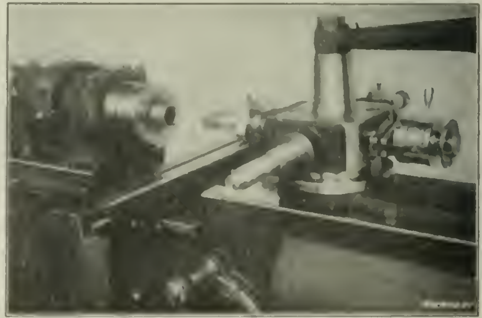

Fig. 3. Machining Inside of Shrapnel Shell, and threading with Automatic Collapsing Tap on Potter & Johnston Automatic Chucking and Turning Machine

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* For additional information on shrapnel making see "Making Shrapnel Cases on the Cleveland Automatic," February, 1914 and "An Interesting Job on the Gridley Automatic Turret Lathe," April, 1912.

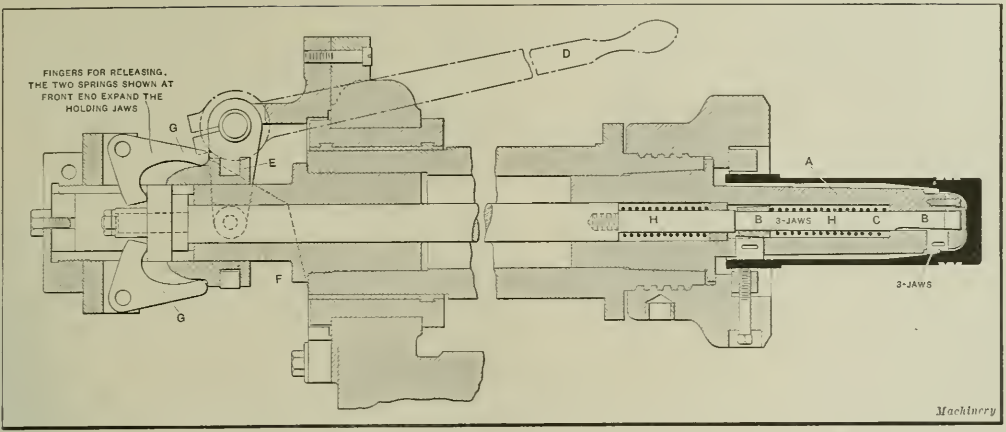

FINGERS FOR RELEASING. THE TWO SPRINGS SHOWN AT FRONT END EXPAND THE HOLDING JAWS
G
D
E
A
H
B
3-JAWS
H
C
B
F
G
3-JAWS
Machinery

Fig. 4. Expanding Arbor and Chucking Mechanism used on Potter & Johnston Automatic Chucking and Turning Machines for performing First Operation on Forged Shrapnel Shells

the jaws. The bar *C* is operated by a hand lever *D* that extends up over the top of the machine, is fulcrumed in a bracket on the rear bearing cap, and is connected to a sliding sleeve *E*.

In clamping the work on the arbor, lever *D* is lifted up, this action drawing the sliding collar *E* to the right along the sleeve *F*, which, in turn, allows the forward end of the fingers *G* to close in. This releases the pressure of the outer end of the fingers on the draw-in bar *C*. When the pressure from bar *C* is released by means of handle *D*, heavy coil springs *H* then come into action forcing the draw-in bar back and expanding the clamping jaws. Additional clamping means is provided by three set-screws which are brought to bear on the work after it has been clamped in position by the jaws. To release the work, the reverse action takes place, that is, lever *D* is forced down which slides the collar *E* to the left, operating the fingers *G*, which, in turn, overcome the pressure of the springs *H*, allowing the clamping jaws *B* to collapse.

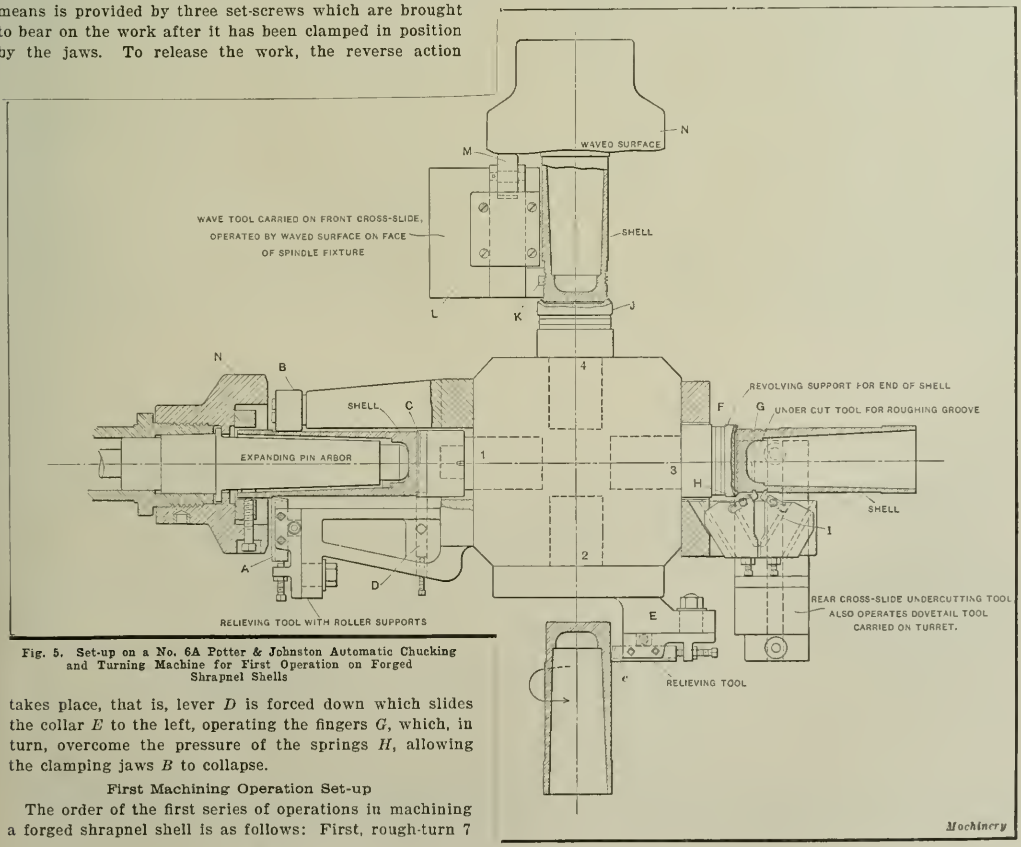

WAVED SURFACE
N
M
WAVE TOOL CARRIED ON FRONT CROSS-SLIDE, OPERATED BY WAVED SURFACE ON FACE OF SPINDLE FIXTURE
SHELL
L
K
J
N
B
SHELL
C
4
REVOLVING SUPPORT FOR END OF SHELL
F
G
UNDER CUT TOOL FOR ROUGHING GROOVE
EXPANDING PIN ARBOR
1
3
H
SHELL
I
A
D
2
RELIEVING TOOL WITH ROLLER SUPPORTS
REAR CROSS-SLIDE UNDERCUTTING TOOL ALSO OPERATES DOVETAIL TOOL CARRIED ON TURRET.
E
RELIEVING TOOL
Machinery

Fig. 5. Set-up on a No. 6A Potter & Johnston Automatic Chucking and Turning Machine for First Operation on Forged Shrapnel Shells

First Machining Operation Set-up

The order of the first series of operations in machining a forged shrapnel shell is as follows: First, rough-turn 7 inches along body of shell, face end and chamfer; second, finish-turn 2½ inches along shell; third, rough-groove for copper band and dovetail; fourth, turn waves in groove.

For the first operation, the work is held on the expanding arbor shown in Fig. 4, and the tool equipment, which is of an unusually interesting character, is shown in Fig. 5. The first rough-turning operation, accomplished by turret tool *A*, which is of the relieving type to be described later, is held on the first face of the turret and roughs down the body of the shell. On the opposite side of the holder is a roller support *B* which supports the shell while the turning tool is in operation. The end of the shell is faced by means of a facing tool

C which is really a type of facing mill. The end of the shell is then chamfered by means of a chamfering tool *D* that removes the sharp corner.

After these operations have been performed, the turret is indexed and the second face of the turret is brought in line with the chuck. This operation is accomplished with a relieving tool-holder *E* carrying a cutter *e*, which takes a cut 2½ inches along the body of the shell. An interesting feature of this tool is that on the return stroke of the turret it swivels back out of the way so that the shell is not scored by the tool dragging over it. The construction of this tool is more clearly shown in Fig. 6, to which reference should now be made.

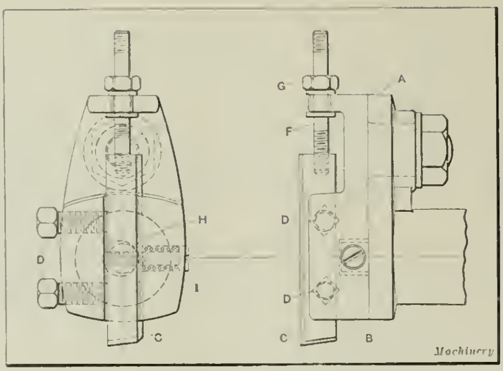


Fig. 6. Details of Relieving Turning Tool-holder shown in Fig. 5

As is clearly shown in this illustration, the turret relieving turning tool comprises a shank on which is fulcrumed a tool-holding member *B*. This is slotted out to carry the turning tool *C* which is clamped in place by two set-screws *D* and is adjusted to turn the correct diameter by means of an adjusting stud and clamping nut *F* and *G*. The method of operating this tool is as follows: The fulcrumed tool-holder *B* is "held up" by means of a fillister-head screw, screwed into a stud *H* and acted upon by a coil spring *I*. A hole to receive the stud is drilled in the tool-holder *B*, allowing about 1/16 inch clearance. When the tool is in action it has a reverse position to that shown in the illustration, that is, the turning tool instead of being parallel with the center line is at a slight angle with it. In action, as soon as the turret advances, the tool comes into contact with the work, and the work, turning around, forces the cutting tool down and consequently depresses the spring, at the same time bringing the "lower part" of the hole into contact with the extended plug on the holder. In this way the tool is held rigidly and in contact with the work. As soon as the turret begins to move back, however, and the cutting pressure is released, the spring comes into action and throws up the tool, bringing it out of contact with the work.

Upon the completion of the operation which is accomplished from the second turret face, the turret is again indexed and the next operation is performed from the rear cross-slide and the third turret face. The third operation consists in cutting the grooves for the rifling band, and on account of the under-cutting necessary involves some interesting points. In order to hold the work rigidly while the grooving tools are acting on it, a revolving support *F* is brought in from the turret. The wide tool *G* for cutting the band grooves (this tool removes the greatest amount of stock) is held on the rear cross-slide and is of the under-cutting type; that is to say, it operates under the work or tangentially instead of radially. Held on a bracket on the third turret face are two tools *H* and *I*, the purpose of which is to dovetail the rifling band grooves. These turret tools are held in a holder working in a slide on the bracket fastened to the turret face and are operated by a block held on the rear cross-slide. The action of these three tools, therefore, is simultaneous. The wide grooving tool, however, is slightly ahead of the dovetailing tools in action.

The last operation is accomplished when the turret is indexed to the fourth position. Here, again, a roller support *J* steadies the work while the waving tool is in action on it. The two waves that are formed are for the purpose of preventing the rifling ring from turning, and they deviate about 1/16 inch laterally from being a true annular rib. The tool for cutting these ribs is shown at *K* and is of the forming type held in a dovetailed groove in the holder *L*. This also carries a roll *M* which contacts with the waved surface of the face cam *N*, the curve of which gives the correct, out-and-in motions to the waving tool *K*. The cam face is on a sleeve that is threaded onto the nose of the spindle of the machine, as is shown to the left of the illustration opposite the first turret face.

Method of Holding Shell for Second Operation

The second series of operations on the shell is also performed on the Potter & Johnston automatic chucking and turning machine. The shell is held at the base end by a special collet of the draw-in type, as shown in Fig. 7. Fixed in the nose of the spindle is a positive stop *A* against which the shell is held by means of the draw-in collet *B*. This collet extends into the draw-in rod *C*, to which it is attached. The method of operating this gripping mechanism differs slightly from that shown in Fig. 4. In this case the spring collet *B* is drawn into a tapered sleeve to clamp it on the work. This is effected by means of lever *D* which is fulcrumed in a

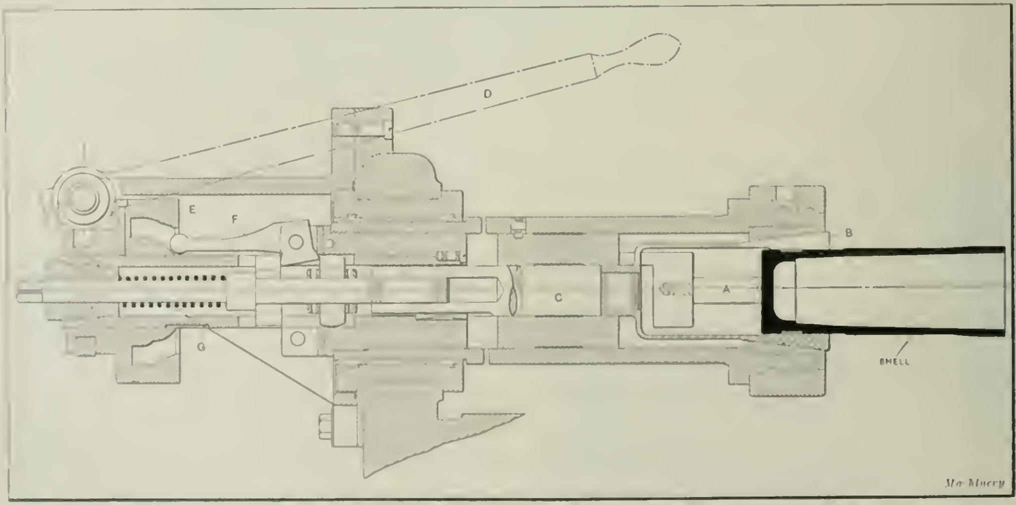


Fig. 7. Type of Draw-in Collet and Chucking Mechanism for holding Forged Shrapnel Shell for performing Second Series of Operations

bracket extending from the rear bearing cap of the machine and operates a sliding cam sleeve *E*. The cam, in turn, operates fingers *F*, only one of which is shown, the latter acting upon the draw-in rod *C* to which the collet is attached. By depressing lever *D*, the chuck is opened by means of the coil springs *G* which act upon the draw-in rod *C* when the pressure of the fingers has been released. Lifting up handle *D* closes the chuck, and depressing it opens the chuck.

Second Series of Machining Operations on Shrapnel Shells

The operations on the shrapnel shell performed in the second setting are shown in Fig. 8. The relieving tool *A*, held on the first face of the turret, covers that section of the shell which in the former operation was held in the gripping jaws. While this cut is being taken, a turret tool *B* rough-bores the powder pocket and diaphragm seat. The relieving tool *A* is constructed and operated similarly to the relieving tool described in connection with Fig. 6. It will be noted here that the threads on the spindle nose are protected by a cast-iron cap to prevent them from being injured.

Upon the completion of the operation just described, the turret is indexed, bringing the second face in line with the spindle. Here the diaphragm seat is finished with a flat cutter *C*, which is held in the boring tool illustrated. The turret is again indexed into the third position, where the powder pocket is finished in a similar manner by means of the flat cutter *D*.

The turret is now indexed to bring the fourth face in line with the spindle where the extreme open end of the shell is turned taper by means of a tool *E* that is carried on the front cross-slide and operated by the turret. By referring to this illustration, it will be noticed that the taper is turned from the spindle toward the outer end of the shell and is, therefore, a reverse turning operation. The tool is caused to move toward the turret by using a rack and pinion to reverse the movement. On this operation, as well as on the previous one, one man takes care of four machines.

Third Machining Operations on Shrapnel Shells

Before any other machining operations are done on the shell, it is taken to a lead bath where it is heated and afterward placed under a press which closes in the nose or open end of the shell. For machining in the third operation, the shell is held practically in the same manner as for the second operation, except that it is gripped farther along the body. The machining performed in this operation is as follows: On the first turret face, rough-bore and finish-bore for a distance of 1 inch from the end of the shell; second turret face, rough-bore the inside of the shell for a distance of 1 inch back from the thread; third turret face, finish-form on the inside for a distance 1 inch back of the thread; and fourth turret face, thread with a collapsible tap. The various machining operations on the 3-inch size of shrapnel shells are performed on a standard Potter & Johnston 6A automatic chucking and turning lathe. It is recommended that these machines be run in batteries or units of seven each, four machines being set up for the first operation, two machines for the second operation, and one machine for the third operation.

Shrapnel shells are also made from bar stock, but this type of shell is not held in as high favor as the forged shell, as mentioned. The operations on the bar shell do not differ materially from those on the forged shell, except that the chuck jaws are used for holding the stock in the first operation, and the work is performed as follows: First, rough-turn the outside diameter as far as the chuck jaws, face end, round the corners; second, finish-turn outside diameter, also finish 3½ inches up; third, cut band groove and dovetail; fourth, cut irregular annular ribs in the band groove. In this case the cam for operating the wave cutting tool is placed on the chuck face.

The second operation on the shell made from bar stock is, of course, entirely different from the forged shell as the interior of the shell must be worked out to a depth of approximately 8 inches. This is done with a step drill in the first position. In the second position the reamer is run in for reaming the tapered hole; third, the short distance on the open end is turned, and the taper on the periphery is turned with the cross-slide tool, the surplus stock left by the first drill being removed from the powder pocket. At the fourth turret position, the powder pocket is bored and the diaphragm seat is completed. The shell is then "nosed in," and the third operation performed, which is identical with that described in connection with the forged shell.

This method of manufacture, together with the operations performed on Potter & Johnston automatic chucking and turning machines in the production of brass cases for shrapnel, will be described in a subsequent article.

D. T. H.

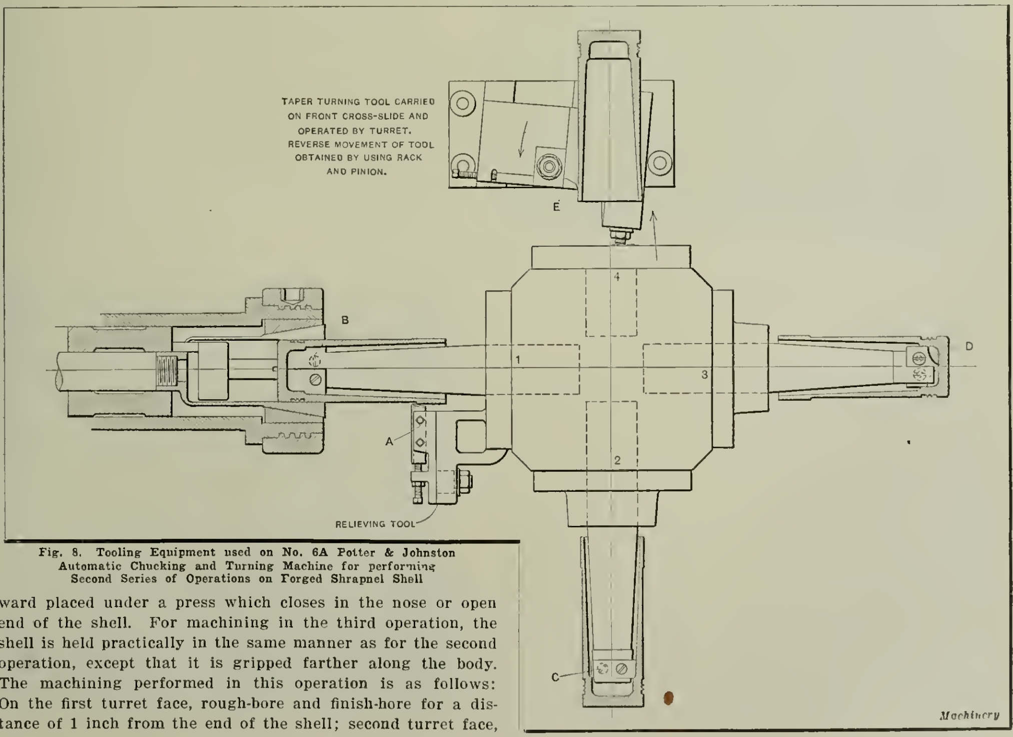

TAPER TURNING TOOL CARRIED ON FRONT CROSS-SLIDE AND OPERATED BY TURRET. REVERSE MOVEMENT OF TOOL OBTAINED BY USING RACK AND PINION.
E
4
B
1
3
D
A
2
RELIEVING TOOL
C
Machinery

Fig. 8. Tooling Equipment used on No. 6A Potter & Johnston Automatic Chucking and Turning Machine for performing Second Series of Operations on Forged Shrapnel Shell

ECHOES FROM THE REPAIR SHOP

BY A. P. PRESS

For a long time I have been foreman of an automobile repair shop, and some of the cases that come before the door (they do not all come in) are worth describing. The foreman of a large automobile repair shop has a hard job, and if he has, say, a hundred jobs on the floor which are owned by one hundred different men, he virtually has a hundred "bosses" all of whom he is trying to satisfy—and some of them never can be satisfied. Every man that owns a car, especially if he drives it, knows his car thoroughly, and he expects the foreman to know it equally well. A case came up recently that will illustrate this point.

A car came in for a complete overhauling. On the front of the dash-board were four little holes, and also a spot where a square plate had been taken off. We supposed it had been removed simply for safekeeping. Well, the car went through the mill—it was overhauled, painted and the dashboard refinished, but the four little holes were not plugged up. When the man came to get his car there was a "circus." It seems that it had formerly belonged to some club and the present owner had removed the plate and wanted the spot and holes refinished, but he forgot to speak of it. There was a stormy time for a half hour, and the outcome was that we had to pull the dash-board off and thoroughly refinish it all over so as to cover up the spot.

Some of the cases are more ludicrous, however. A gentleman—and he was a gentleman, too—came driving in one day and said he wished certain repairs made on the rear end of the car. He said if he jacked up the car and turned one wheel one way, the other would revolve in the opposite direction. (This, of course, is the natural action of the differential gear.) It seems this party had gone down to another garage where he was told that the transmission was entirely gone and that a new one would have to be installed; but before leaving the car for repairs, he drove down our way to see what we would say about it. It took a half hour of earnest explanation to convince him that his car was absolutely all right, and also to explain to him the purpose of the differential. All this had to be done without a smile or he would naturally have been offended and gone away indignant; but once he was convinced, we made a customer for life, and a box of cigars which he sent around the next day showed his appreciation. Of course no charge can be made for a "job" of this kind.

And then the ladies—for we have a good many of them who own and drive their own cars—give us some bad moments. One came in not long ago and she wished the oiler removed, thoroughly cleaned out and replaced; a leak soldered in the radiator; and the carbureter adjusted and "tuned" up—at least a half day's work. She said she could not leave the car over ten or fifteen minutes, as she had to catch a train some miles away. Did she get it? Yes—two days afterward, and we had to send her to meet the train in one of our own cars. Still, with all the troubles, there are some bright spots that help to relieve the strenuousness of the job.

There was the lady who came in and purchased a high-grade car; and in addition she was to be taught how to operate it herself, and for that reason it must not crank too hard. She wore a hobble skirt of some exquisite material—satin I thought. She insisted upon a Harrel bumper on the front of the car. The combination of the Harrel bumper and the hobble skirt was too great for the best interests of the garage. However, I must say she was equal to the situation, and the way she learned to step over that bumper and crank that car, and to handle it afterward was a feat to be remembered.

Naturally we had a great deal of outside testing to do and some of it is speed testing. One instance, which we call the "seventy-mile case," is still a by-word in the room. The customer bought the car with the understanding that he would not accept it unless it made seventy miles an hour. He came from Missouri and he "wanted to be shown." When the car was ready (we had taken it out once before and knew it would make the seventy) our customer came down to see the test, and took a seat in the rear of the tonneau. We took the car out on the turnpike which was a long stretch of woods about five miles from the shop, and where we were reasonably sure that the cops would not see us—or would look the other way if they did. The car was warmed up for a few moments and then started down the pike. When the indicator got near the seventy mark, the mechanic turned around to the customer and said: "There she is at 70. Do you want to see it?" The customer was lying back in the seat, his face as white as chalk. "Y—yes! yes!" said he. "Yes, I am satisfied. Slow her down!" He got his car and we got our money, but we do not think that indicator ever touched the seventy-mile mark again.

Here is another incident that will bear telling. One day two of the boys were out on the road testing a car, and when they got well out into the country they found that the radiator was leaking and that they would have to get a little water somewhere. So they stopped at the next farmhouse and one of the mechanics took a collapsible rubber pail and went around the back of the house. He could not find a pump so he knocked at the door and went inside and filled it at the sink. As he stood there with the pail in his hand he got to talking with the hired girl, and he had occasion to set the pail down on the floor. Why he did it is a question, but anyhow he wanted to use both arms. Now when you set a rubber collapsible pail full of water on the floor there is something doing right off, and this case was no exception. He grabbed the pail with what was left of the water and hurried out. The radiator had to wait until they got to the next farmhouse before it was filled.

To come back to the practical side of automobile repair work, a systematic method of keeping track of the car—what is to be done and what has been done—is a great help in giving satisfaction to customers. It will not help at all the job that requires two days and is wanted in fifteen minutes, but it will enable a foreman to tell just where he is at on each and every job; and about when he can deliver the same and do it with the least expenditure of gray matter on his part, or clerical work in the office.

* * *

SAFETY MEDAL AWARDS

The American Museum of Safety awarded on February 10, at the United Engineering Societies building, six safety medals as follows: The Scientific American medal, awarded for the most efficient safety device invented within a certain number of years and exhibited at the museum, was given to the Shurloc Elevator Safety Co., Inc., New York City. The Travelers Insurance Co.'s medal, awarded to the American employer who has excelled in protecting the lives and limbs of workmen, was given to the Commonwealth Edison Co. of Chicago. The Louis Livingston Seaman medal, awarded for progress and achievement in the promotion of hygiene and the mitigation of occupational disease, was given to Surgeon-General William C. Gorgas. The E. H. Harriman memorial medal, awarded to the American steam railroad which during the year has been the most successful in protecting the lives and health of its employes and of the public, was given to the New York Central Railroad Co. The Anthony N. Brady memorial medal, awarded to that American electric railway company which for the year of the award shall have done most to conserve the safety and health of the public and of its employes, was given to the Boston Elevated Railway Co. The jury of award also gave honorable mention to the Public Service Railway Co., New Jersey, and the Northern Ohio Traction and Light Co.

* * *

That the German metal industry suffers considerably from the lack of raw materials, all assurances to the contrary notwithstanding, is indicated by the high prices at present quoted in the German market for certain metals; thus, copper is now quoted in Germany at twice the price of the current quotation in other countries, and aluminum is quoted at three times the price prevailing when the war began. Antimony costs about four times as much as when the war broke out.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in Machinery

ASSEMBLING FIXTURE FOR FRANKLIN FRONT AND REAR AXLES

A labor saving assembling fixture used for assembling the front and rear axles of Franklin motor cars has been designed, built and is now in operation at the factory of the H. H. Franklin Mfg. Co., Syracuse, N. Y., through whose courtesy the accompanying illustrations are shown. Fig. 1 shows the fixture without work on it, while Figs. 2 and 3 illustrate two phases of the assembling operation.

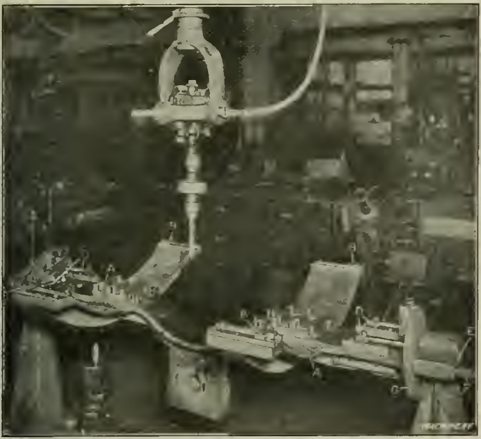


Fig. 1. Assembling Fixture for Franklin Axles

The work done on this fixture is assembling the sets of springs to the axle by means of U-bolts, making several adjustments inside the differential case and bolting the differential case cover to the case. The assembled springs, and also the axle completely assembled except for the springs, come to the fixture ready to be put together. A pneumatic drill outfit is used for setting the bolts, and it is suspended overhead for convenience, being mounted on a universal joint, which makes it easy to manipulate. The operation is started with the fixture in the position shown in Figs. 1 and 2. The four U-bolts are put in position, two in each end of the fixture, and located in grooves in blocks *A*. It will be noticed that there are two slots in each of these blocks, thus permitting of assembling either the front or the rear axles, which differ in width. After the U-bolts are in place, the springs are set in these blocks and the horizontal alignment of the pair of springs is made by adjusting the springs to gages carried in the slots of the blocks *B* which are located on the projecting arms of the fixture. In conjunction with this (in the case of the rear axle) the axle is correctly located by means of the end blocks *C*, which are not shown in Fig. 1 but may be plainly seen in Fig. 2. Passing down through these end blocks are locating pins that engage the ends of the axle and hold it while the assembling is being done. These end blocks may be slid in or out of the fixture between ways, and when located are clamped by lever bolts *D*. The operation of setting the nuts on the bolts is quickly performed by using the pneumatic drill, as shown in Fig. 2. This is a "Thor" pneumatic drill made by the Independent Pneumatic Tool Co. and in connection with it a "Magic" chuck is used with a nut setter that insures each of the nuts being set up to the same tension.

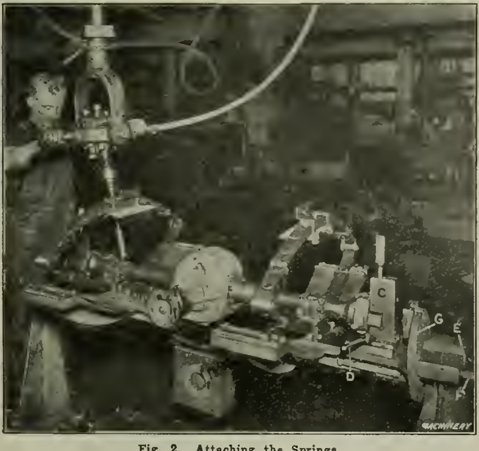


Fig. 2. Attaching the Springs

The entire fixture for holding the springs and axle is mounted on trunnions so that it may be swiveled about point *E*. While locating the fixture in either plane, a pin *F* is used that engages holes in the disk *G*. The fixture is used in the vertical plane while several adjustments are being made on the differential mechanism within the case, after which the cover is put in place and the cap-screws that secure it are set by means of the nut setter on the overhead pneumatic drill. By the use of this fixture, the assembling of the springs and axle is easily performed, and the time for the operation has been greatly reduced. C. L. L.

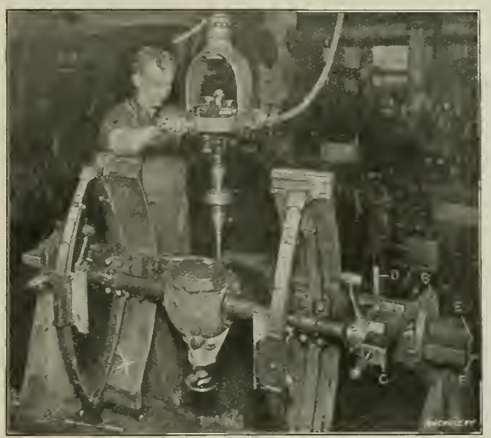


Fig. 3. The Last Operation—Bolting Down the Differential Case Cover

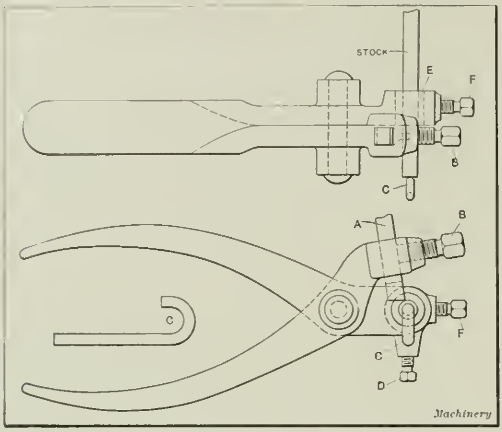
HOW SHOULD THE GRAIN RUN?

Referring to the "How and Why" article in the January number of Machinery, page 414, entitled, "How Should the Grain Run?" the writer would say that many toolmakers believe that steel, as manufactured today, is so homogeneous that there is no grain in the sense in which this word has been used in the past when referring to wrought iron. There is no tendency to open, under strain, along lines parallel with the sides of the bar. In the minds of many, the word grain represents a condition similar to the grain of wood. Even if we could imagine that a bar of tool steel were as fibrous as a bar of iron, it is difficult to see how a cutter made as shown at *C* in Fig. 2 in the article referred to would be as lasting as one made with the grain in the other direction; but with steel homogeneous in structure this consideration is probably of no account anyway.

Turtle Creek, Pa. William S. Rowell

CUT-OFF TOOL FOR SMALL PINS

It is sometimes necessary to cut off several dozen small dowel pins, the usual method of doing this work consisting of cutting off the pins with a hacksaw and then filing them up in a speed lathe. The accompanying illustration shows a handy tool for cutting off such pins, which is provided with a cutter ground in such a way that the ends of the pins are rounded up without the necessity of filing them. The cutter *A* is made of $\frac{1}{4}$-inch high-speed steel, and is held in place by a suitable set-screw *B*. It will be seen that in general appearance the tool resembles a pair of pliers, the cutter being mounted in one jaw and an adjustable stop *C* being carried in the other jaw. The stop is held in place by a set-screw *D* and may be adjusted to provide for cutting off pins of different lengths. In order to adapt the tool for handling different sizes of stock, hardened steel bushings with different sized holes are used, the bushing *E* being mounted in the same jaw with the stop and held in place by a set-screw *F*.



Tool for cutting off Pins and finishing their Ends in a Single Operation

Swissvale, Pa. William Mursch

ONCE-MORE—SHORT FOREIGN POSTAGE

The writer wishes to draw the attention of American manufacturers to a matter which is of the pin-prick order. In nearly every case when manufacturers send us catalogues and letters, insufficient postage is prepaid. We have at this end the option of refusing delivery or paying 3d (6 cents) per letter. The mail this morning cost me about 40 cents. Now there is no necessity for this, and I am sure your advertisers, with some of whom I have had satisfactory business, would be glad to prevent the recurrence of this slight annoyance.

Auckland, New Zealand F. J. Cullen
Cullen & Coy, Mechanical Engineers

SENSIBLE CATALOGUES

I often wonder why manufacturers do not get out more business-like catalogues. There seems to be a tendency nowadays to spend a great deal of money on art for catalogues, which is certainly all right so long as the artistic end is not overdone; but that does not necessarily make the book a useful tool. A catalogue should be economic, first, and second, it should be useful; if it is not useful how can it be economic?

Ninety-nine buyers in a hundred do not care for a fancy catalogue. All they want is something sensible. A durable book that will withstand wear is most desirable. A convenient filing size—6 by 9 inches—is also wanted. Show plenty of pictures but don't show useless pictures to tire the reader before he gets to the vital point. And don't say too much.

Before getting out your next catalogue take a look at the catalogues of some of our big mail order houses. They are almost beyond criticism. Everything is illustrated; the descriptions are concise, yet nothing of value is omitted; and the prices are given. There is no discount. That is one of the principal reasons why those houses are so successful. Their catalogues are equally valuable in Alaska, Australia, Africa and America.

Just for "effect" it may be all right to get out a work of pure art once in a while, but don't make a practice of it.

N. G. Near

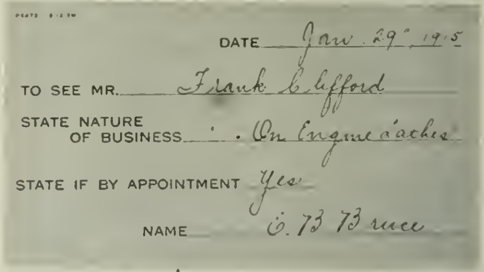
HANDLING OFFICE VISITORS

The interesting method for the courteous and efficient treatment of office visitors by using a private telephone system, described in the December number of Machinery, brings to the writer's mind an equally effective arrangement established throughout the works of a large electric light and power company on the Pacific coast and which, additionally, does not require any time of officials unless fully warranted. Callers for any and all departments are received by a diplomatic young man and handed a small writing tablet about 3 by 5 inches in size, carrying wording as shown in the specimen here reproduced. No visitor worthy of attention will object to filling this out, and the sheet pulled from the pad is taken immediately to the official or department head whom the visitor desires to see.

A glance at this blank informs the official of the name of the caller and the nature of his business, and should he justify attention it can be given. On the other hand, in the case of an obviously needless interview, a polite refusal explaining the impossibility or uselessness of seeing him at that particular time and, if desired, requesting that he call again, can be reported at once to the messenger and transmitted to the visitor. By this arrangement no time is unnecessarily consumed and no particular harm is done should the visitor not be seen, while the importance of the official and the demands upon his time are impressed upon the caller. Further, the proper filing of these slips from week to week, with notations as to whether an interview resulted or not, affords an accurate reference to callers in the past, as it frequently becomes necessary to trace matters of this kind for a complete record of different conditions.

A. R.

[In comparing the present system with that described in the December number of Machinery, the writer has overlooked the fact that the use of the private telephone system enables the caller to come into personal contact with the man he wishes to see, so that in case he is not granted an interview, he does not go away with the feeling of having failed entirely in bringing his project to the attention of the proper individual.—Editor.]


DATE Jan. 29", 1915
TO SEE MR. Frank Clifford
STATE NATURE OF BUSINESS . On Engine catches
STATE IF BY APPOINTMENT Yes
NAME E. B. Bruce

Form used by Office Visitors in making Application for an Interview

CLAMPING DEVICES FOR JIGS AND FIXTURES

In Fig. 1 is shown a clamping device that has been found useful on large work. It consists of four arms *A* with the ends bent to a right angle and knurled so as to hold the work firmly in place. These arms are pivoted on the stud *B* and their action is guided by the blocks *C*. The spring handle *E* is pinned to the shank of the stud, and the upper edge of the handle is beveled to fit the rack *D*, which is fastened to the side of the base. By turning the handle in the direction indicated by the arrow the work is securely clamped; and if necessary, ordinary straps may be added for holding the work.

When making tools for thin castings of odd shapes, it is often desirable to use an adjustable clamping device that can be easily moved out of the way when reloading the fixture.

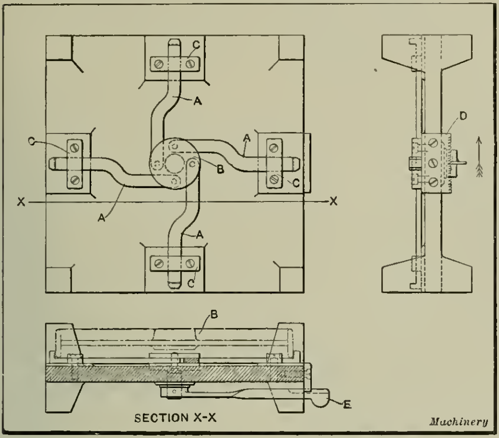


Fig. 1. Clamping Device for holding Large Work

Such a floating clamp is shown in Fig. 2, where the piece of work to be drilled was properly located and clamped, with the exception of one arm *E*. for which no ordinary clamp could be used. By pushing the support *A* down against the work and clamping the strap *B*, the work is held tight without springing it; and by tightening the nut *C* the clamp is held in place by the bunter and the work is securely supported. When reloading the fixture, the clamp is brought out of the way by means of the handle *D*.

In Fig. 3 is shown a small clamping device used when drilling the rivet holes through the beading *A* and the plate *B*. The steel bracket *C* is fastened by screws to the side of the fixture. The front face of the clamp bracket is used as a stop for the plate and the beading, and the clamp *D* with a small hole drilled in one end is fitted loosely in the milled slot in the bracket. The set-screw is located a little higher than the hole in the clamp and by a few turns of the screw, the clamp is brought down against the work and forces the beading up against the stop ready to be drilled.

Spring bunters are often used in designing fixtures where adjustable supports are necessary, and the form of bunter shown in Fig. 4 has proved very efficient. The bunter *A* and the binder *B* fit freely in the holes in the casting. The bunter is slightly tapered and a tapered flat is milled on one side of the binder. When the fixture is loaded the spring *D* forces the bunter up against the work, and by means of the cam *C* the binder is pulled outward and holds the bunter firmly in place. The double taper on both bunter and binder makes it impossible to press the bunter downward away from the work.

Hartford, Conn. S. Helweg

DEVELOPING A TYPEWRITER

As there has several times been expressed an interest in the time and cost of bringing out small mechanisms of various sorts, it may be worth while to place on record the following experience. It was my fortune, some years ago, to be engaged to go to a western city to take part in the development of a typewriter. I landed in that city on June 22. The manager, who was also the inventor of the improvement we were to put into practicable shape, had engaged a room on the upper floor of an office building, and had ordered an engine lathe, a milling machine, a shaper, a bench lathe, a small bench emery grinder, a portable forge, an anvil, and a three-horsepower electric motor.

Our first aim was to get the shop fitted up ready for work. One machinist was engaged, the machinery put in place, shafting, hangers, pulleys and belting bought, and all set up in running order. About fifteen feet of bench was put up with two vises, and the necessary equipment of small tools and supplies procured, including drills, taps, reamers, counterbores, files, steel, brass, waste, oil, etc. While this work was progressing, the manager went over with the writer, in detail, the previous steps in his invention, its present condition, and his conception of further improvement. Several model machines had been made, mostly in a crude and primitive manner, but the latest one had been made in a well equipped eastern factory. Each model showed distinct progress, yet further improvement was necessary before reaching a practicable stage.

The situation did not permit making complete drawings of the proposed machine before beginning work; it was necessary to take one feature of the machine at a time, such as frame, carriage, levers, type-bars, etc., decide upon it, and get the work started. A jobbing patternmaker was found in the city, and as soon as each part of the frame, that is, side frames, back, front, top, etc., was decided upon, it was drawn,

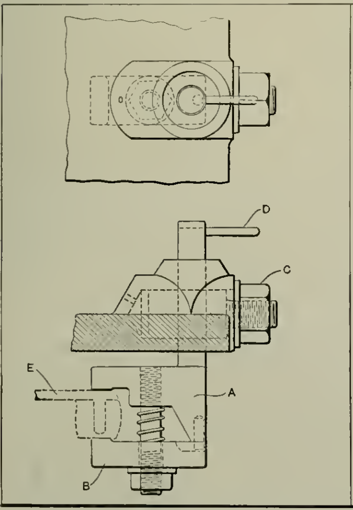


Fig. 2. Auxiliary Clamp for Use in holding Odd Shaped Castings

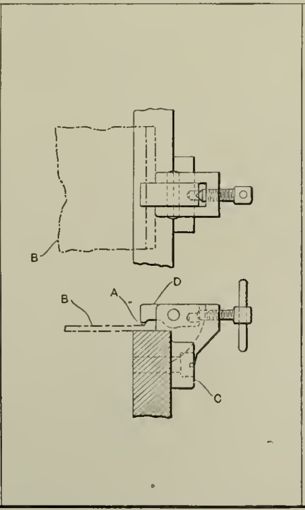


Fig. 3. Special Clamping Device for drilling Rivet Holes

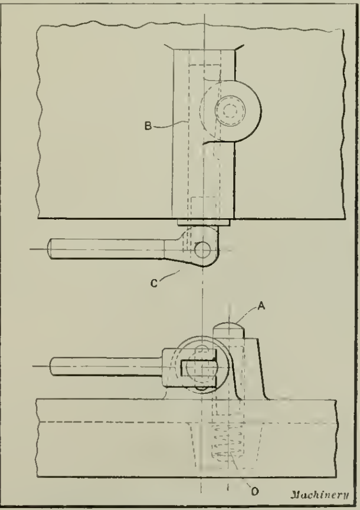


Fig. 4. Adjustable Support for Use in holding Work in a Jig

the pattern made, and castings procured. As soon as the plan was sufficiently developed, another machinist was engaged.

Fortunately, the inventor was not of the typical kind, usually portrayed in literature; on the contrary, we worked together smoothly, he giving his ideas of the improvements to be attained, and not interfering with the technical processes. There were some set-backs, of course; some plans were tried and found not practicable, and had to be changed.

The only parts bought were the roller—commonly, but erroneously called "platen"—and the types; all other parts were cut out of the bars, rods and sheets. Neither of the two machinists employed had ever worked on typewriters or in any shop east of the Mississippi River, yet on October 22, four months from the beginning of operations, the typewriter was finished, at a total cost, for wages and current expenses, of about fourteen hundred dollars.

Brooklyn, N. Y. JAMES DANGERFIELD

JIG AND FIXTURE DESIGN

In the May number of MACHINERY, Charles Staples raises several points in regard to my article on jig and fixture design that was published in the December, 1913, number of MACHINERY. It seems that the points raised by Mr. Staples can properly be made the subject for further discussion, owing to the differences of opinion which exist in regard to this matter. This is particularly true of the question of where square-head screws should be used, where knurled-head screws should be employed, and where a pin should be put through the screw to make it easier to turn.

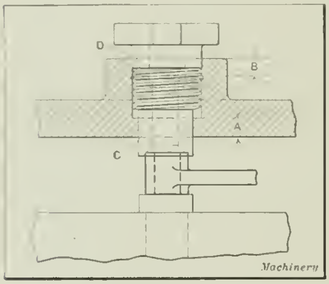


Fig. 1. Design of Bell-mouthed Bushing

Taking up the subject of the bell-mouthed bushing referred to, for which Mr. Staples recommended a substitute, the writer agrees that a bell-mouthed screw bushing of the type shown in Fig. 1 of this article has to be made fairly long for the drill when the bushing is used for guiding drills ¼ inch in size or smaller. This increases the chances of breaking the drill, but whether the breakage which results from this cause is likely to assume serious proportions, is a question which is open to some argument. For guiding drills larger than ¼ inch in size, I do not believe that any trouble with broken drills would result.

Another objection to this clamping device, raised by Mr. Staples, is that chips work into the threads of the bushing and prevent it from turning easily; and the claim is made that this shortens the life of the threads. In this connection, I would call attention to the fact that the bushing is constructed in such a way that chips are excluded from the thread. By not tapping the hole all of the way through, as indicated at *A*; and by counterboring the hole at the top marked *B*; and then grinding the pilot *C* and shoulder *D* on the bushing to a snug running fit, the bushing is held true and chips are excluded from the thread.

It might be well to note that while the writer's experience has shown that the average tool designer has no love for screw bushings and will avoid their use whenever possible, such bushings are frequently selected after careful consideration because of their neat appearance and effective operation. The danger of breaking drills is really not a matter of primary importance because the general run of work with a boss on it, is of such a size that the drills are too large to be easily broken. It also appears that Mr. Staples has been rather hasty in advocating the method of tightening a screw by means of a pin through its head, as shown in Fig. 2, in preference to a hand knob on the screw, as shown in Fig. 3. The method illustrated in Fig. 2 is often used, and it has been the writer's experience that on large fixtures where the pin is ½ inch in diameter and requires the use of both hands, it works very effectively. On smaller sizes of fixtures where the pin is about ¼ inch in diameter by 4 inches long, and must be used with one hand, the pressure is concentrated across the palm of the hand, and if the fixture is used frequently it is likely to develop a sore spot.

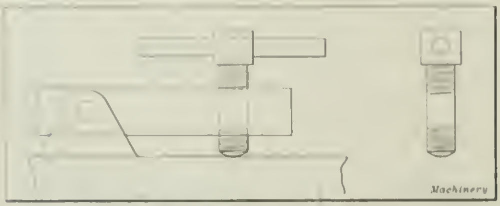


Fig. 2. Binding Screw with Pin through Head

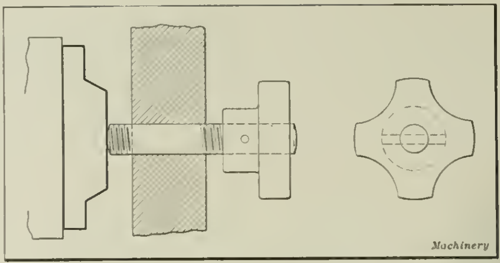


Fig. 3. Hand Knob for Binding Screw that gives Good Results

In the case of the hand knob shown in Fig. 3, however, it is evident that the pressure is distributed over the palm of the hand, and therefore the likelihood of producing a sore is much less. A table of sizes of knobs for different classes of fixtures is presented in this connection. If the writer used a pin and screw as recommended in Mr. Staple's article, the screw would have been made as shown in Fig. 4, with a square head through which the pin passes. The object of this design is to use the pin for turning the screw quickly until it is down in place, and then to make a final clamping by putting a suitable wrench on the square head and tightening the screw down in the usual manner.

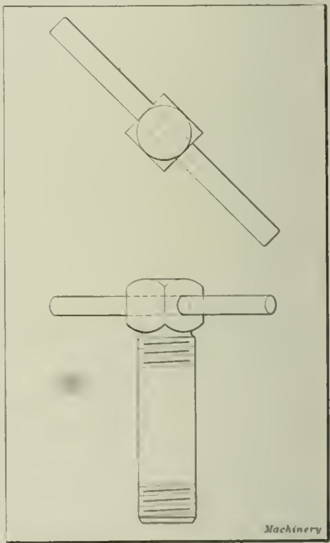
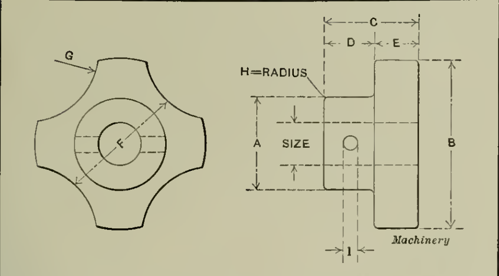


Fig. 4. Square-head Screw with Pin through Head

The questions naturally arise, how much pressure can a man exert with his fingers in operating a knurled-head screw, how much pressure can he develop with a screw and hand knob, and how much pressure can he exert in operating a screw with a pin through it? It is quite safe to say that for continuous operation on jigs or fixtures all that can be depended upon with a knurled-head screw is to bring the screw up to steady the work, but with a screw and pin through it, it is not uncommon to bend the pin. With a hand knob the amount of pressure is doubtful and depends largely upon a man's endurance and the position of the screw, which governs

TABLE OF DIMENSIONS* FOR CAST-IRON KNOBS



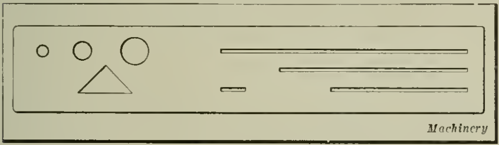
Size	5/16	3/8	1/2	9/16	5/8	3/4
A	11/16	7/8	1 1/16	1 3/16	1 1/4	1 1/2
B	1 1/4	1 5/8	2 1/8	2 3/8	2 3/4	3
C	11/16	7/8	1	1 1/16	1 1/4	1 1/4
D	3/8	1/2	5/8	5/8	3/4	3/4
E	5/16	3/8	3/8	7/16	1/2	1/2
F	7/8	1	1 3/16	1 1/2	1 1/2	1 3/4
G	1/2	9/16	5/8	3/4	7/8	1
H	1/16	3/32	3/32	1/8	1/8	1/8
I	3/32	3/32	1/8	3/16	3/16	3/16

* All dimensions given in inches.

the grip that he can get on the knob. While I cannot see where the pin and screw has any advantage over the hand knob, when suitably proportioned, there seems to be a great difference of opinion as to where to draw the line between the use of a hand knob and of a square-head screw. This matter is often decided by the personal preference of the designer, my experience being that in a jobbing shop where hand knobs are used quite extensively, an occasional request is made for square-head clamping screws. SERVER

ERASING INK LINES

Draftsmen often have trouble in erasing ink lines on bond paper or tracing cloth and if this is not well done an unsightly defect in the drawing will result. Errors will often creep into the work regardless of the amount of care which may be exercised by the draftsman, and as machines and tools are repeatedly rebuilt, improvements are constantly being made which require erasures on the standard drawings. If these changes are not of great magnitude it is much cheaper to make them on the original tracings than to make complete new drawings. On some drawing paper a very sharp knife can be used, but even where the greatest care is taken the surface will be left ragged and no eraser will smooth it down sufficiently to allow a clean-cut ink line to be drawn. The same trouble is experienced in using ink erasers, and those who have had trouble with either method will be glad to hear of a way in which satisfactory results can be obtained.



Shield used to protect Surface of Drawing surrounding Line to be erased

I have found that the green "III Emerald" pencil erasers made by Eberhardt Faber will remove the ink and not injure the paper at all, so far as the surface is concerned; and these erasers will make the paper very little thinner so that after the new lines have been drawn the places where the changes were made cannot be distinguished from the original work, except by looking through the paper and seeing that it is slightly more transparent. More time is required to make an erasure with one of these pencil erasers than if an ink eraser or a knife was employed, but the results are so superior that any draftsman who takes pride in his work will not wish to return to the old method after he has tried the one which I recommend. Most employers and chief draftsmen will be only too glad to have this additional time spent when they see the superior quality of work which is produced.

To avoid erasing too large a space, the well-known device of using a thin piece of German silver or brass 0.002 to 0.005 inch in thickness, with holes of various sizes and narrow slits of different lengths and widths, can be employed to good advantage, so that only those lines which are incorrect will be erased. I have recommended the particular brand of pencil eraser which I use, but there are undoubtedly many other rubber erasers which will give just as satisfactory results.

SIMEON D. WILLIAMS

METHOD OF MAKING AND USING PIERCING DIES

Without wishing to go on record as approving or disapproving of the article entitled, "Improved Doweling Method for Dies," which appeared in the July number of MACHINERY, the writer feels that a few useful features that would be of general interest could be added to a piercing die of this kind. To begin with, the "set edge" or the "jacket," as the writer of the article calls it, which locates and at the same time holds the blank in the desired position preparatory to piercing, should have the top edge rounded as shown at *A*, Fig. 1; for in this way the operator can more readily slip the blanks into place. It also pays to use bevel headed screws to fasten the set edge to the die, as shown at *B*, in order to prevent the knuckles and fingers of the operator from becoming sore by continually coming into contact with the exposed heads of the screws.

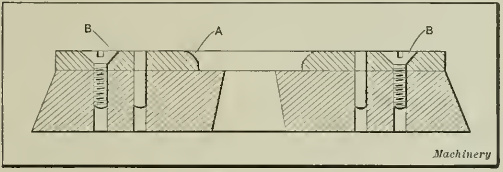


Fig. 1. Method of rounding Mouth of Hole in Set Edge to facilitate placing Blanks

Another point that may be worth while going into is that after the set edge has been filed out to fit the blanks to be pierced (which we will assume are somewhat similar in

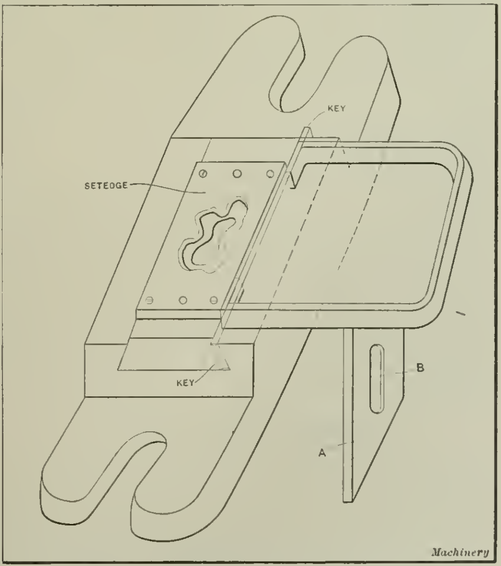
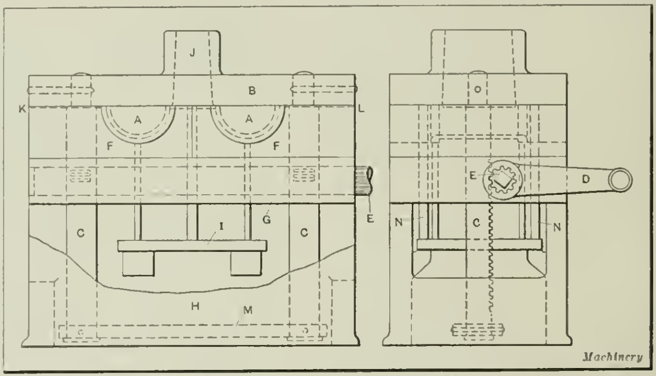


Fig. 2. Type of Container used to hold Work ready to be fed to Piercing Die

shape to the one shown on the top of the die in the article referred to), a scrap punching from the piercing die is laid with the burr-side down on the top of the blank. After the punching has been laid on the blank in the desired position, the outline of the punching is scribed on the face of the blank, and the blank is then slipped into the set edge which is adjusted on top of the piercing die so that the scribed outline of the punching coincides with the irregular shaped hole in the piercing die.

The set edge is then clamped tight to the die, and the position of the tapped holes in the die are readily transferred to the set edge, as the holes are drilled all the way through. Before countersinking the holes in the set edge, it often pays to fasten it to the die with four fillister-head screws and then pierce a few blanks to see if it is in the right position, so that in cases where extreme accuracy is required it can be shifted if desired. After the set edge has been found to be in the right position, the holes for the set pins are drilled and the pins are driven into place. The temporary screws are then removed and the screw holes countersunk.

When piercing blanks or shells that are fed to a die of this kind by hand, the adjustable container for holding them is most useful, for the reason that the container can be so adjusted as to be flush with the top of the set edge, which makes it an easy matter to slide the blanks or shells into the set edge. In most cases this is done by pushing the work in with a small stick, which not only helps to increase the output but also helps to make the job a great deal safer. This container, as shown in Fig. 2, is held in place by the angle piece *A* which is fastened to the bed of the press by cap-screws through the elongated slot *B*; or if the press is a bench power press, the container is fastened to the bench by lag-screws. Two screws in connection with two elongated slots, together with the slot *B*, allows for any desired adjustment. In cases where the work is fed to the die without the aid of a container or other similar device, the usual procedure of the operator is to pick up a handful of the blanks with the left hand and lay them in the set edge with the right, which is a slow and rather dangerous method.



Improved Form of Mold for casting Two Babbitt Bearing Liners at a Time

By using the container, the blanks are readily turned right side up and arranged in line one after the other with one hand, while the other hand slides them into the set edge by the aid of a stick, as previously explained. Another feature of a container of this kind is that it can be used with any number of different kinds of jobs, and does away with the necessity of making a special fixture in order to enable the operator to feed the blanks to the dies readily; also, it can be made suitable for a larger class of work by using two angle pieces similar to the one shown at *A* in Fig. 2, thereby making the container stronger and more serviceable.

Waterbury, Conn. CHARLES DOESCHER

BABBITT BEARING MOLD

Under the title "Babbitt Bearings" in the December number of MACHINERY a pouring mold (Fig. 2) was shown which, in the opinion of the writer, can be considerably improved and thereby produce a higher grade of castings more rapidly. It will be noted that in the pouring position of the mold referred to in this article, the bearing is horizontal and gated at the flange, and that the metal in entering the mold has a tendency to splash and divide into two or more streams. The result is that air is likely to be trapped and so produce a large percentage of porous castings. Denser castings can also be produced by increasing the height of the pouring nozzle, so that the weight of the excess metal will exert a pressure on the bearing as it solidifies and shrinks. In his experience, the writer has found that the hinged construction mold, as illustrated in the article referred to, is exceedingly unreliable. The pressure being applied at the handles, the edge along that side will always be kept tight shut; but the joint on the hinge side will have a tendency to open, the opening increasing with the wear in the hinge, and in a comparatively short time a leakage of babbitt will take place at that point.

The accompanying illustration represents a multiple mold which overcomes the defects mentioned and is especially adapted for quantity production. The cores *A* form the inside as well as the over-all length of the bearings, and projections can be milled on them to cast any desired form of oil grooves. These cores are doweled and screwed to the cover plate *B* which is raised and lowered by the racks *C*. The racks are made of round stock with teeth milled on a flattened surface, and are operated by the lever *D* which turns the pinion *E*. The outside of the bearings is formed in the blocks *F* which are fastened to the plate *G*, and the entire mold is mounted on a cast-iron base *H*. The shrinkage between the flanges will usually cause the castings to stick on the stationary part of the mold and means must be provided for ejecting them. For this purpose ejector plate *I*, which in the casting position rests on four lugs of base *H*, carries an ejector pin located under each flange of the bearing. A nozzle *J* which is tapered inward directs the metal to the side of each bearing, while on the opposite sides, at *K* and *L*, openings about 0.010 inch deep and extending the full length of the bearing should be provided to permit the air to escape from the mold as it is filled.

The operation of the mold is as follows: When the castings solidify, the handle *D* is operated, thereby raising the cover plate *B* about 5 or 6 inches. Further movement causes the strip *M* connecting the racks *C*, to engage and raise the ejector plate *I* and thus eject the finished castings. When the cover plate is lowered again, it strikes against two heavy pins *N* which are mounted on the ejector plate *I*, and the latter is thus brought back to its normal position on the lugs of the base *H*. The mold is then ready for another casting.

In this form of construction only a small additional expense is involved in producing a mold for making two castings at a time. For example, the space for the outside of the bearings, which is purposely shown on two separate blocks *F*, can readily be machined at the same time by clamping them together for the boring operation. Likewise the two cores *A* can be screwed together for performing the turning and milling operations. And surely the increased production will many times offset the small additional cost of a double mold. In the operation of the mold good results will be obtained if a strong yellow gas flame is directed against the mold from time to time. A coat of carbon will be deposited in this way which helps the babbitt to flow more freely.

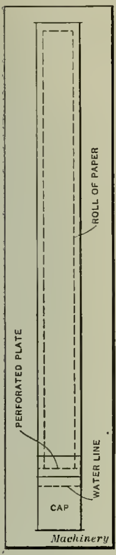
S. SCHRAM

SHOP AND DRAFTING-ROOM KINKS

INGENIOUS MEANS AND SHORT CUTS FOR SAVING LABOR AND MATERIALS

RESTORING VAN DYKE PAPER

We had a roll of Van Dyke or black process paper which was not used very frequently and finally became so dry and brittle that it could not be handled. After trying various schemes for restoring it, the following method was found very satisfactory. A tin tube of the kind used for keeping blueprint paper was employed; the cap of this tube was divided into two sections as shown in the accompanying illustration, which were separated by a perforated plate. The lower section of the cap was nearly filled with water, after which the roll of paper was placed endwise on the perforated plate and the tube slipped over it onto the cap. In this way the roll of paper was held in a very humid atmosphere, and after remaining there for thirty-six hours, it was found that the moisture had penetrated the roll and made the paper so pliable that it could be easily handled.



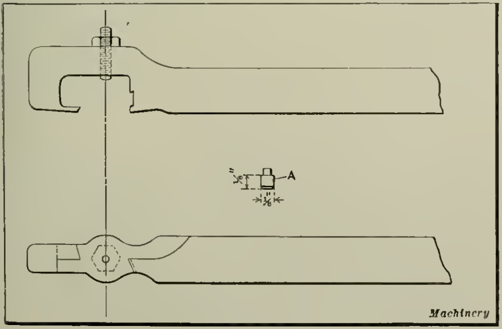
Restoring Van Dyke Paper

Another useful kink for the drafting-room is found in our practice in regard to pencil sketches which are sent out to the shop. It is frequently desirable to retain a copy of these sketches in the drafting-room, and although the originals could be returned, they are sometimes lost and if not lost they are generally so badly soiled that they are hardly worth keeping. We have found it good practice to make carbon copies of all pencil sketches, these copies being preserved in the drafting-room. No extra time is required for this, the only additional expense involved being the cost of the paper. For this purpose unprepared blueprint paper is very satisfactory; it is not costly, and as it is both white and smooth it takes the carbon lines very well. If sheets of carbon paper large enough for the entire drawing are not available, several sheets can be joined with thin adhesive tape. It is a good plan to keep these carbon sheets on hand in sizes to correspond with all the standard sizes of drawings that are used in the shops.

Aurora, Ill. **E. J. G. Phillips**

COMBINATION CUTTING OFF AND FORMING TOOL

We were called upon to make five hundred small brass studs of the form shown at *A* in the accompanying illustration, and as we did not have a screw machine for this purpose, I devised the tool which forms the subject of this article and used it with very satisfactory results. The tool was made of ⅜-inch drill rod and used in the toolpost of a Rivett lathe. After setting the tool to the proper height and setting the stop on the cross-feed, it was merely a matter of working the cross-feed backward and forward to first form the stud and then cut it off with the two cutters of the tool. After cutting off a finished stud, the bar was advanced until it engaged the stop on the tool, after which the next piece was formed and cut off, the lathe being used in the same way as a hand screw machine. The studs were made of ⅛-inch round brass stock and it was important that their heads should be exactly ⅛ inch in length. By the use of this tool and method of procedure very satisfactory results were obtained.



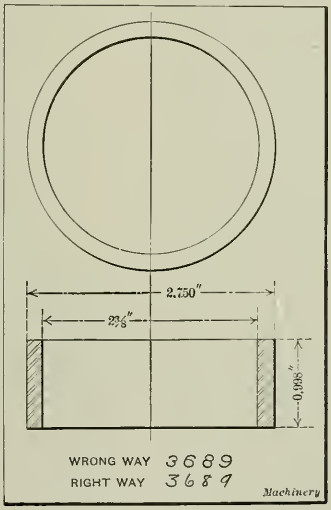
Combination Cutting Off and Forming Tool for making Stud A

Philadelphia, Pa. **Fred Henke**

THE RIGHT WAY TO MAKE FIGURES

A short time ago an order went into our shop for a ring to be made in accordance with the design which is presented herewith, but when the work arrived at the inspection table the width was found to be 0.866 inch instead of 0.998 inch, the dimension having been read upside down. While the drawing was theoretically correct, the mistake would not have occurred if the correct reading had been suggested. This incident led us to adopt the following rules in regard to making figures. The 3, 6, 8 and 9 must be made like those in the illustration marked "Right Way"; when made the "Wrong Way," the 3 may be mistaken for an 8 and the 6 and 9 may be read upside down and so mistaken for each other. Furthermore, the 8 made the wrong way is of no assistance in helping one to read the other figures correctly.

The essential features of the figures made the right way are as follows: The top of the 3 should be sharp instead of round. The 6 should be made with a large curve at the lower left-hand corner, and with a rather small loop which is well away from the initial vertical stroke of the figure. The ends of the 8 should cross each other to avoid confusing the 8 and 3. The 9 should have a sharp point at the top to distinguish it from the 6. With figures that are carefully made in this way it is hard to imagine any confusion in reading them, even if there are no decimal points or inch marks to serve as a guide. The only possibility of error would be in the case of a number made up entirely of ones or noughts, and even in the case of the figure 1 we may add a "hat" and a "pair of shoes," making the figure in the way it appears in ordinary type. It seems, however, that there would be little justification in going to this extreme.



Right and Wrong Ways to make Figures

Franklin, Pa. **William O. Milton**

* * *

The greatest item in the export trade of the United States is raw cotton, which in 1913 amounted to more than half a billion dollars. The next largest item is food stuffs, amounting to $176,000,000; the third largest item is copper, amounting to $100,000,000; and the fourth largest item is oil—petroleum and all its by-products—amounting to $49,000,000.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

MECHANICAL POWERS

H. A. W.—What are the five mechanical powers?

A.—The five mechanical powers were defined in the old books on mechanics as the lever, the screw, the wedge, the inclined plane and the pulley. The wedge, the inclined plane and the screw are essentially one and the same. A screw is simply a cylinder with an inclined plane wrapped around it and, of course, an inclined plane and a wedge are the same. The pulley is but another form of the lever; hence, there are really only two mechanical powers so-called, the lever and the wedge or inclined plane.

STEEL PISTON RINGS

F. W. S.—I am interested in obtaining information relative to the use of packing rings of forged steel for steam engine pistons, and have searched the text-books on machine design and steam engine design, etc. with little reward. I found steel piston rings alluded to in some of the books, but no definite statements of the extent they are used or of the satisfaction they give. Common cast-iron packing rings cause considerable trouble by breaking frequently and cutting the cylinder after they break. I shall appreciate any information that you can give on making forged steel piston rings, their durability, etc.

A.—Steel piston rings are seldom used in stationary steam engines or locomotives, but are used generally in steam hammer pistons, because cast-iron rings are quickly broken by the excessive shocks; it is generally conceded that under usual conditions cast iron is the best material available for piston rings inasmuch as cast iron in contact with cast iron wears better than with steel. However, improved foundry practice has produced a cast iron that wears well in contact with steel, and certain automobile concerns are now building motors in which steel piston rings are successfully used. Steel rings for steam hammer pistons are bent with rollers to the desired circular shape, and after having the ends fastened together either by welding, brazing or pinning, are machined and then cut apart. Any reader having had experience with the making and use of steel piston rings will confer a favor by contributing an article on the subject.

CASTING MONEL METAL

P. J. A. D.—Where can I obtain information on casting monel metal? I have been trying to make monel metal castings 1½ inch by 10 inches long, but without success. The castings, when poured, look fair and solid, but on breaking the skin they are found to be full of blow-holes. The metal melts at high temperature and requires a very refractory sand. I use a mixture of Jersey sand, coarse sharp sand, old crucibles ground up, a small amount of fireclay and flour as a binder, with a little ground coke to make the mold porous. I have taken the precaution to provide a high head and to pour the castings on end. The molds are perfectly baked, well vented and were poured warm, no facing being used on the mold except plumbago.

Answered by E. F. Lake, Detroit, Mich.

As monel metal is a natural alloy made direct from an ore containing nickel, copper and iron, its chemical composition varies considerably. Its nickel content varies from 65 to 75 per cent, copper from 25 to 30 per cent, and iron from 0.40 to 5.25 per cent. This variation in composition causes difficulties that are not encountered when casting alloys with definite compositions. In one case eight propeller wheels were cast and scrapped before a good one was made for one of the battleships of the U. S. navy.

It is difficult to distinguish monel metal from pure nickel, but its cost is considerably lower. This low cost has caused it to be used in many places where non-corrosion is desirable. It is not equal to some other metals and alloys in this regard, but it has considerably more strength and resistance to fatigue than brass or bronze compositions. Its physical properties are about equal to high grade steel castings. When subjected to a rise in temperature, it loses its strength more slowly than metals ordinarily used. At 1000 degrees F. it has lost only about 20 per cent of its strength. Most metals have lost more than 40 per cent at this temperature, and many of them are practically useless; 1000 degrees F. seems to be a critical point, however, as monel metal rapidly loses its strength after that temperature is passed.

It acts somewhat like steel when it is made into castings and hence many of the same rules are applied. The greatest difficulty encountered is that of blow-holes. The nickel content has the greatest influence on the metal and its melting point is but 160 degrees below that of pure nickel, namely 2480 degrees F.; this is but 70 degrees below the melting temperature of steel. Its high shrinkage, one-quarter inch to the foot, makes it advisable not to have the temperature of the molten metal over 3000 degrees F. when it is poured into the molds. If this temperature falls much below 2800 degrees F. there are likely to be cold-shuts in the mold. While monel metal may be melted in any form of furnace that will withstand these temperatures, an oil-fired furnace gives the best results, providing the fuel is an oil that is low in sulphur. Sulphur has a very injurious effect on monel metal and should be kept as low as possible; so also has an oxidizing atmosphere in the furnace. Thus the flames should be made neutral or reducing.

When the metal is at the right temperature to pour and the crucibles have been taken from the furnace, tongs should be used to push metallic magnesium to the bottom of the bath as quickly as possible. The magnesium should then be well stirred into the molten metal. One and one-half ounce of magnesium should be used for every hundred pounds of monel metal. This must be done each time the monel metal is melted, if blow-holes are to be avoided. The molten metals should then be allowed to stand for a few minutes while the magnesium is impregnating the bath and raising the impurities to the top, so that they can be skimmed off before pouring. Monel metal melts quickly, and when it is poured into the molds it sets rapidly. Castings should therefore be poured on end to insure quick feeding and the maximum amount of pressure from heads and risers.

In the making of molds practically the same rule should be followed that is used in making molds for steel castings. The same sands should be used in order to take care of the high melting temperature and the molds should be constructed so that the gases will leave the solidifying metal as freely as in steel castings. The patterns should have liberal fillets to assist in the flow of metal and to help overcome any defects that might be caused by the contraction due to the high shrinkage.

* * *

HISTORY OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

A history of the American Society of Mechanical Engineers from 1880 to 1914, including the present administration, has been prepared by Prof. F. R. Hutton who was secretary of the society for twenty-four years. The history will contain over two hundred pages 6 by 9 inches and will be illustrated by over fifty photogravures of former presidents and the executive officers, views of the headquarters, etc. The price of the history has been fixed at $5 a volume with the understanding that if over four hundred copies are subscribed for the price per volume will be reduced.

* * *

A contributor of an article recently published in MACHINERY received many letters in regard to it, requesting more information, advice, etc. The contributor was quite willing to give additional information although it involved considerable labor, but he very properly objected to using his own postage for the correspondence. It is always a matter of business courtesy to enclose stamps or a stamped envelope for reply when information is requested of an individual who has nothing to sell and who could expect no profit to result from the correspondence.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

GORTON UNIVERSAL ENGRAVING MACHINE

This is a universal machine adapted for all classes of engraving and profiling which come within its range. It operates on the familiar pantograph principle in which a tracing point at one end of the pantograph follows an accurate "copy" of the design to be engraved, and causes the engraving tool to make an accurate reproduction of this copy to a specified scale. The work-holder may be set at any angle from perpendicular to 15 degrees beyond the horizontal, thus affording an ample range of settings for engraving on various classes of work. The following article explains the method of operation and gives a good idea of the rate at which work can be produced.

In the following description of the universal engraving machine which has recently been placed on the market by the George Gorton Machine Co., Racine, Wis., the method of operation is explained by referring to various examples of tire molds which have been engraved on it. This is quite a natural course to follow, as the machine was primarily developed for the purpose of engraving molds used in the manufacture of automobile, motorcycle and bicycle tires. It must not be assumed, however, that this is in any sense a special tire mold engraving machine, as it is fully universal and adapted for a great variety of engraving and profiling operations of the character met with in die-sinking, toolmaking and certain manufacturing operations. It works on the familiar pantograph principle, as employed in other engraving machines of this company's manufacture, where a tracing pin at one end of the pantograph is guided over a carefully prepared copy of the design which it is desired to reproduce on the work, and the engraving tool at the opposite end of the pantograph accurately reproduces this design. In other Gorton engraving machines the relation of the size of the copy to the size of the work produced may be varied by adjusting the pantograph mechanism, but in the present case the size ratio between the copy and the work is maintained at 3 to 1.

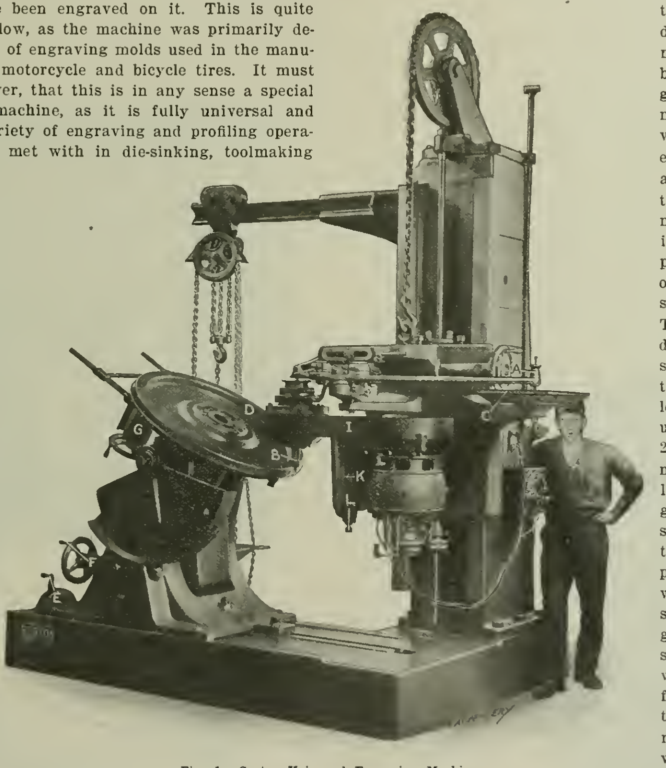


Fig. 1. Gorton Universal Engraving Machine

The engraving machine is shown in Fig. 1, and referring to this illustration the tracing pin will be seen at *A* and the engraving tool at *B;* the copy to be followed is secured to the holder *C*, while the work is clamped to the index-plate *D*. It will be seen that the copy is held horizontally and the workman stands on an adjustable platform—not shown in the illustration—which is at such a height that he can conveniently watch the progress of the tracing pin over the copy. It will be noticed that the index-plate *D* may be set at any convenient angle for handling the work, this angular setting being obtained by the handle *F* which turns the worm and segment. The handle *E* provides for adjusting the position of the workholder for various diameters.

Fig. 3 shows half of a mold for use in the manufacture of Goodyear "chain tread" tires, which was engraved on the new Gorton machine, and an idea of the rate at which the work can be done will be gathered from the fact that the engraving of the chain was completed in 2½ hours, while the engraving of the nameplate and address of the Gorton Machine Co. required ½ hour. The work is 36 inches in diameter and the depth to which the chain was engraved 3/10 inch. The copy used for this engraving operation and the engraving tools employed are illustrated in Fig. 4. It will be seen that the copy is in three parts which are marked Operation 1, Operation 2 and Operation 3, respectively. The first part of the copy is used for roughing out the impression of two adjacent links. The second part is used for rounding the edges and deepening the cut in the connecting link. The third part is used for rounding the edges of the flat link, *i.e.*, the link the impression of which appears to be lying on its side.

A brief consideration will make it evident that the work must be indexed to bring it under the engraving tool, and means must be provided for moving the engraving tool on the arc of a circle owing to the fact that the mold is concave. The indexing is accomplished by the hand-operated mechanism shown at *G* in Fig. 1. This consists of a drum mounted on a shaft that is turned by the handwheel at its lower end. At the upper end there is a 20-tooth spur pinion—not shown in the illustration—which engages a 480-tooth spur gear secured to the back of the faceplate on which the work is carried. The size of the pinion and gear makes it necessary to turn the handwheel through twenty-four revolutions to obtain one complete revolution of the work. To provide for moving the work through fractional parts of a revolution, the drum *G* has a square thread or helix cut on it, which makes twenty-four complete turns. At the bottom of this thread or helix holes are drilled, a special drum being made for each engraving operation, which has the same number of holes as the number of divisions for which it is required to index. A spring plunger is provided that can be locked up out of engagement with the holes, although it cannot be lifted high enough to clear the thread; and when the plunger is down in one of the holes, it locks the mechanism and work in position for the engraving operation. The reason for this construction is to prevent the possibility of mistakes occurring in indexing.

To explain the operation of the indexing mechanism, sup-

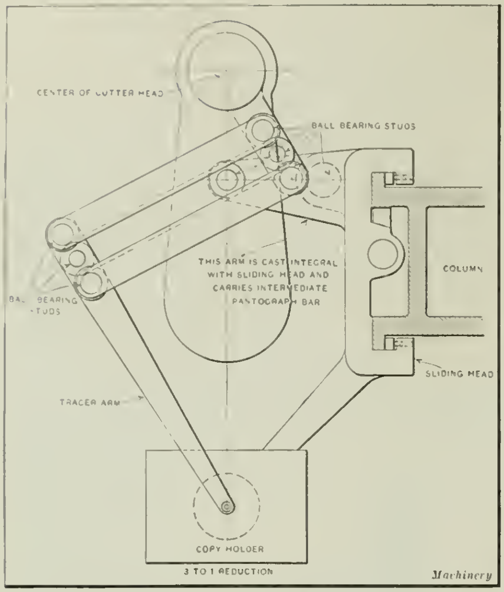


Fig. 2. Arrangement of Pantograph Mechanism for a Fixed Reduction of 3 to 1

pose it is required to engrave fifty "links" in the mold illustrated in Fig. 3. A drum would have to be made for this job with fifty holes equally spaced on the helix. Owing to the nature of the work, the operator cannot see the cutter and he depends on the micrometer collars on the feed-screws to get the required depth. But despite this fact, he must occasionally inspect the work to see that satisfactory results are being obtained, and to facilitate doing so a boy is stationed at the index head to rotate the index-plate and work to bring the section on which the tool was working into view. To do this he lifts the pin out of the hole in the index drum and locks it up so that he can turn the work by rotating the handwheel. When he lifts the index pin out of the hole and before starting to turn the work, the boy sticks a hard wood plug into the hole from which the pin has just been removed. When the inspection has been completed he turns the index plate back quickly to the original position, and the pin which follows the helical groove in the drum hits the wooden plug, breaks it off and drops into the hole, pushing the end of the plug out into the hollow drum. The arrangement is simply a "fool proof" device that enables a boy to be employed to look after the indexing, thus conserving the time and strength of the machine operator. Without this arrangement it would be difficult to find a station on the index drum after once leaving it, but no difficulty has been experienced in following the method of procedure which has been adopted.

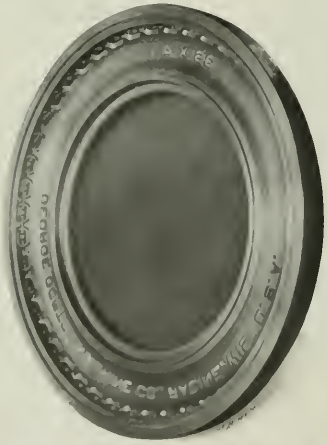


Fig. 3. One-half of a Goodyear "Chain Tread" Tire Mold engraved on Gorton Machine

In engraving tire molds and other classes of work for which this machine is adapted, it is necessary to be able to locate the work at different angles according to the position in which the engraving is being done. For instance, in engraving tire molds the manufacturer's name is engraved in the mold in a position corresponding to the side of the tire, while the cavities in the molds used for making "non-skid" tires are naturally located on the tread. It has already been mentioned that the handle *F* provides for setting the work at the different angles that may be required. For instance, in milling the links in the half mold shown in Fig. 3, the work-holder was set at an angle of 65 degrees. The work-holder is of exceptionally heavy construction and provided with a rotating spindle, on the nose of which faceplates of any required shape or size may be mounted. The faceplate spindle bearings are mounted in trunnions to provide for making the angular adjustments previously referred to, the range of such adjustment being from a vertical position to about 15 degrees beyond the horizontal, the total angular movement provided being sufficient to present any part of the interior of the mold normal to the cutter.

The "copy"—as shown for a chain tread tire mold in Fig. 4—guides the engraving tool in a horizontal plane, but owing to the fact that the mold is concave, means must also be provided for guiding the tool vertically. For this purpose a templet of the proper form is provided, as shown at *H* in Fig. 1. At the top of the spindle in which the engraving tool is carried, there is a point which runs over this templet; and in this way the vertical position of the tool is controlled as it is guided over the work by the pantograph. The vertical cutter spindle is mounted in the frame *I* and the motor which drives the spindle is also supported by this frame, the motor being belted to the spindle. The motor and spindle mechanism are supported on the link *K*, which, in turn, is carried by the pivot *L* and a similar pivot on the column slide. These

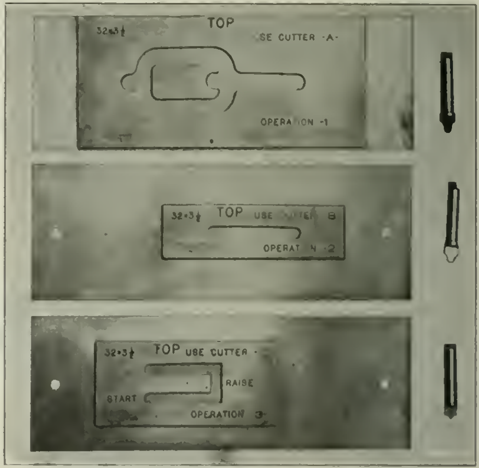


Fig. 4. "Copy" and Tools used for engraving Tire Mold shown in Fig. 3

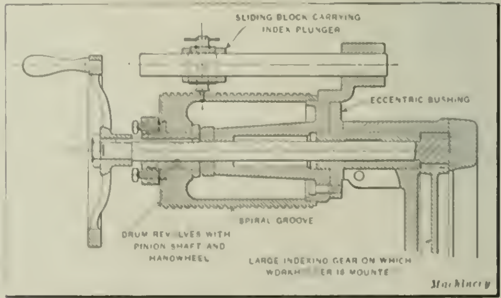

SLIDING BLOCK CARRYING INDEX PLUNGER
ECCENTRIC BUSHING
SPIRAL GROOVE
DRUM REVOLVES WITH PINION SHAFT AND HANDWHEEL
LARGE INDEXING GEAR ON WHICH WORKHOLDER IS MOUNTED
Machinery

Fig. 5. Index Mechanism—a Special Drum is made for Each Job

pantograph pivots are fitted with radial and thrust ball bearings so that the movement is very sensitive.

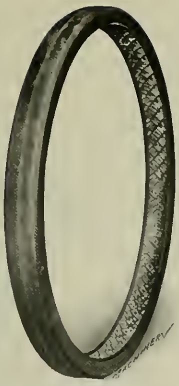


Fig. 6. "Non-Skid" Tire Mold engraved on Gorton Machine

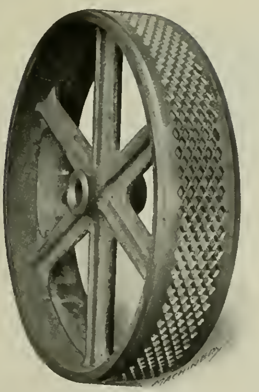


Fig. 7. Mold for "Diamond Tread" Tire made by forming Rubber before cementing it to Tire Foundation

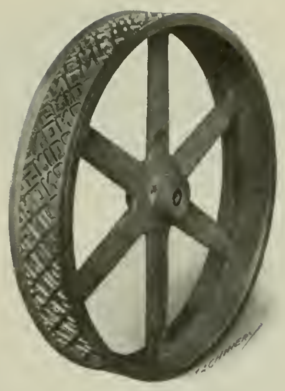


Fig. 8. Mold for "Non-Skid" Tire when made by forming Rubber before cementing it to Foundation

Figs. 7 and 8 show another form of mold used for forming the treads of rubber tires, which can also be engraved on the new Gorton machine. Here the design is cut on the periphery of a drum and the sheet of rubber for the tread is wrapped tightly around this engraved drum and partially vulcanized. It is then stripped from the drum, reversed and wrapped around the tire foundation and shaped to it, after which the rubber is vulcanized with the tire fabric and firmly cemented to the foundation. The fact that work of this character can be engraved on the same machine as that used for producing molds of the form shown in Figs. 3 and 6 goes to show the wide range of work for which it is adapted.

Bicycle tire molds are made in one piece and while being engraved are held in the fixture shown in Fig. 9. This is not an indexing fixture, and when it is necessary to reset the work, the clamps are loosened for this purpose and the mold is moved around by hand to bring it into position to continue the engraving. As it is impossible to cut all of the design and lettering in a one-piece mold with the work held at any one angle, means are provided for reversing the angle of inclination so that after one side of the mold has been engraved, it may be reversed ready for engraving the opposite side. It will be seen that the clamping ring is mounted on trunnions which are graduated in degrees to provide for obtaining the required angular setting. Each trunnion is provided with a short slide *M* so that the center of the arc of the mold can be made to correspond with the axis of rotation. The circular nuts seen at the outside are provided for the purpose of clamping the trunnions to hold the work in any required position.

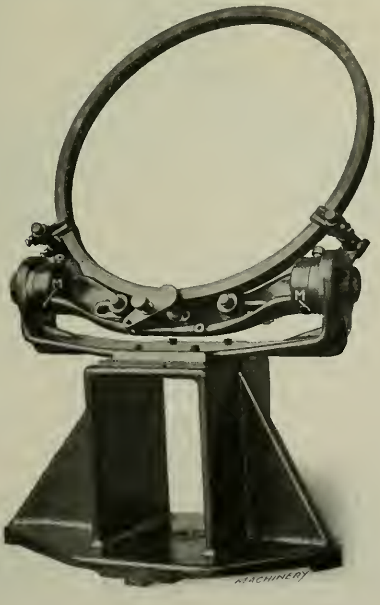


Fig. 9. Non-indexing Fixture used for engraving Bicycle Tire Molds

The spindle of the cutter head is driven by a three-horsepower variable speed motor with the controller mounted on the column of the machine, as shown in Fig. 1, and sliding adjustment is provided to maintain the required belt tension. The entire mechanism of the machine is carried by the sliding head which has a vertical adjustment of approximately 4 feet on the scraped ways on the column. The adjustment is regulated by a handwheel which is fitted with a micrometer collar reading to 0.001 inch. The feed-screw has a ball bearing to take the thrust, and the head is counterbalanced by a weight located inside the column, the counterweight being supported by a chain as shown. The column is of box construction and the ways are accurately scraped to surface plates. The height of the column is about 9 feet and the thickness of the walls 1 inch. It will be seen that a small jib crane is provided for use in lifting heavy pieces onto and off of the index plate. The baseplate is a heavy one-piece casting which is heavily ribbed throughout, and the column is secured tó this base casting by six 1½-inch bolts. The indexing work-holder is also secured to this base casting and provided with means of adjustment for handling work of various diameters in the manner previously referred to.

A good idea of the capacity of the machine will be gathered from the fact that all types of molds for all sizes of tires up to 48 inches in diameter can be engraved on it. To emphasize the fact that the machine is fully universal in its application, it will not be out of place to mention that it is used for engraving the tire maker's name on the side of the mold and for engraving the impressions for various forms of treads used on non-skid tires. Sufficient power is provided to drive a high-speed steel cutter 1 inch in diameter to the limit of its capacity. In regard to the rate of production, a letter S 1½ inch high was engraved with a ⅜-inch cutter to a depth of 5/16 inch in four minutes, the material in which the engraving was done being a concave forged steel ring. The same letter was engraved in cast iron in 1½ minute. The principal dimensions of the machine are as follows: height, 12 feet, floor space occupied, 5 by 9 feet, and net weight, approximately 18,000 pounds.

DODGE SAFETY CLUTCH

The multiple disk friction clutch which forms the subject of this article is a recent product of the Dodge Mfg. Co., Mishawaka, Ind. The mechanism is completely enclosed so that there are no projecting moving parts to cause accidents by catching the clothing of the workmen. Having the mechanism enclosed in this way provides a perfectly smooth contour, and the use of cumbersome and unsightly makeshift safeguards is eliminated. The design of the roller toggle operating mechanism and the materials used for the multiple friction disks, make this clutch exceptionally powerful for its size. The rollers on the toggle levers travel on conical surfaces which are arranged to give a high driving pressure

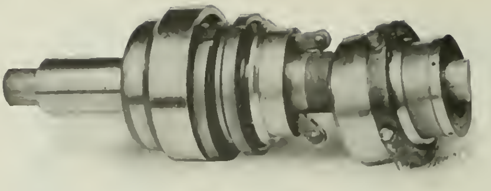


Fig. 1. Parts of Dodge Safety Clutch

on the friction disks with the minimum amount of mechanical friction. The use of rollers in place of sliding parts makes the clutch easy to operate and it is claimed that the action of centrifugal force tends to keep the clutch disengaged when it is thrown out.

The clutch is automatically lubricated by means of an oil ring which revolves in a large reservoir and carries up a continuous supply of oil which is circulated through suitable grooves to all parts of the bearing on which the pulley is mounted. The oil reservoir is completely sealed so that oil cannot work out into the mechanism of the clutch. The shifter ring is made with a channel section which serves to retain the oil and insure positive lubrication at this point at all times. The clutch is easily adjusted by means of a single nut. Backing off this nut permits of the removal of the operating cone to expose the toggle mechanism; and this also permits of the removal of the entire inside mechanism for making adjustments. The clutch occupies only a small amount of space on the shaft and requires very little attention to keep it in a satisfactory working condition. It may be easily applied to stationary or portable tools and is also well adapted for use on countershafts, pulleys, gears, sprockets, etc. The design and construction have been worked out in a way which makes this clutch particularly suitable for high-speed transmissions.

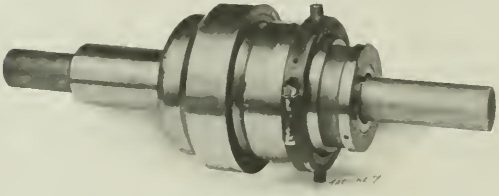


Fig. 2. Dodge Clutch assembled ready for Operation

"THOR" ELECTRICAL GRINDER AND DRILLS

The portable electrical grinder illustrated in Fig. 1 is a recent product of the Independent Pneumatic Tool Co., Thor Bldg., Chicago, Ill., and is particularly adapted for grinding castings, polishing, buffing, etc. Reference to the illustration will show that a wheel guard is provided to insure the safety of the operator in the event of a wheel's bursting. The grinder has a free speed of 4500 revolutions per minute; the wheel is 4 inches in diameter by 3/4 inch wide and the weight of the tool is only 16 pounds.

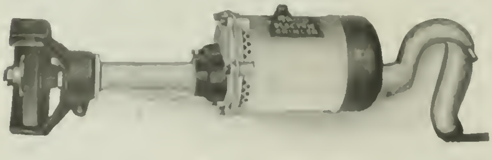


Fig. 1. "Thor" Electrical Grinder

In the November, 1913, number of MACHINERY, the No. 000 portable electrical drill of this company's manufacture was illustrated and described. This tool has a capacity for driving drills up to 1/4 inch in diameter. Since the publication of the preceding article, the Independent Pneumatic Tool Co. has added to its line four other sizes of electrical drills, the largest of which has a capacity for driving drills up to 7/8 inch in diameter. Fig. 2 illustrates the No. 00 tool which has a capacity for drills up to 5/16 inch; and in Fig. 3 the No. 2 tool is illustrated, the capacity of which is for drills up to 3/4 inch. The drills are equipped throughout with ball and roller bearings.

The motors used on these tools are of the series wound repulsion type, and may be provided for use on either alternating or direct current. The motor is cooled by an aluminum fan which is keyed to the armature shaft and the power is transmitted by a pinion screwed onto the armature spindle. This arrangement enables a new pinion to be easily substituted in case of damage. Different users of these drills require them to run at various speeds, and on this account three sets of gears are manufactured, any one of which may be supplied with the drill to give the high, intermittent or slow speed, as required. A center-plate is placed between the gears and the motor, making it possible for the gears to be packed with grease without the lubricant getting into the motor. This center-plate also takes the end thrust of the spindle. The spindle runs in annular ball bearings which afford the maximum of transmission efficiency and smooth running properties.

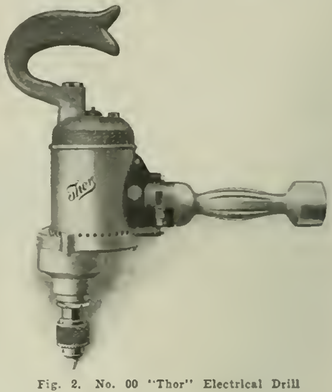


Fig. 2. No. 00 "Thor" Electrical Drill

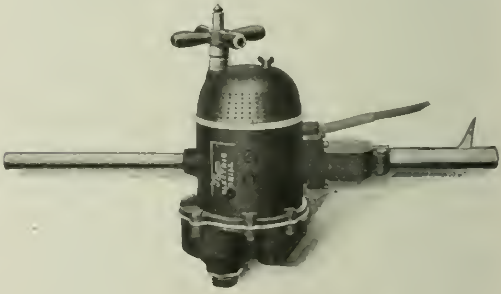
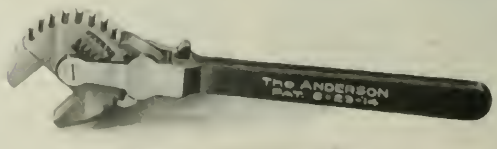


Fig. 3. No. 2 "Thor" Electrical Drill

ADJUSTABLE RATCHET WRENCH

The Adjustable Ratchet Wrench Co., Room A, 1651 Marquette Bldg., Chicago, Ill., is now manufacturing the "Anderson" adjustable ratchet wrench which is illustrated and described herewith. The jaws of the wrench are opened or closed to fit any size of nut or bolt by the worm in the center, and this means of adjustment eliminates the necessity of having an assortment of different sized wrenches. The ratchet works at either side. This wrench is particularly convenient for use in places where space is limited. It is made in 6-, 8- and 10-inch sizes, with either a plain finish or nickel plated. The material is casehardened drop-forged



"Anderson" Adjustable Ratchet Wrench

steel. Mechanics will find this wrench especially useful in assembling machinery and it will also be found valuable in plants where the machines require frequent adjustment.

J. H. WILLIAMS & CO.'S TOOL-HOLDERS

Reference to the illustrations of these tools will make it evident that the cam fastening for the cutter is one of the important features. The cam used for this purpose has a very gradual rise so that a powerful grip is secured, and difficulties arising from broken set-screws are eliminated. The features of the boring tool are the elimination of the necessity for using bushings with different sizes of bars; and the single cap that serves for holding both straight and angular cutters. The threading tool may be used either as a solid or a spring tool. The planing tool provides fine adjustment and easy means of setting, together with great strength and durability.

J. H. Williams & Co., 61 Richards St., Brooklyn, N. Y., is now manufacturing a line of tool-holders which includes turning, cut-off, side-tool, boring, knurling, threading and planing tools. A great deal of time and experimental work has been devoted to the development of this line for the purpose of overcoming all weak points. The holders or shanks are drop-forged from a strong tough grade of steel, after which they are carefully heat-treated to refine the structure of the metal and give it the necessary strength and resistance to wear which is required to successfully meet the class of service performed by the average tool-holder. Those who have had experience in the use of tool-holders in which the cutter is held in place by a set-screw know that trouble is frequently experienced through the breaking of the screw. When this happens it is a difficult matter to remove the broken part of the screw from the holder because the screw is bearing against the cutter and the back pressure locks it in the thread. An investigation of workmen's time cards in many shops has shown that it is not an uncommon occurrence for a man to spend more time on the removal of a broken set-screw than the entire tool-holder is worth. Furthermore, it is often found necessary to anneal the screw in order to drill it out, and when this is done the metal in the tool-holder is likely to be damaged so that it will stand up for only a short time when it is again ready for use.

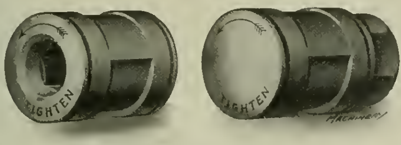


Fig. 1. Two Forms of Locking Cams used on Turning, Cut-off and Side-tool Holders

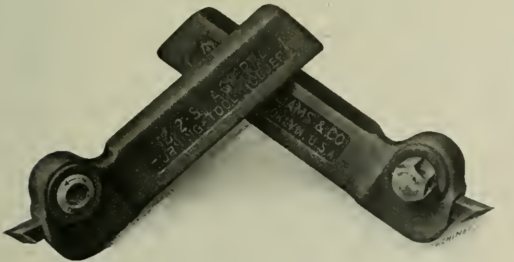


Fig. 2. Turning-tool Holders with Straight Shanks, showing the Two Types of Cams used

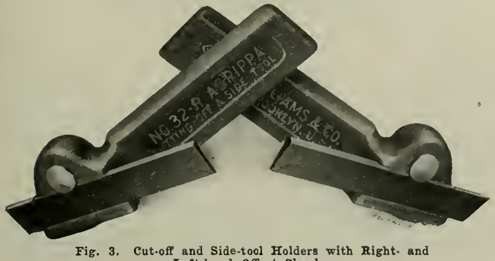


Fig. 3. Cut-off and Side-tool Holders with Right- and Left-hand Offset Shanks

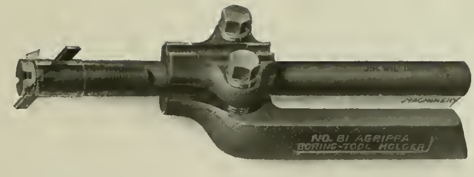


Fig. 4. Boring-tool Holder showing Cutter in Straight and Angular Positions

With the view of overcoming the difficulties resulting from the use of set-screws, a carefully designed form of locking cam made of hardened and tempered tool steel has been substituted on the Williams tool-holders. These locking cams have a very gradual rise so that an extremely powerful grip is obtained through the application of a moderate pressure on the wrench with which the cam is turned. These cams are made in two forms as shown in Fig. 1, one of which is provided with a hexagonal head so that it may be turned with the special wrench provided for that purpose or with any other wrench that will fit. The second form of cam has a hexagonal socket and is turned by the same kind of key wrench that is used on the well-known hollow safety set-screws. The cams with the hexagonal head are of the standard form, but the cam with the socket is provided for cases where there is not sufficient clearance to admit the head of the cam, an example being the turning of small crankpins and facing the cheeks of the cranks. The two forms of cams are interchangeable in the same holder. Only about 1/12 of a turn is necessary to tighten the cutter in the holder or release it, so it will be evident that the operation is quite rapid. Full freedom of operation is obtained without removing the holder from the toolpost. With the idea of determining the relative strength of the grip obtained with the Williams cam fastening and with the commonly used set-screw, tests were conducted by mounting tool-holders provided with ¼-inch cutters held by the two forms of fastenings in a fixture mounted on a Riehle testing machine and applying pressure to the point of the cutter. It was found that the cutter held by a set-screw could be moved by the application of a pressure of 2400 pounds, while the cutter held by a cam required the application of 4200 pounds pressure to move it.

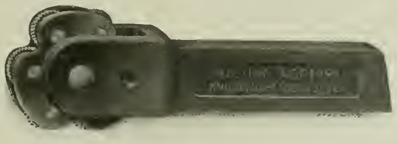


Fig. 5. Knurling-tool Holder provided with Coarse, Medium and Fine Knurls

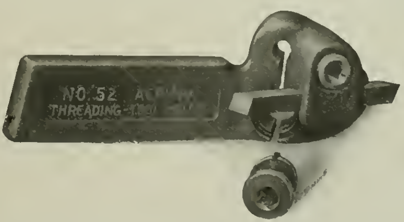


Fig. 6. Threading-tool Holder with Lockable Spring Head

Fig. 2 shows the Williams turning tools provided with the two forms of cams and with straight shank holders. Turning tools of this type are also made with both right-hand and left-hand off-set shanks. The holders with straight shanks are made in seven different sizes with capacities for square cutters ranging from ¼ to ¾ inch in size; and the holders with off-set shanks are made in six different sizes with capacities for square cutters from ¼ to ⅝ inch.

Fig. 3 shows a combination tool-holder for cutting-off tools and side-tools. Evidently the provision of a single holder suited for both styles of cutters means a material reduction in the investment in tool-holders which a shop is called upon to make. It will be seen that the broad edge of both the cut-off and the side-tool cutters are at the top. In the case of the cut-off tool this is necessary to provide the required clearance; and in both cases, having the broad edge of the cutter at the top provides more metal behind the cutting point for the purpose of conducting away the heat generated by the cut as rapidly as possible to avoid damaging the cutter. These tool-holders are made with straight shanks with the cutter on the right-hand side, and with right- and left-hand off-set shanks. Both styles of holders are made in five different sizes with capacities for cut-off tools ranging from 3/32 by ⅝ inch up to 3/16 by 1⅛ inch in size; and for side-tools ranging from 5/32 by ⅝ inch up to ⅜ by 1⅛ inch.

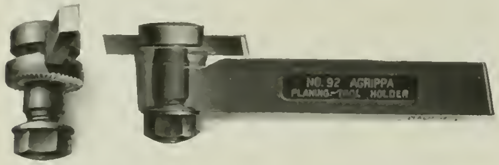


Fig. 7. Planing-tool Holder with Serrated Washer which affords Fine Adjustment

The distinctive features of the new Williams boring-tool holder are that the same holder can be used for all sizes of boring-bars which come within its range without requiring the use of bushings or shims; and that the cutter can be supported in the sleeve bar in a straight or angular position without requiring the use of more than one cap. Reference to Fig. 4 will make these features quite clear. The shank is provided with a shoulder in which there is a groove which receives the boring-bar, the bar being held in place by a cap and two screws. The larger sizes of bars are held as shown in the illustration, but when the bar is so small that the cap contacts with the holder, the cap must be removed and replaced in the reverse position so that the slot in the top engages the bar. Fig. 4 shows quite clearly the way in which the cutter may be held in the bar in either a straight position or at an angle. Reference to this illustration will also show that there is a tapped hole in the end of the bar, which receives the clamping bolt. This bolt has two holes through it to accommodate the cutter in either of the two positions in which it is used. A sleeve with corresponding holes abuts against the end of the bar and the cutter is slipped through these holes in the sleeve and clamp bolt, after which the bolt is tightened to secure the cutter in place. These boring-bars are made in four sizes with capacities for all sizes of bars ranging from 3/16 inch in diameter to 1¼ inch in diameter. This tool-holder holds either round, hexagonal or octagon bars with an equally efficient grip, the clamp securing a four-point contact on bars of any of these shapes. A plain solid bar with straight and angular cutters at opposite ends is also provided for use in connection with these holders.

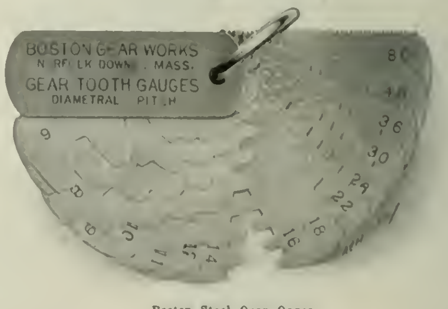
Fig. 5 shows the Williams knurling tool which is fitted with three pairs of knurls carried in a revolving head. These knurls provide for handling coarse, medium and fine work, and any set of these knurls may be instantly brought into the operating position by revolving the head. It will be seen that there is a hole in the side of the holder, which is for the purpose of enabling the pins to be driven out when it is desired to put new knurls in the holder. The knurls and the pins on which they revolve are made of carefully heat-treated tool steel. The size of the shank of this holder is ½ by 1⅛ inch by 6¾ inches, and the size of the standard knurls is 3/16 by ¾ inch

The distinctive feature of the threading tool-holder shown in Fig. 6 is the provision of a lockable spring head which provides a solid head for the holder when used for taking heavy roughing cuts, after which the lock may be loosened to provide for taking the finishing cut. The lock by which this result is secured consists of a bolt, the head and nut of which have an annular V-groove cut on the inside. These grooves fit over corresponding V-bearings on the holder and when the bolt is tightened it locks the spring head of the holder so that it is perfectly rigid. When it is desired to use the holder as a spring tool for finishing operations, it is merely necessary to loosen the bolt through part of a turn. The cutter is held in place by the form of locking cam which has already been described in detail. This tool is adapted for all classes of threading operations from the coarsest to the finest, and its lockable spring head is also especially well adapted for other classes of lathe work. These holders are made in three sizes with capacities for square cutters, ¼, 5/16 and ⅜ inch in size, respectively.

Two noteworthy advantages are secured by the use of a separate serrated adjustment ring in connection with the Williams planing-tool holder. First, the serrated ring provides twenty-eight positions in which the cutter may be set, so that any desired adjustment may be obtained without the necessity of grinding the tool. Second, the ring may be made sufficiently hard so that the pressure of the cut will not result in the cutter wearing down its bearing so that the entire holder becomes worthless; and the use of a separate ring allows the remainder of the holder to be left soft so that it possesses the necessary strength to resist the intermittent strains which would be likely to result in breaking the holder at the neck, if the entire shank were hardened to provide the necessary durability for the cutter bearing. Another feature is that the serrated adjustment ring makes it only necessary to turn the nut on the locking bolt through a half turn in order to loosen it sufficiently to adjust the position of the cutter. Reference to Fig. 7 will show that the washer under the nut on the locking bolt is provided with a spherical bearing on its under side. This permits the bolt to adjust its position to compensate for the strain of the cut without any tendency to bend the bolt and introduce transverse stresses in it. Either square or rectangular cutters may be used. In addition to its use as a planing tool, this tool is especially adapted for use on the heavier classes of lathe work—particularly those classes of work where off-set tools are required. The holder is made in six different sizes with capacities for cutters ranging from 5/16 by 7/16 inch up to ⅞ by 1⅛ inch in size.

BOSTON GEAR GAGES

To meet the requirements of inspectors, designers and others who need accurate means of testing the accuracy of gear teeth, the Boston Gear Works, Norfolk Downs, Mass., has developed the set of rack type gear gages which are illustrated herewith. It is claimed that the rack type of gage is preferable to the circular gage for the following reasons: First, greater accuracy is obtained when the gage is in the form of a rack; second, there are more teeth in contact while testing and it is possible to roll the gear in contact with the gage; third, the circular pitch of the rack type of gage can be tested with great accuracy.



Boston Steel Gear Gages

This set of gear gages comprises fourteen individual gages which provide for measuring twenty-two standard diametral pitches. The pitches provided in the standard set of gages are as follows: 6, 7, 8, 9, 10, 11, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 36, 40, 48, 64 and 80. Reference to the illustration will show that individual gages with teeth cut on only one side are provided for pitches from 6 to 11, inclusive. For pitches ranging from 12 to 80 by the steps already referred to, teeth are cut on both edges of the gage so that each gage provides for measuring two different pitches.

In addition to the standard set shown in the illustration, the Boston Gear Works is making gages of this type in 5, 4 and 3 diametral pitch; and in 1/4, 3/8, 1/2, 3/4, 1 and 1 1/2-inch stub-tooth circular pitches. These special gages are all made with teeth on only one side—as in the case of the 6-pitch gage of the standard set.

MARVIN & CASLER BORING HEADS

In the March, 1909, number of MACHINERY the eccentric boring head of this company's manufacture was illustrated and described. Since that time the demand has arisen for smaller boring heads of similar design, and to meet this demand the models C and D heads which form the subject of this article have been developed. The reduction in size of these heads necessitated the substitution of a new method of holding the tool in place of the drill chuck formerly used.

On the style C head which is illustrated in Fig. 1, a hardened V-block and set-screws are provided for holding the tool, two set-screws being used which insures holding the tool quite rigidly. The V-block is carefully aligned so that twist drills within the range of the chuck can be brought to run true by centering with the micrometer screw. A take-up ring is provided which keeps the moving parts in close contact. This tool has a capacity for drills or other tools with shanks ranging from 3/16 to 3/8 inch in diameter, and the available offset is 1/8 inch.

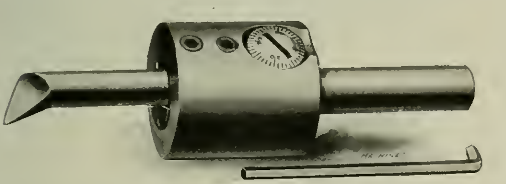


Fig. 1. Marvin & Casler Style C Boring Head

The style D head illustrated in Fig. 2 consists of a shank and body across which the head is moved which carries the boring tool. The offset adjustment is secured by two opposing hollow set-screws which bear against a cone-shaped extension on the head. The adjusting screws are set at the proper angle for the cone on which they bear and act similarly to a gib, drawing the head up firmly against the outer face of the body in addition to locking the head and tool in place for the required depth of cut. In setting the tool for any required depth of cut, one of the opposing screws is released and the opposite screw tightened up until the proper position has been obtained. The tool is held in a V-block by two set-screws. This style of chuck is made in two sizes, one of which has a capacity for tools with shanks ranging from 3/16 to 3/8 inch and an offset of 1/4 inch, while the other has a capacity for tools with shanks ranging from 1/4 to 3/4 inch in diameter and an offset of 1/2 inch. These boring heads are manufactured by the Marvin & Casler Co., Canastota, N. Y.

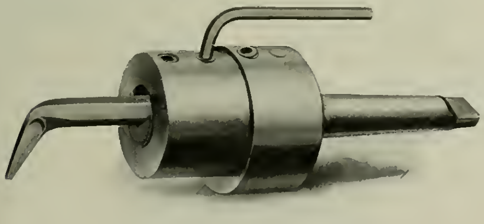


Fig. 2. Style D Marvin & Casler Boring Head

SLOCOMB BENCH MICROMETER

The J. T. Slocomb Co., Providence, R. I., is now manufacturing a bench micrometer which has a range of from 0 to 6 inches, and is provided with two interchangeable measuring heads. The micrometer is illustrated in Fig. 1 and an enlarged view of the two measuring heads is shown in Fig. 2. One of these heads is graduated to give readings to 0.0001 inch directly from the thimble. This head is provided with a very accurate screw and is suitable for use in making gages or for any work where exceptionally fine measurements must be made. The other head has a 10-pitch screw and is graduated to read directly to 0.001 inch, this head being intended for use where rapid measurements must be made, and the graduations are spaced far enough apart so that the readings may be accurately estimated to 0.00025 inch. It makes a useful caliper for tool-work or fitting where frequent measurements must be made.

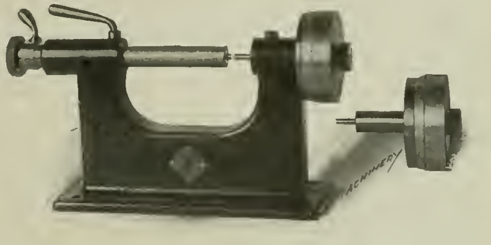


Fig. 1. J. T. Slocomb 6-inch Bench Micrometer

In both heads the thimble is 4 inches in diameter, and the 10-pitch screw of the second head referred to makes all readings direct, it being merely necessary to take the first figure from the sleeve and the remainder of the reading from the graduations on the thimble. As shown in Fig. 2, the reading of this head is 0.78125. The anvil is made with a sliding bar which is held by a split clamp in the main bed or frame. This is used for approximate adjustments and has a maximum movement of 5 inches. A fine adjustment is made through the center of this bar, using the knurled headed screw shown at the left-hand end. There is a plunger in this bar which is held back against the adjusting screw by a coiled spring, and a key prevents the anvil from revolving.

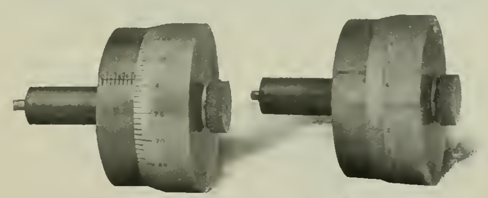


Fig. 2. Interchangeable Measuring Heads for Slocomb Micrometer shown in Fig. 1

GOULD & EBERHARDT BEVEL GEAR ROUGHING SHAPER

The multiple spindle bevel gear roughing shaper, opposite sides of which are illustrated in Figs. 1 and 2, is now being manufactured by Gould & Eberhardt, Newark, N. J. As its name implies, the function of this machine is to take a roughing or stocking cut on both gears preparatory to finishing them on a bevel gear planer. As the stocking cut consumes a large percentage of the time involved in cutting a bevel gear on a gear planer and because this type of machine is far more expensive than a roughing shaper, it will be evident that it is more economical to take the roughing cut on a shaper and then finish the gear on the gear planer. A further advantage of this procedure is that the expensive finishing planer is relieved of the severe strains incident to taking the stocking cut. The Gould & Eberhardt roughing shaper is particularly adapted for roughing out steel bevel gears for automobile differentials. These gears have projecting hubs on the small end which prevent their being roughed out with the ordinary disk type of gear cutter, as the rotary cutter would not be able to work over the entire face of the gear owing to the interference of the hub with the cutter.

Reference to the illustrations will make it evident that the design of the shaper has been developed in such a way that either one or two bevel gear blanks may be worked on at a time. These blanks are held at the proper angle and indexed at every return stroke of the ram while the shaper head is automatically fed down at each stroke until the proper depth of cut has been reached. The feed is then automatically disengaged and the blank removed from the arbor. This machine is designed to run at 100 strokes per minute. The most important feature of the design is the improved style of head which is equipped with an efficient cam feed mechanism. In the previous design of bevel gear roughing shaper built by this company, the vertical feed of the head was operated by a feed-screw, but in the present construction the feed-screw has been eliminated, as it has been found that the cutting stresses are better controlled by the cam feed mechanism. This new construction also allows the amount of feed to be varied according to the location of the cutting tool in the blank, *i. e.*, when the cutting tool is just entering the blank the maximum feed is employed and as the tool is gradually fed deeper into the blank the rate of feed is decreased. This not only relieves the machine and tool of the heavy strain to which they would be subjected if a constant vertical feed were employed, but it also produces a finer finish on the work.

In general the construction of this machine is that of the high-duty shaper built by this company. The regular cross-head slide and table have been removed and a special work-head substituted in their place, which is provided with the indexing mechanism previously referred to. This work-head may be arranged to cut one or two gears at a time, and suitable means are provided for holding the blanks and lubricating the cutting tools. The illustration shows the machine roughing out two nickel steel gear blanks which have twenty stub teeth of 5/7 pitch. The time required to do this work is three minutes for each gear. It will be seen that these gears have projecting hubs of the form which has already been referred to, and to remove the chips that accumulate between the projecting hub and the inside of the face, two hook tools have been provided that fit in the grooves under spring tension and which may be easily thrown out of position when taking off the finished gears. The indexing of the work from one tooth to the next consecutive tooth takes place when the ram reaches the end of its return stroke, *i.e.*, when the tool is clear of the work. After the indexing operation has taken place and before the tool engages the work for the next cut, the work-spindle is automatically locked so that the blank is securely held in place. While the ram is returning and the tool is idle, the automatic vertical feed of the head takes place; and this feed continues to operate until the feed cam has made one revolution. In revolving, the cam comes to the point where the feed is started and then the head moves back from the work ready to start on another set of gear blanks.

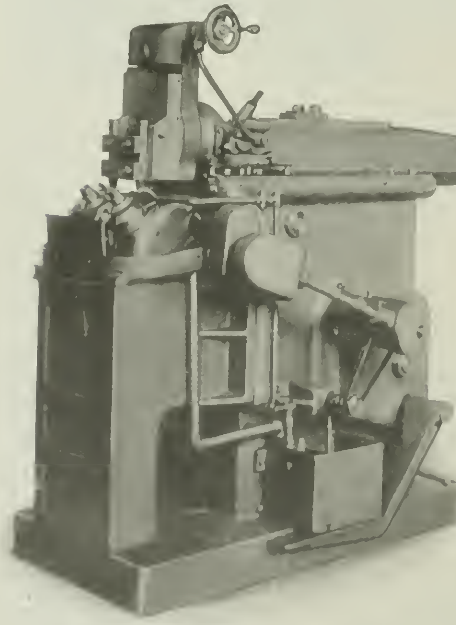


Fig. 1. Gould & Eberhardt Bevel Gear Roughing Shaper

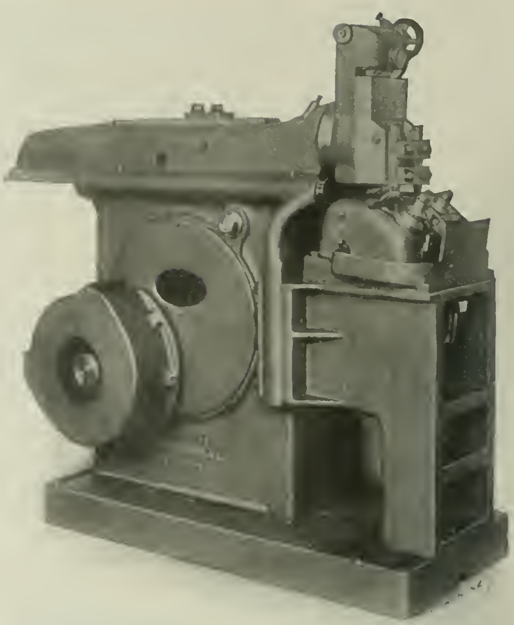


Fig. 2. Opposite Side of Gould & Eberhardt Shaper shown in Fig. 1

KIMBLE ADJUSTABLE SPEED MOTOR

The most important feature of this motor, as concerns its application for driving machine tools, is that the speed may be adjusted by infinitesimally small steps. This adjustment of speed is made by a handwheel mounted on the machine, which makes connection with the motor governor through a shaft or chain. Dynamic braking is employed to produce a quick stop, the action being very powerful. These motors are made in sizes from 1/6 to 2 horsepower, and all sizes are equipped with S. K. F. ball bearings.

The Kimble Electric Co., 2406 W. Erie St., Chicago, has developed a new adjustable speed single-phase alternating-current motor, which has the unique features of being adjustable by the smallest of graduations and of holding its speed within a few per cent of the set value under loads that vary all the way from no load to full load. In this motor the operator adjusts the speed by means of a handwheel connected by shaft or chain to a governor located on the motor. In the case of a lathe drive, the handwheel is placed on the front of the lathe below the headstock, and the start, stop and reverse lever is carried along on the apron. The range of speed is regularly 3 to 1, as 600 to 1800, or 700 to 2100, or 800 to 2400; but in the smaller motor a range of 6 to 1, as from 600 to 3600 revolutions per minute is readily obtained. The speed adjustment is by extremely small steps, any speed whatever within the range being obtainable. The control is

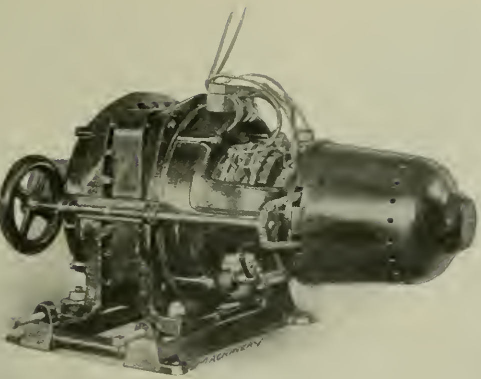


Fig. 1. Kimble Adjustable-speed Single-phase Alternating-current Motor

said to be even more accurate than that obtainable with a direct-current field control motor.

The motor in some respects resembles the direct-current multi-voltage control motor (with an infinitely large number of working voltages) in which the power capacity increases with increasing speed, rather than the direct-current field control motor in which the power capacity does not increase with increasing speed. The motor will deliver its rated horsepower at any running speed, but will deliver more than the rated horsepower at the higher speeds, with the speed drop from no load to full load not over 2 per cent. The motor will deliver its full rating at the lowest speed, but the speed drop from no load to full load may increase to 5 per cent when running at the lowest rated speed. The results obtained with respect to accurate speed control are unique for alternating-current motors, and it is claimed that they can be favorably compared with the best obtainable with direct-current motors.

Dynamic braking is used to produce a quick stop, the braking action being extremely rapid. It differs from that used in direct-current motors in that the turning over of the motor by hand at a low speed does not bring the brake into action. Thus when chucking a piece in a lathe, the spindle can be turned by hand without encountering the slightest resistance from the dynamic brake. In the sizes of ¾ horsepower and above, an outside controller is furnished for bringing the forward or reverse of the motor, or the dynamic brake, into action. In the smaller sizes a double-pole double-throw switch is furnished instead of the controller.

The motor is furnished with or without a mounting; and if without the mounting, the equipment includes slide-rails, a pulley, the speed adjusting handwheel mounted on the motor, and either the outside controller or switch depending on the size. The motor may also be furnished with two types of mounting, either being well adapted for use in driving a lathe or similar machine. On one type the motor is set on slide-rails on a flat topped pedestal fastened to the floor, the controller box being on the side of the pedestal; and the space within the pedestal body is provided with shelves for the storage of tools, etc. The motor is belted to the largest or next largest cone step, this with the back-gear giving every speed required. This arrangement has the advantage of keeping all motor vibration away from the lathe. In the other type of mounting, the motor is carried on the rear side of a swinging frame, the lower end of which is attached by a hinge to the floor, so that the whole assembly may be swung away from or toward the lathe to adjust the belt tension. This adjustment is made by a distance piece of adjustable length. The controller box is mounted on the front of the frame. This type of mounting is more compact than the other. With either type of mounting the following attachments are included with the motor: the sprocket, chain, speed adjusting wheel, shaft and bracket, two start, stop, and reverse levers with the shaft and brackets for attaching them to the apron and frame of the lathe, and the connecting link that goes between the apron and controller.

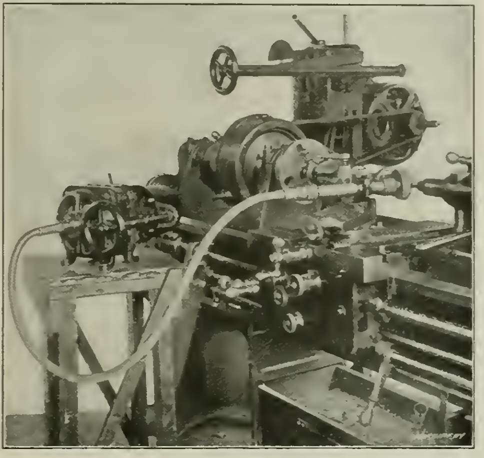


Fig. 3. Motor provided with Flexible Shaft for driving Grinder Head

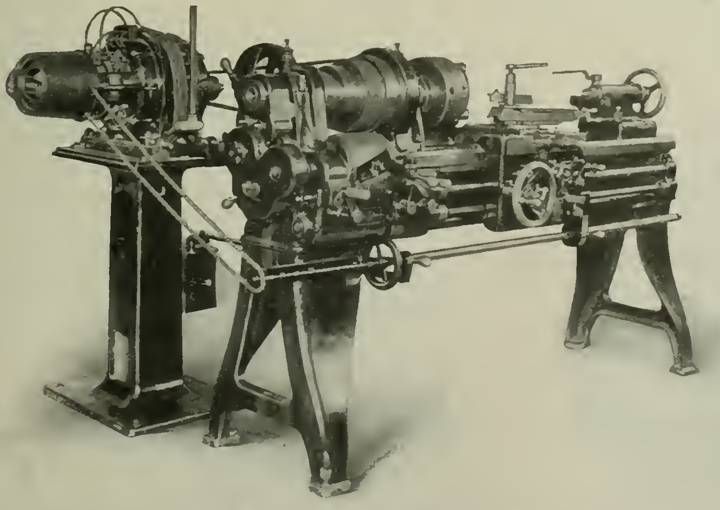


Fig. 2. Application of Kimble Motor for driving Engine Lathe, with Motor mounted on Pedestal

The motor may also be furnished with a standard length of flexible shaft with which a grinder head, buffing head, or drill chuck may be used. These motors are made at present in sizes from 1/6 to 2 horsepower, inclusive, the standard speed range being 600 to 1800 revolutions per minute for all sizes, and this range can be extended if desired. All sizes are equipped with S. K. F. ball bearings. The motor can be used on any machine application requiring adjustable speed; such as lathes, drill presses, milling machines, grinders, and other machine tools, as well as many other classes of machinery.

SMITH TRIPLE-BIT SCREW-DRIVER

It will be evident from the accompanying illustrations that the noteworthy feature of the Smith No. 612 "Perfect Handle" screw-driver which forms the subject of this article is the provision of the two auxiliary side bits. These adapt the screw-driver for turning screws in closely confined places where lack of clearance makes it impossible to use the tool in the ordinary way. In addition, the regular bit on the end of the screw-driver can be used in the usual manner.

It will be seen that the screw-driver is one solid piece which is of carefully tempered drop-forged steel. The wooden handle is waterproofed and rests solidly against the steel, the metal protecting the handle at each end so that it cannot be readily damaged. The length of this screw-driver is 9 inches over-all, and the blade is 5 inches long. The bits are ¾ inch wide by 1/16 inch thick and the shank is ½ by ⅜ inch in size. This screw-driver is a recent product of H. D. Smith & Co., Plantsville, Conn.

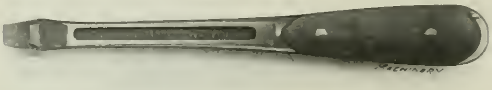


Fig. 1. Smith Triple-bit Screw-driver

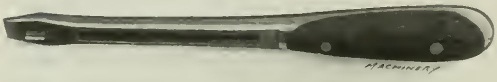


Fig. 2. Opposite Side of Smith Screw-driver shown in Fig. 1

OHIO EXPANSION SHELL REAMER

Standard practice in toolmaking requires the cutting end of a machine reamer to be somewhat larger than the rear end, thus producing a "back taper" to afford the proper clearance. It is also well known that the cutting end of such a reamer wears more rapidly than portions of the tool nearer the back. With the view of producing an adjustable reamer the action of which will very nearly approach that of a solid reamer, and to enable the reamer to expand most at the point of maximum wear, so that it need not be ground after adjustment, the Ohio Reamer Co., 5337 St. Clair Ave., Cleveland, Ohio, has placed on the market the tool shown in Fig. 1.

The adjusting mechanism consists of a cone on which under-cut threads are machined. The form of these threads is illustrated in Fig. 2, from which it will be seen that the cone cannot move outward because one side of the threads is inclined toward the horizontal axis of the reamer. For a similar reason, the prongs on which the cutting edges of the reamer are carried cannot move out from the axis of the tool and dig into the work. It is claimed that the adjusting mechanism locks the reamer so that no screws, clamps, etc., are needed to make it tight after making the adjustment. The adjustment can be made without removing the tool from the machine in which it is used. An important feature is that the necessity of taking the reamer to the tool-room for adjustment and grinding is avoided, thus overcoming loss of time by the workman and having the machine standing idle.

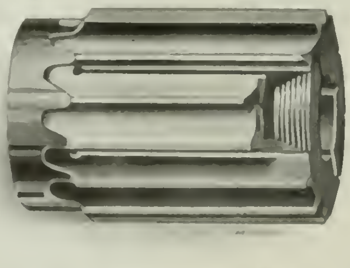


Fig. 1. Ohio Expanding Chucking Reamer

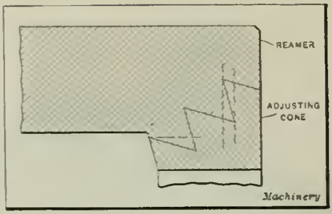
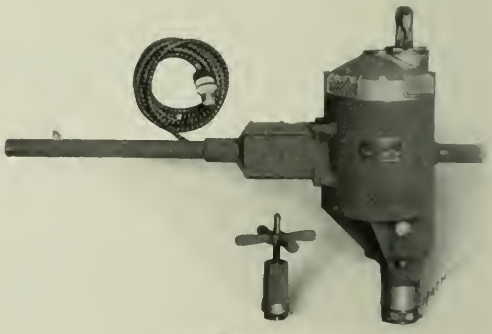


Fig. 2. Means of adjusting Ohio Reamer

CINCINNATI HEAVY-DUTY ELECTRICAL REAMER

The Cincinnati Electrical Tool Co., Cincinnati, Ohio, has recently added to its line of portable electrical drills and grinders the heavy-duty reamer which is shown in the accompanying illustration. This tool is particularly designed for bridge and other structural work, in addition to its use in shops. It is made in three sizes with capacities for reaming holes up to 15/16, 1 1/16 and 1 3/16 inch, respectively. A special type of slip socket is provided which does away with the use of a drift key and drift hole in the spindle.

The motor which is wound for direct current is of the series four-pole type and is fully enclosed. It is air cooled by a fan mounted on the armature shaft. The gears are made of chrome nickel steel and mounted on roller bearings. They are fully enclosed in a case at the lower end of the reamer and are packed in grease. A plate separates the gear-box from the motor housing to prevent oil and grease from getting into the windings. Annular ball bearings are used at both ends of the armature shaft and the spindle thrust is taken by a ball thrust bearing.

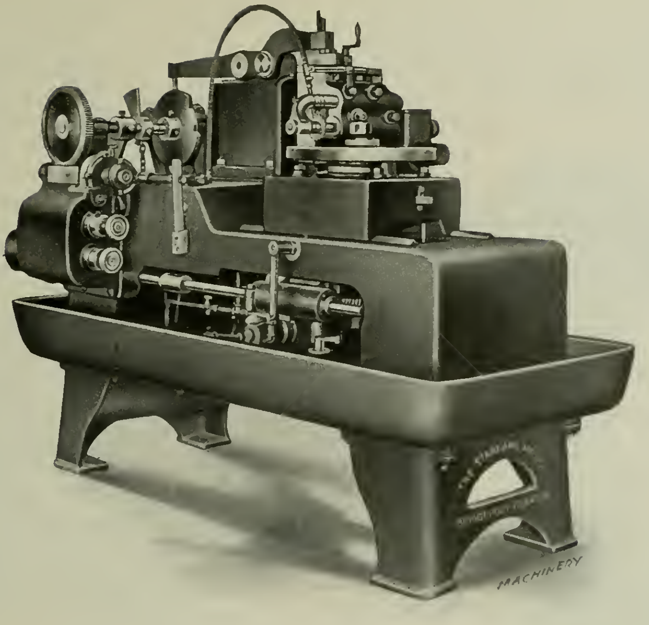


Cincinnati Heavy-duty Electrical Reamer

The switch is of the quick make-and-break type and there is a release lever in one of the side handles. The brush holders are mounted on fiber blocks and are carefully insulated. The binding posts which hold the leads are designed to secure contact by means of compression springs, thus entirely eliminating the use of nuts and screws which may give trouble by working loose and getting into the motor. The brushes are readily accessible through four removable guards and can be instantly replaced without disturbing any part of the tool.

STANDARD DIAL MILLING MACHINE

The dial milling machine illustrated and described herewith is a recent addition to the line of machines built by the Standard Mfg. Co., Bridgeport, Conn. This machine is arranged for single pulley drive and there are eight changes of speed and ten changes of feed. These are obtained through gear-boxes. The machine is adapted for dials ranging from 7 to 24 inches in diameter, the work-table being adjusted longitudinally on the ways by means of a crank-operated rack and pinion. In this way the work may readily be brought into any desired position. The cutter is raised clear of the dial on the return stroke to avoid having it pass backward through the work. The indexing is accomplished by a worm and worm-wheel, the operation being performed during the return stroke of the cutter. The depth of cut is regulated by a micrometer adjustment and adequate lubrication for the cutter is provided.



Standard Dial Milling Machine adapted for Dials from 7 to 24 Inches in Diameter

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OESTERLEIN MILLING MACHINES

The most important feature of the Nos. 34 heavy and 42 plain milling machines built by the Oesterlein Machine Co., Cincinnati, Ohio, which are illustrated and described herewith, is the provision of quick power movements of the knee, saddle and table. These are merely "fleeting" motions for use in connection with whatever feed may be engaged, and are operated by depressing the treadle at either side of the machine. These treadles make connection with a clutch at the rear of the machine which is normally engaged with a gear driven from the feed-box. When the treadle is depressed, the clutch engages with the quick speed derived from the countershaft or lineshaft; and the clutch automatically re-engages the gear driven from the feed-box when the treadle is released. A safety stop is provided at the limits of all motions.

These machines—like all the milling machines of this company's manufacture—are equipped with a special belt shifting device which provides for moving the belt from one step on the cone pulley to the adjacent step by one turn of a handwheel. This device was described in detail in the October, 1913, number of MACHINERY. Another important feature is the exceptionally rigid construction of all parts where vibration may develop. The column and base are cast in one piece with an unusually heavy front wall forming the slide for the knee and the main support for the spindle.

Ample power is provided by the unusually large cone pulley on the machine. To insure efficient transmission, the spindle is arranged with positive drive for the arbor by means of an interlocking recess and flat. The spindle runs in bronze bearings which are lubricated from oil wells in the column. The double back-gears are eccentrically mounted on the inside of the column below the spindle. These gears are cut with single-purpose cutters and run noiselessly under all conditions. The feed is transmitted from the spindle by a roller chain which makes connection with the feed-box where all changes are controlled. From this feed-box the motion is transmitted through a universal joint and telescopic shaft to a tumbler in the knee which is provided for the purpose of reversing all feeds. From this point the power is transmitted to the table, saddle and elevating screws. All control levers are centralized for the sake of convenience.

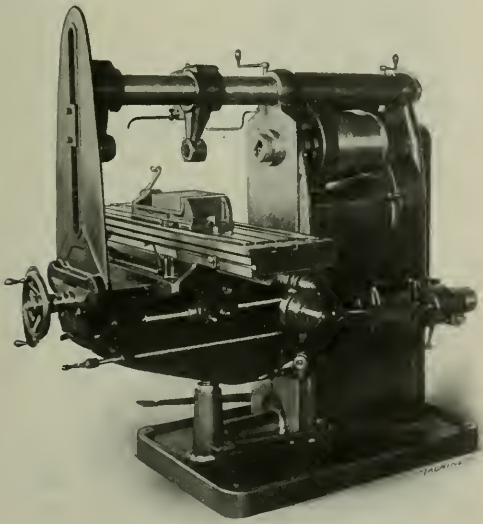


Fig. 1. Oesterlein No. 42 Plain Milling Machine

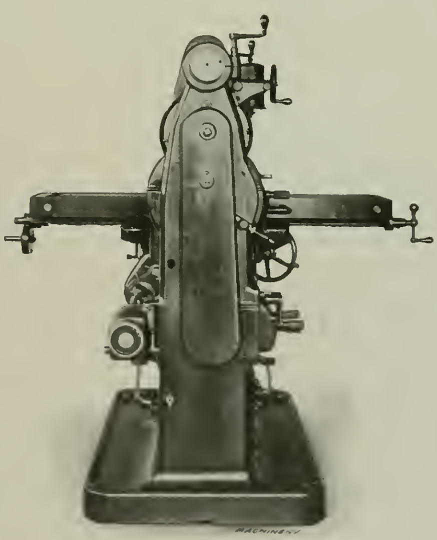
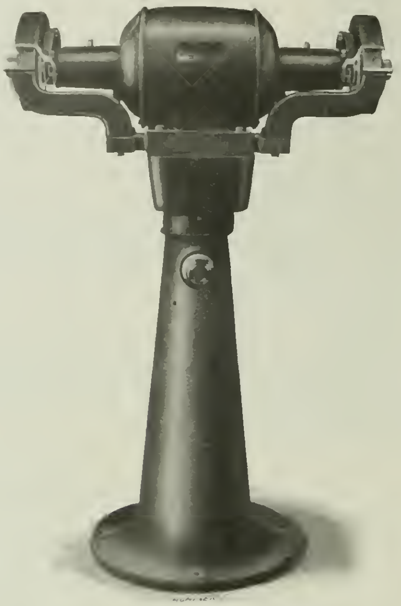


Fig. 2. Rear View of Oesterlein Milling Machine

DILLON MOTOR-DRIVEN GRINDER

The motor-driven grinder shown in the accompanying illustration is a recent product of the Dillon Electric Co., Canton, Ohio. This machine is adapted for use in tool-rooms, and for tool grinding and a variety of other operations in machine shops, where the power requirements are within the capacity of the motor. The motor is rated at ½ horsepower continuous duty and its momentary capacity will be from 2 to 2½ horsepower. The motor was especially designed for driving this grinder, which is a point that will commend the machine to the experienced man. It is completely enclosed and dust-proof, the construction being particularly rugged to withstand heavy momentary overloads. The motor is controlled by means of a carefully insulated snap switch which is mounted on the pedestal. Motors are provided for use on 110 or 220 volt direct-current circuits, and for 110, 220, 440 or 550 volt 60-cycle alternating-current circuits of either 1, 2 or 3 phase. The dust-proof feature has been so successfully provided for that it is said that bearing troubles are practically eliminated.



Dillon Motor-driven Grinder

The spindle runs in S. K. F. ball bearings and is made of high carbon steel. In addition to the increased transmission efficiency obtained through the use of ball bearings, the improvement of true running properties of the wheels as compared with a machine using plain bearings is very marked. The wheel guards are of heavy construction and they are designed in a way which affords protection to the eyes of the operators from flying particles in addition to protection from accidents resulting from the possible bursting of a wheel. The guards enclose approximately one-half of the circumference of the wheels, as well as both sides down almost to the spindle

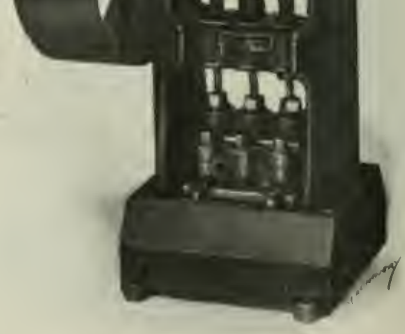
The grinding rests have broad lips in the front and at the outside of the wheels, the construction giving great strength and rigidity. The rests are fastened to the pedestal by means of two bolts passing through slots which provide adjustment for radial wearing of the wheels. The principal dimensions of the machine are as follows: distance between centers of wheels, 26 inches; height from floor to center of spindle, 39¼ inches; diameter of base, 17 inches; size of wheels, 7 by 1½ inch, speed, 3400 revolutions per minute, and net weight of machine, 300 pounds

HYDRAULIC SINGLE-ACTING TRIPLEX PUMP

To meet the demand for a hydraulic pump delivering a small quantity of water, which is still capable of exerting a high pressure upon the press ram, the pump illustrated and described herewith has been developed by the Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. On account of its light weight this pump, when motor driven, may also be mounted on a truck and used as a portable unit for operating small hydraulic shop tools on which no pump is mounted. It is provided with a knock-out attachment which automatically cuts off the delivery of water to the press ram but holds the pressure thereon, when the predetermined maximum pressure is reached. A slight drop in the pressure automatically starts the flow which continues until the maximum pressure is again reached. The base of the pump forms a reservoir for the liquid used in the operation. The pump is built for either gear, chain or belt drive.

The design of this pump is such that any one of twelve different sized plungers may be furnished. These range in size from 3/16 inch to 1 inch in diameter, advancing by increments of 1/16 inch. They are capable of exerting a maximum pressure ranging from 750 pounds to 8000 pounds per square inch; the larger the plunger diameter, the lower is the pressure capacity. It is a single pressure pump. The three plungers are of the same diameter and work to the same maximum pressure. The stroke is 2¾ inches and each plunger has a speed of 35 feet per minute at 150 strokes per minute, which is the rated speed. When driven at this speed the pump has a total capacity of 0.41 gallon to 4.20 gallons per minute, depending upon the diameter of the plungers. The suction and discharge valves are located in the pump cylinder.

The frame of the pump is cast in one piece of semi-steel; the crankshaft is machined from a solid bar of steel; the cross-heads are of cold-rolled steel; the connecting-rods are made of malleable iron with bronze bearings; and the pump plungers are of naval bronze on all diameters, except on the 5/16-inch and ⅜-inch sizes where steel is used to withstand the high pressure. The pump cylinders are cast *en bloc*. With the 5/16-inch and ⅜-inch plungers the cylinder is made of forged steel. For the pumps having plunger diameters larger than ⅜ inch, a special bronze is used for the cylinders. The pump has a height over all of 35 inches, and occupies a floor space of 16 by 18 inches. The weight of the pump without motor base or belt shifter is only 500 pounds.



Hydraulic Vertical Single-acting Triplex Pump

IMPROVEMENT ON BRYANT CHUCKING GRINDER

On the chucking grinder made by the Bryant Chucking Grinder Co., Springfield, Vt., which was described in its original form in the November, 1909, number of MACHINERY, the starting and stopping of the work-spindle was accomplished by an idler on the overhead countershaft, that was thrown against the belt or released from it in order to make or break the driving contact of the belt on the pulley. To provide a more rapid and convenient means of stopping and starting the machine—for gaging the work while grinding, etc.—a friction clutch has been provided in the driving pulley and this clutch is automatically operated by the withdrawal of the grinding wheel carriage from the working position. Aside from the greater convenience in starting or stopping, this improvement in no way affects the principle on which the machine works.

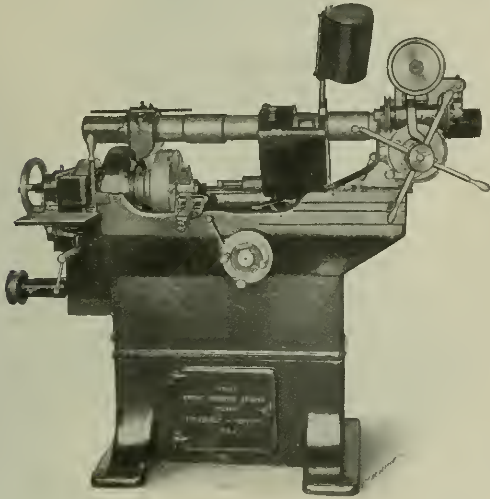


Fig. 1. Improved Bryant Chucking Grinder

A bracket has been placed at the center of the top casting of the machine, which carries a cam surface that is engaged by a roller supported from the under side of the grinding wheel spindle housing. When the grinding wheel is withdrawn beyond the operating position, this roller engages the cam surface, causing the wheel-spindle and its mounting to swing away and give the operator room for gaging the work. The bracket has a section at its right-hand end parallel to the grinding line, that acts as a support for the grinding wheel slide while gaging is being done. The swinging back of the grinding wheel head causes a movement of a shifter rod at the rear of the machine to take place. This rod extends over to the clutch in the driving pulley and throws it out. Conversely, the advance of the grinding wheel head causes this rod to swing back and the clutch is thus thrown in. Consequently, the single operation of withdrawing the grinding wheel causes it to swing out of the way for gaging and also causes the work-spindle to stop, while the cycle takes place in the reverse order in starting. This greatly simplifies the operation of the machine and adds materially to its efficiency.

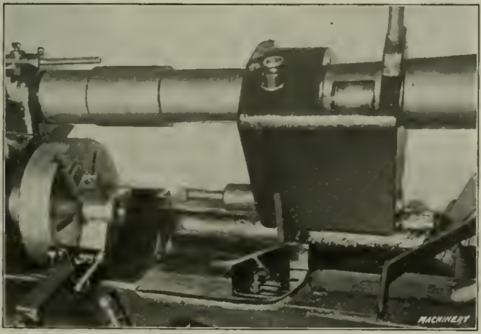
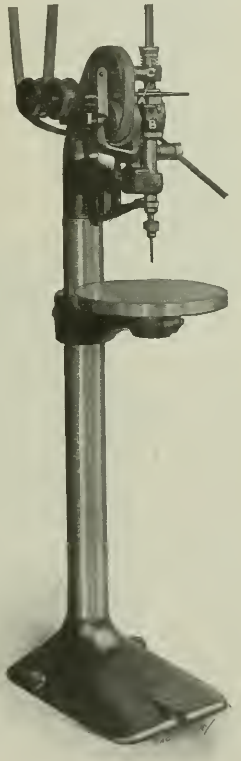


Fig. 2. Close View of Improved Power Control Mechanism

RICKERT-SHAFER VERTICAL TAPPING MACHINE

In the September, 1914, number of MACHINERY the horizontal tapping machine manufactured by the Rickert-Shafer Co., Erie, Pa. was illustrated and described. In this machine there is an aluminum disk mounted on the spindle which can be engaged with either of two friction disks which rotate in opposite directions. In this way provision is made for the reversal of the spindle for backing out the tap after it has reached the required depth. The disk on the spindle is engaged with the driving friction by feeding the work up to the tap, thus causing the disk on the spindle to be pushed into contact with the friction. After the desired depth has been reached, the work is drawn back, thus pulling the spindle in the opposite direction and engaging the disk with the reverse friction to provide for backing out the tap.

The vertical machine which is illustrated herewith has recently been placed on the market by the Rickert-Shafer Co., and combines the same form of friction drive used on the horizontal machine with a hand-operated vertical movement of the spindle. The hand-operated sliding motion for the spindle was adopted owing to the fact that it was found impractical to raise and lower the table when handling certain classes of work. The spindle on which the friction disk is mounted is shown at *A*, and this spindle also carries the operating bracket *B* on which a pinion is mounted that raises and lowers the tapping spindle. The friction disk spindle also carries an adjustable compensating spring *C* that is used to hold the friction disk in the neutral position when the machine is not in use. The tapping spindle is connected to a counterweight which is sufficiently heavy to withdraw the tap from the work and lift the spindle to its highest position, leaving the operator's left hand free to reach for the next piece of work. On this machine the friction disk is brought into contact with the driving friction by a slight downward pressure on the hand lever, thus eliminating a large amount of strain on the tap and providing a powerful though sensitive tool. It will be seen that the machine is driven by a single belt which runs around the pulleys that drive the forward and reverse frictions in the manner shown. The two pulleys rotate in the same direction and the reversal of the tap is due to the fact that the friction disk comes into contact with the opposite sides of the forward and reverse frictions.



Rickert-Shafer Vertical Tapping Machine

RIVETT INTERNAL GRINDING MACHINE

This No. 8 plain internal grinder is not intended for handling work where power feed is required, for which purpose the No. 3 internal grinder of this company's manufacture is well suited. Its particular field is work where the actual time of grinding is so short that one operator cannot attend to more than one machine. In designing this grinding machine particular attention has been paid to the provision of convenient means for controlling all parts of the mechanism.

To meet the requirements of internal grinding where the duration of each operation is so short that it is not practical to use power feed and have each operator in charge of more than one machine, the Rivett Lathe & Grinder Co., Brighton, Boston, Mass., has developed the No. 8 plain internal grinder which is illustrated and described herewith. In general, it may be stated that this machine is intended for roughing operations or for work where the highest degree of accuracy and the highest quality of finish are not essential.

Referring to Fig. 1 it will be seen that the work-head is mounted on a carriage which is traversed by means of a pilot wheel. The shaft on which this pilot is mounted carries a pinion which meshes with a rack on the under side of the carriage. This rack and pinion are of the herringbone type and provide a smooth uniform feed motion. The work-spindle is of the standard construction used on other Rivett grinding machines and runs in hardened and ground bushings. The work may be rotated at either 300 or 590 revolutions per minute, and the work-head may be swiveled up to 25 degrees either way from the center to provide for grinding tapered work. The head is positively located in the central position by a tapered pin. The spindle is ground internally to take draw-in collets, and the nose of the spindle is threaded and hardened so that any of the regular methods of holding work may be employed.

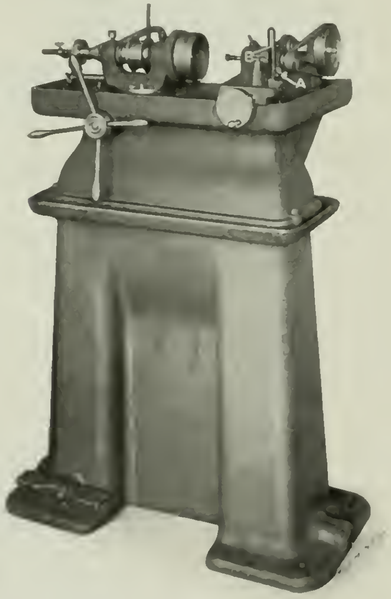


Fig. 1 Rivett No. 8 Internal Grinding Machine

An improved form of water guard has been applied on this machine, which consists of a casting in which either of three sheet metal shields of different widths may be easily inserted or removed. These shields hold themselves securely in place without requiring the use of screws or any other form of fastening. The arrangement is simple and effective. The regular type of pump is located at the back of the grinder and delivers the water through the spindle, the connection between the pump and spindle being easily detached if necessary. The water may also be directed against the work from the outside. The swing of the work head is 7 inches and the carriage has a travel of $4\frac{1}{4}$ inches. A spring bumper is provided which absorbs the shock at the end of the stroke. The entire grinding machine table is surrounded by a deep guard which prevents the water from running over the sides of the machine.

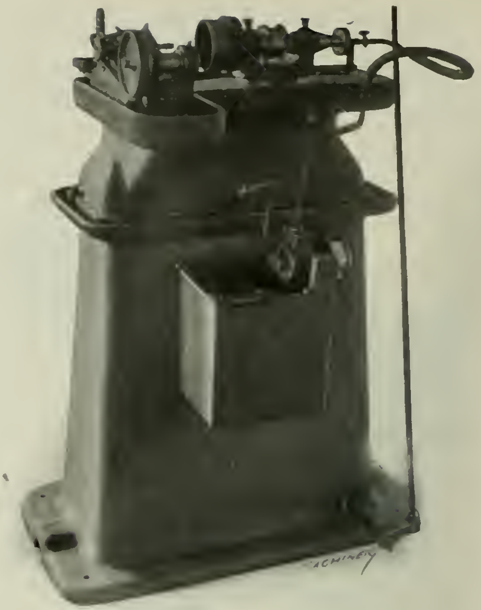


Fig. 2. Opposite Side of Rivett Grinding Machine shown in Fig. 1

The wheel-spindle is mounted in ball bearings and the entire spindle may be quickly removed from the machine by simply loosening two wing nuts. The spindle is driven from the countershaft on the machine by means of an endless cloth belt, and the desired belt tension is maintained by means of a spring acting in connection with the countershaft. The countershaft which drives the grinding wheel spindle also runs in ball bearings. Two movements are provided for the wheel-head, the first of which is the regular cross-feed con-

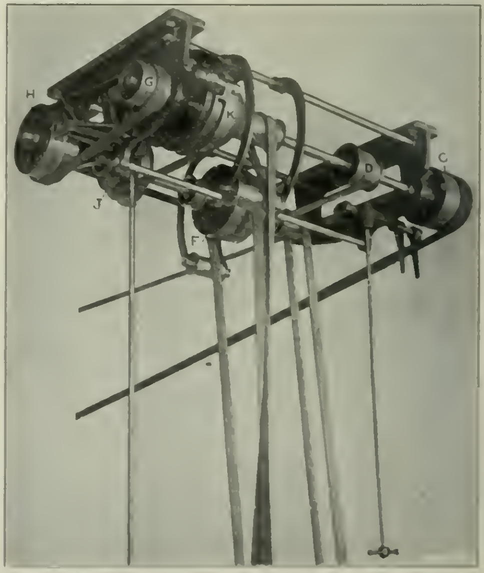


Fig. 3. Special Countershaft used in connection with Rivett Grinder

trolled by the handwheel shown in Fig. 1, which provides a maximum cross movement of 1 inch forward from the central position and 2 inches back from the central position. The feed-screw is of large diameter and runs in an exceptionally long nut. The micrometer collar on the feed-screw is graduated to 0.001 inch and the spaces on the collar are so wide that it is an easy matter to accurately estimate to 0.0001 inch.

The second movement of the wheel-head referred to is provided by an auxiliary slide mounted on the wheel-head carriage. This slide is normally locked in the central position, but when space is required for chucking and removing the finished work, or for gaging work during a grinding operation, the wheel may be moved back 4 inches by means of this auxiliary slide. For this purpose the pin which locks the auxiliary slide to the carriage is lifted out of engagement by means of the small handle *A* which turns a pinion that meshes with rack teeth cut in the locking pin. After the pin has been lifted out of engagement, the vertical handle *B* is used to push the slide back. A spring bumper is provided to absorb the shock when the slide reaches the end of its travel.

Three grinding wheel speeds of 11,200, 15,200 and 21,400 revolutions per minute are available; but in spite of these high speeds there is never any trouble due to heating of the spindle bearings. These three speeds, in connection with the two available work speeds, afford plenty of latitude for handling all sizes of work for which the machine is adapted. The floor space occupied by the machine is 2½ by 3 feet and the weight approximately 1000 pounds.

The Countershaft

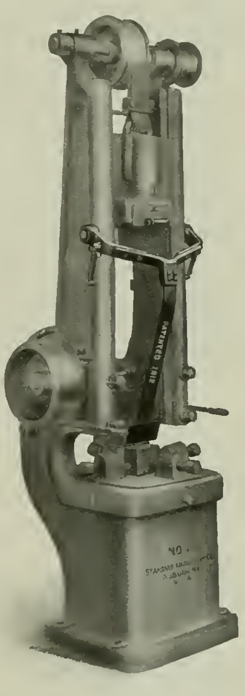
A special countershaft has been developed for use in connection with the Rivett No. 8 internal grinding machine. In this countershaft there are only two shafts. Referring to Fig. 3, it will be seen that power is brought to the countershaft by the belt running on the tight and loose pulleys *C*. Keyed to the same shaft there is a cone pulley *D* from which power is transmitted to a cone pulley which is mounted on ball bearings and runs freely on the second shaft. Secured to this pulley there is a pulley *F*, over which a belt runs down to the countershaft on the machine from which the grinding wheel spindle is driven, the tension of the belt being maintained by an idler pulley as shown in the illustration. At the opposite end of the shaft from the tight and loose pulleys *C* there is a pulley *G*, over which a belt runs to the tight and loose pulleys *H* which drive the second shaft. From the cone pulley *J* on this shaft, a belt runs back to the first shaft and drives a cone pulley *K* secured to the left-hand end of the drum over which the belt runs which drives the work-head. In addition to driving the drum, the cone pulley *J* has a back step which carries a belt that drives the pump on the grinder.

Secured to the cone pulley *K* there is a brake drum which is engaged by a band brake that provides for quickly stopping the rotation of the work-head. The treadle at the front of the grinding machine operates this band brake. When the treadle is pushed down, it throws a bell-crank which operates a square rod on the countershaft, this rod being given a sidewise motion which operates the belt shifter to throw the belt from the tight to the loose pulley *H* or *vice versa*, thus causing the work-head and pump to be stopped or started. At the same time the band brake is automatically engaged or disengaged by a cam mechanism, the band brake being disengaged when the belt is thrown onto the tight pulley or engaged to quickly stop the rotation when the belt is thrown onto the loose pulley to stop the machine. The foot treadle is mounted on ball bearings so that it operates very easily. The countershaft as a whole is started or stopped by the hand lever above the machine which throws the driving belt from the loose to the tight pulley, or *vice versa*.

STANDARD DROP HAMMER SAFEGUARD

The safeguard for drop hammers, which is illustrated and described herewith, has been developed by the Standard Machinery Co., Auburn, R. I., for use on any type of plain, automatic or board drop hammer where the operator uses his hands to place the work on the die. The guard is not intended for hammers handling hot work, as such parts are handled with tongs, and as a result there is no danger of injury to the operator's hands. Reference to the illustration will make the principle upon which this device operates quite clear without requiring more than a brief description. It will be seen that there is a "fan" or plate which swings over the face of the die. When the hammer is at the top of its stroke, this guard is back of the die so that the latter is exposed to enable the operator to put the work in place. When the hammer descends, the roller shown in the illustration engages the inclined arm on which the plate is supported, causing it to swing across the face of the die.

Should the operator trip the hammer and neglect to move his hand, the plate will push it out of the danger zone. The face of the plate is covered with leather so that it cannot bruise the workman's hand. An important feature is that the guard is bound to operate no matter whether the hammer is dropped in the usual way or if its descent is caused by some abnormal condition, such as the breaking of a belt, etc. When the hammer rises, the guard is returned to the position shown in the illustration by means of the two coiled springs. To adapt the guard for use on hammers of different widths, the bolts in the side brackets fit into slots so that the brackets may be adjusted to fit the hammer on which the guard is to be used. Similarly, the bolts which connect the swinging arm to the side brackets fit into slots so that the vertical position of the guard plate may be regulated for dies of various heights.



Standard Safeguard for Use on All Types of Drop Hammers

NEW MACHINERY AND TOOLS NOTES

Hoist: Wright Mfg. Co., Lisbon, Ohio. A shop hoist which has a capacity for loads ranging from 300 to 600 pounds. A new form of hand chain is provided for operating the hoist, which makes jerking and catching of the chain impossible.

Filing Machine: Thurston Mfg. Co., Providence, R. I. A machine particularly adapted for accurate filing operations on die work. The adjustment of the table provides for obtaining any desired clearance angle from 1 to 10 degrees, or for filing the hole in a die square.

Staybolt Machine: Ferracute Machine Co., Bridgeton, N. J. A coining press equipped to shear a staybolt blank from a bar and form the head on the preceding blank. These two operations are performed simultaneously and the finished bolt is ejected from the machine.

Shaft Centering Machine: Detrick & Harvey Machine Co., Baltimore, Md. A machine adapted for centering shafting, solid gun forgings, etc. This consists of two headstocks and two vises for holding the work, which are mounted on a common bed. The headstocks are motor driven.

Keyseating Attachment: Sunderland Machinery & Supply Co., Omaha, Neb. An attachment which provides for performing keyseating operations on an engine lathe. Various other milling and slotting operations can also be performed, and the attachment can be used on any lathe ranging from 13 to 26 inches swing.

Double Disk Grinder: Guy G. Townsend, Winchendon, Mass. A double disk grinder in which the shaft and heads are made from a solid forging. A truing attachment is bolted to the swing slide, where it is readily available. The machine is built in three sizes having wheels 18, 24 and 30 inches in diameter, respectively.

Car Wheel Boring Machine: Putnam Machine Co., Fitchburg, Mass. This is the machine formerly built by this company with several important improvements incorporated in its design. Chief among the changes is the substitution of single pulley and geared drive in place of the cone pulley drive formerly employed.

Ball Bearing: Auburn Ball Bearing Co., 33 Elizabeth St., Rochester, N. Y. Special ball thrust bearings built for the United States Government for use at the Jupiter Inlet Lighthouse on the Florida coast. These bearings are used on the revolving "flash panels" which give the light its distinctive periods of illumination and darkness.

Grinding Machine: Norton Grinding Co., Worcester, Mass. A plain grinding machine which has a swing of 10 inches, and a capacity for handling work up to 50 inches in length carried on centers. Other sizes of this machine are made to handle work 36 and 24 inches in length, respectively, the swing being the same, i.e., 10 inches.

18-inch Lathes: Monarch Machine Co., Sidney, Ohio. Two 18-inch quick-change gear lathes which are of similar design except that one machine is fitted with a turret, while the other machine is not equipped in this way but is provided with cabinet legs. The turret machine is particularly adapted for machining projectiles and is made with a six-foot bed.

Piston Ring Lathe: Reed-Prentice Co., Worcester, Mass. In the August, 1914, number of MACHINERY an automatic lathe built by the Reed-Prentice Co., Worcester, Mass., for the Ford Motor Co., was illustrated and described. Since that time the design of the machine has been slightly modified to adapt it for turning automobile engine piston rings.

Friction Saw: Joseph T. Ryerson & Son, Chicago, Ill. A high-speed friction saw designed for cutting rails, I-beams, angle irons and other steel shapes. The saw is known as a No. 3 size. The mechanism is carried on a heavy cast-iron base of box section. The wheel-head operates horizontally on vertical rollers with horizontal rollers to prevent sidewise motion.

Hydraulic Pump: L. Henderer's Sons, Wilmington, Del. A combined quick-acting and high-pressure hydraulic pump which is of the double piston type and operated by hand. The provision of two pistons enables continuous discharge to be secured. The principal feature of the pump is the variation of pressure that can be obtained, the range being from 1000 to 6000 pounds per square inch.

Wiring and Horning Press: Fred J. Swaine Mfg. Co., St. Louis, Mo. The noteworthy feature of this machine is the exceptional distance between the slide and table, which makes the press suitable for work which is too high to be handled on a machine of ordinary dimensions. The table is hinged to the column and may be swung out of the way to adapt the press for horning operations.

Grinding Machine: St. Louis Machine Tool Co., St. Louis, Mo. A self-contained countershaft grinding machine. Making the countershaft an integral part of the machine does away with the necessity of attaching it to the ceiling and lining it up properly. It is claimed that all belt strain comes against the body of the machine and that an unusually smooth running transmission is secured.

Bending Machine: Riehle Bros. Testing Machine Co., Philadelphia, Pa. This machine has a capacity for bending bars up to 2½ inches square, and may be readily adjusted for handling different sizes of bars, center pins of various diameters being used for this purpose. It is adapted for either individual motor drive or belt drive. This machine is intended for testing material by bending it cold.

Clutch: O. K. Clutch & Machinery Co., Columbia, Pa. A combination friction and positive clutch which is especially adapted for use on heavy-duty machinery. The load is picked up by the friction clutch, after which the positive clutch may be engaged for driving. However, the frictions are strong enough to carry a heavy load. The clutch is easily engaged or disengaged by a single operating lever.

Shaper Feed Mechanism: Queen City Machine Tool Co., Cincinnati, Ohio. An improved feed mechanism which has been applied to the 20- and 24-inch machines of this company's manufacture. An important feature of this device is that it is designed along lines which make it impossible for the operator to be injured by the gearing or for carelessness on the part of the workmen to result in damage to the machine.

Universal Milling Machine: Rockford Milling Machine Co., Rockford, Ill. An all-geared universal miller in which all shafts with the exception of the main spindle run in Hyatt roller bearings. The starting lever may be placed on either side of the machine; and a feed reverse lever which controls all feed motions is located at each side of the knee. The feed trip lever which disengages all feeds is at the front of the knee.

Suspended Grinding Machine: Stow Mfg. Co., Binghamton, N. Y. A direct-connected drilling, buffing and grinding machine that is suspended from the ceiling. The driving motor is provided with a cord and connection for taking power from a standard lamp socket. The motor is held at one end of a rod which is counterbalanced by a weight, the position of which is adjustable. The grinding wheel or buff is driven by a flexible shaft.

Hardening Furnace: Chicago Flexible Shaft Co., 149 W. La Salle St., Chicago, Ill. A furnace in which three units are mounted on a single base. At the left-hand end there is a crucible for a barium chloride bath. The center section consists of an oven with a molded fireclay lining. At the right-hand end there is a furnace of the direct heat-giving type which provides a sufficiently intense temperature for the heat-treatment of high-speed steel.

Geared Table Feed: W. B. Knight Machinery Co., St. Louis, Mo. This company has recently applied a geared table feed to the vertical milling and drilling machine which it manufactures. This consists of a geared speed-box mounted near the top of the column from which a telescoping universal jointed shaft transmits the motion to the cross shaft in the saddle. Only the transverse motion is given to the table, the cross-feeding being done by hand.

Safety Hood for Grinding Wheels: Pittsburg Emery Wheel Co., Rochester, Pa. It is claimed that this hood meets all the requirements of the Pennsylvania Department of Labor and Industry in regard to safety regulations. The hoods are rigidly constructed of 8-inch channel and sheet steel. Cast-iron caps are mounted on the hoods to protect the ends of the spindle and nuts. Ample adjustment is provided, and the hoods are so constructed that there is plenty of room beneath the wheel where particles of metal and abrasive may collect.

Adjustable Tool-holder: Krieger Tool & Mfg. Co., Grand Rapids, Wis. A combination adjustable lathe, drill press, milling machine, boring and grinding tool-holder which is used in combination with the Krieger adjustable lathe boring tool-holder. It consists of a taper shank which carries an eccentric wrist-pin, the shank fitting into the machine spindle. The eccentric wrist-pin allows the head to swing so that holes ranging from ½ to 6 inches in diameter may be bored. This holder is particularly adapted for work which cannot be swung in a lathe, such as frame castings, crank rods, etc.

Universal Joint: Plank Flexible Shaft Machine Co., Grand Rapids, Mich. In the April, 1914, number of MACHINERY the three-piece universal joint of this company's manufacture was illustrated and described. Since that time the design has been improved in certain details, among which the following may be mentioned: There is now only one position in which the joint can be taken apart instead of two positions as was formerly the case. The size of the center-block has been increased to give greater durability. A ball center has been adopted in place of the sharp fillet formerly employed. These changes give increased strength and durability, thus making the joint better adapted for severe classes of work.

* * *

The Shipping, Engineering and Machinery Exhibition which was scheduled to be held at Olympia, London, England, September 25 to October 17, 1914, was postponed to August and September, 1915, owing to the outbreak of the European war. The promoters of the exhibition point out that it will afford the manufacturers of the United States an exceptional opportunity of showing what the resources of this country are, not only for the British buyer but for the buyers from other parts of Europe. The capture of German and Austrian trade in general engineering machine tools, shipping appliances, etc., is engaging special attention in England and the United States, and the exhibition offers the opportunity for the American manufacturers to show their specialties under favorable conditions. The committee having the exhibition in charge is prepared to set aside for collective American exhibits about 20,000 square feet of floor space, all near the center of the hall and practically forming one block.

* * *

CORRECTION

In the advertisement of the American Emery Wheel Works, Providence, R. I., appearing on page 95 of the February number of MACHINERY, the wheel-cost per box should have been given as $0.002, instead of $0.1002. The purpose was to indicate that the wheel-cost per box was remarkably low, which would not have been the case if the cost had actually been $0.1002.

ELECTRO-MAGNET FOR REMOVING PARTICLES OF IRON FROM THE FLESH

The removal of pieces of shrapnel, steel-jacketed bullets, etc., by the use of powerful electro-magnets in hospitals abroad has been highly praised by many newspapers as a most valuable application of science to surgery. It is interesting to note that the Westinghouse Electric & Mfg. Co. has installed in the relief department of its East Pittsburg Works a magnet for removing metal embedded in the flesh, which is one of the most powerful in the world. This magnet is mounted on a box containing the resistor which is used to regulate the amount of current flowing through the coils. It requires 4000 watts for its operation, or enough power to supply 100 32-candlepower Mazda lamps. It is designed for operation on 70 volts, and as the circuit from which it draws current is used for testing purposes and ranges from 70 to 120 volts, a resistor is necessary.

It is not an infrequent occurrence for steel and iron workers to get bits of metal in their eyes or hands. Previous to the installation of a magnet the only means of removal was by probing, a method which is as uncertain as it is painful. Since this machine has been in operation it is a very simple proceeding to extract such particles. The portion of the body in which the foreign particle is embedded is placed near the pole tip of the magnet, the switch closed, and the magnet does the rest. The pole is removable, a number of different shapes being supplied for various classes of work. It is very common for flying bits of metal to lodge in the eye; and should they strike with force enough to become embedded, their removal without the aid of a powerful magnet is apt to be difficult as well as painful. The protecting coating of the eye must be cut, and there is danger that instead of removing the particle, it may be pushed further into the eye. When the foreign body is once within the eyeball it is properly a case for the specialist.

Steel workers frequently have their hands punctured with minute pieces of metal, which become embedded under the calloused skin. If these bits are allowed to remain, the wound is likely to become infected. The use of a powerful magnet insures the removal of all traces of iron from such wounds in the hand, or any other part of the body. Some remarkably small pieces have been extracted in this way, one recently recovered being not a twelfth of the thickness of a delicate needle. Dr. C. A. Lauffer, medical director of the Westinghouse Electric & Mfg. Co., relates a number of instances in which the magnet has proved invaluable. Among these is the rather amusing case of a workman who attempted to drill one of his own teeth. The drill broke off about half an inch from the end and remained in the cavity, and it seemed as if the only way to remove it would be to pull the tooth. However, a special extension was made and fitted to the magnet pole. As soon as the extension was brought in contact with the drill and the current switched on, the drill was immediately drawn out.

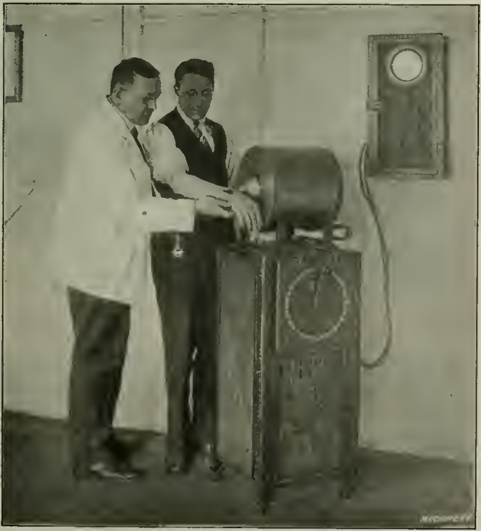


Fig. 1. Removing a Chip embedded in Workman's Wrist

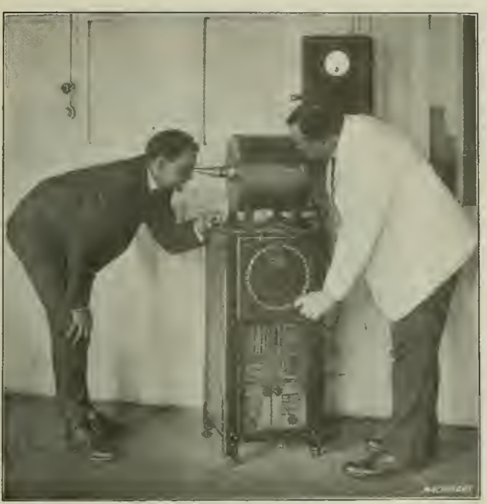


Fig. 2. The Electro-magnet is especially Useful in removing Particles of Iron from Eye

* * *

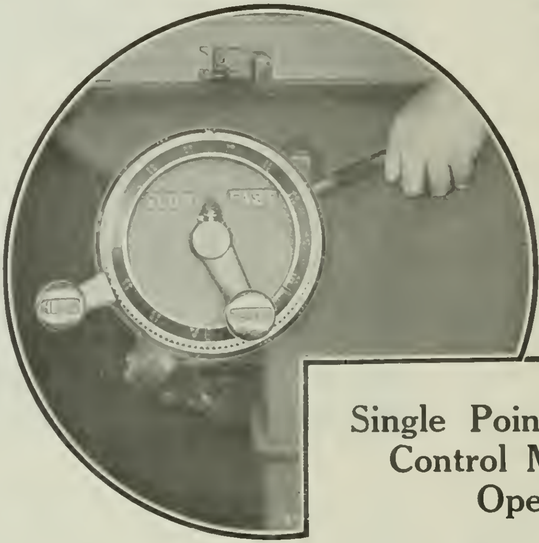
THE A. S. M. E. BOILER CODE

One of the most extensive undertakings ever attempted by an engineering society was brought to a close in February when the council of the American Society of Mechanical Engineers received the report of the boiler code committee of that society. The report contains specifications for the construction of stationary steam boilers and rules for allowable working pressures. The work of its preparation was begun nearly four years ago and has since been continuously under way by the following committee: John A. Stevens, chairman, W. H. Boehm, Rolla C. Carpenter, Richard Hammond, Charles L. Huston, Edward F. Miller and E. D. Meier (deceased).

In the preparation of the preliminary draft of the work, frequent conferences were held with engineers, manufacturers and associations interested and a public hearing was finally arranged, which took place last September in the Engineering Societies Building in New York and was largely attended. It is noteworthy that as a result of these conferences and hearings, an agreement was reached upon uniform specifications for boiler steel and other material and for boiler tubes; and uniform rules for safety valves, fire-tube boilers, water-tube boilers and steam and hot water heating boilers.

At the conclusion of these hearings the code was entirely revised and brought up for discussion at the annual meeting in December where the interest in the matter was so great that five sessions were devoted to this subject. The many suggestions that were there offered were then digested, and to facilitate the work and bring to bear a still broader experience and consequent authoritative rendering of the report, an advisory committee of eighteen prominent engineers was appointed to sit with the regular boiler code committee. The final work of revision began on December 15 and continued without interruption until presented to the council on February 13.

The report has the merit of being condensed, comprising only about 100 pages, and it is phrased with great care. It is expected that it will form a model for such states as introduce laws governing the construction of steam boilers, and materially assist in bringing about uniformity of construction along safe lines.



How It's Done

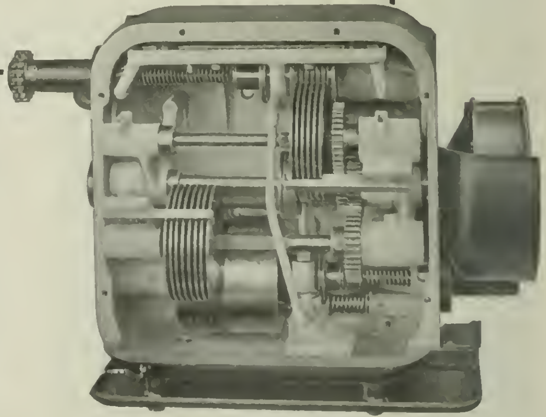
This simple and efficient controller mechanism gives full and instant control of the entire machine, independent of the wheel.

Single Point, One Hand Control Means Easy Operation

with the result that continuous high production is assured. Easy and dependable control from one point on our Nos. 10 and 11 Plain Grinding Machines is a feature appreciated by both factory executive and operator. Are quality, accuracy and high production your requirements in grinding? If so, these machines can easily meet them.

The Mechanism That Does It

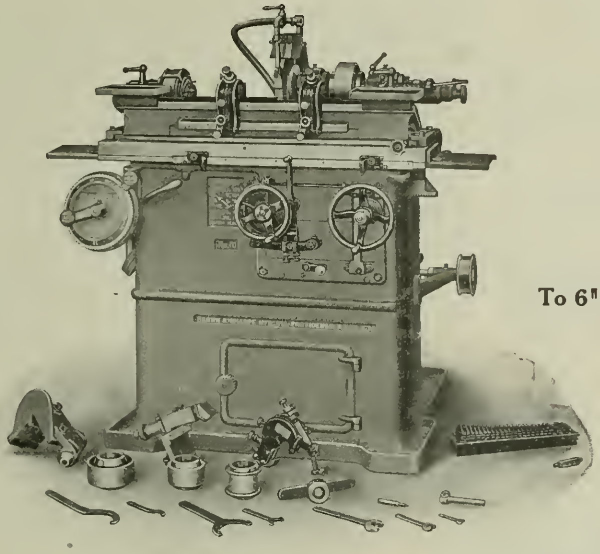
Here's a picture of the interior of the speed case. The arrangement of the multiple friction disks, which give a powerful, reliable drive at a wide range of speeds, is clearly shown.



BROWN & SHARPE MFG. CO.,

OFFICES. 20 Vesey St., New York, N. Y.; 654 The Bourse, Philadelphia, Pa.; 626-630 Washington Blvd., Chicago, Ill.; 305 Chamber of Commerce Bldg., Rochester, N. Y., Room 419 University Block, Syracuse, N. Y.

REPRESENTATIVES: Baird Machinery Co., Pittsburgh, Pa., Erie, Pa.; Carey Machinery & Supply Co., Baltimore, Md.; E. A. Kinsey Co., Cincinnati, O., Indianapolis, Ind.; Pacific Tool & Supply Co., San Francisco, Cal.; Strong, Carlisle & Hammond Co., Cleveland, O., Detroit, Mich.; Colcord Wright Machinery & Supply Co., St. Louis, Mo.; Perine Machinery Co., Seattle, Wash.; Portland Machinery Co., Portland, Ore.



No. 10 Plain
Grinding Machine

Capacity
To 6" Dia. 20" Long

It is Easy to Get Correct Speeds and Feeds

Did you ever fully realize the value of this feature? In your grinding department when a man is given a job is he able to get just the combination of work speed and table travel to give the required finish and the most profitable results? In this respect our Nos. 10 and 11 Plain Grinding Machines offer important advantages.

With these machines there is no temptation to allow a wrong combination to stand. If the operator knows what combination to use, it is simply a matter of reading plain figures on a dial. If he doesn't, it is equally simple to try out various speeds and feeds until the best combination is secured.

The long lever behind the controller mechanism on the left side of the machine controls the machine by bringing into contact two series of powerful multiple friction disks. The levers marked "Head" and "Table" control the relation of the disks and consequently the speed of these parts. They are independent of each other and any desired combination may be quickly secured. Changes are gradual and not by jumps and are indicated on the dial. Thus the machine can be quickly set up and the best conditions secured without losing time or spoiling work.

We should be glad to send full details of construction and operation of this mechanism. Find out for yourself how these machines offer a profitable solution of your grinding problems.

Write for Descriptive Circulars

PROVIDENCE, R. I., U. S. A.

CANADIAN AGENTS: The Canadian Fairbanks-Morse Co., Ltd., Montreal, Toronto, Winnipeg, Calgary, Vancouver, St. John, Saskatoon.

FOREIGN AGENTS: Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow. F. G. Kretschmer & Co., Frankfort, a/M., Germany. V. Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway. Schuchardt & Schutte, Petrograd, Russia. Fenwick Freres & Co., Paris, France; Liege, Belgium; Turin, Italy; Zurich, Switzerland; Barcelona, Spain. F. W. Horne, Tokio, Japan. L. A. Vail, Melbourne, Australia. F. L. Strong, Manila, P. I.

READ PAGE 67

IMPORTANT PATENT DECISION

A decision recently rendered by the United States Circuit Court of Appeals, at Chicago, is particularly strong and clear in the expression of principles relating to patent litigation and is of considerable importance. The decision relates to a tie plate for railroads, but the specific device referred to is of little importance. The principles enunciated, however, are as follows: The court distinguishes clearly between a patentable combination and a mere aggregation of parts, but confirms the practice of the patent office in sustaining patent claims "on the theory that it is sufficient if the elements are associated in a unitary structure and there cooperate to produce either a new mode of operation or a new result, or the old result in a modified and improved way."

Another interesting point emphasized by the court is that if a large and important business has grown up based on the invention, it is evident that the inventor has discovered a need and fills it by his inventive talent. "The last mentioned fact (the instant and large demand for the patented article) might also be taken as sufficient to evince the novelty" of the device, the patent rights of which are questioned, because otherwise no one would probably have ventured to trespass upon the patent rights, "if they could have found upon the public common what would serve their purposes."

In commenting upon the fact that the invention was extremely simple and that this militated against the claim of the invention, the court said: "In an old and well developed field the apparent simplicity of a new device is often the highest evidence of inventive genius. So far as human minds are able, judges should exclude from view the disclosure of the patentee, should regard the patentee's problem as of a time antedating the application, and should therefore not too readily accept the *ex posto facto* wisdom of the bystander. Prior art structures are to be examined in view of the purposes and laws of such structures. It is not enough that a prior art device approach very near the idea of the patent in suit; it must so clearly disclose the idea that it would be apparent to a mechanic of ordinary intelligence who was not examining the device for the purpose of discovering in it the idea of the patent; for, if he already had that idea, he would not be getting it from the prior art device, but from his own imagination or some other source."

The most interesting part of the decision, however, is that it refers to the fact that the building up of a business on the basis of a patent which is not challenged before the business has been built up and proved successful is a strong evidence of the validity of the patent. "A patent is a contract between the government on behalf of the people and the patentee. The grant of a patent might have been made conclusive evidence of its validity except against suits by the government for fraud or mutual mistake in the issuance. But the fact that certain defenses are left open to the individual should not make us lose sight of the nature of the presumption that attaches to the grant. Not merely has the application been examined on behalf of all the people by experts who have access to all the prior patents and publications of the world; not only has the applicant spent his time and invested his money in procuring the patent; but in most of the important cases the patentee and those working under him have invested very large sums in buildings and machinery and have expended other large sums and put in great energy and effort to build up, by advertising and salesmanship, a profitable business. And this is done before anyone challenges the presumptive validity of the patent. Courts therefore should not view the application as of the date of its filing and constitute themselves into a board of reviewing examiners and on nicely balanced considerations find that the patent office examiners were in error; but they should consider the patentee's equities in his business, which has developed under the presumptive validity of the patent, should give heed to the place achieved by the patented article in the field of the practical art since the date of the patent, and should therefore decline to sustain the defense of non-invention and to strike down the patent and the business built upon it unless that defense has been established beyond a reasonable doubt.

FORD PROFIT-SHARING PLAN

In testifying before the Federal Commission on Industrial Relations, Henry Ford of the Ford Motor Co., Detroit, Mich., gave a complete statement of the rules governing the profit sharing plan inaugurated by the company a year ago. In the first place, he stated that the regular wages received by the men working in the Ford plant were about 15 per cent above the usual wages paid for similar services by other manufacturers. In addition, anyone who qualified under certain rules was entitled to a certain part of the profit so that the minimum daily income under the plan, wages plus profit, would be $5. The profit sharing rate which is added to the wages is so arranged as to give to those receiving the lowest daily wage the largest proportion of the profits. For example, a man receiving 34 cents an hour receives a profit of 28½ cents an hour in addition, making a total income of $5, while a man receiving as his regular wage 54 cents an hour receives a profit sharing rate of 21 cents an hour only, making the total daily income $6. The working day has been reduced to eight hours (instead of nine), the week now consisting of forty-eight hours. The wages and the profits are paid in currency every two weeks.

Those qualified for participation in the profits are of three classes: (1) married men living with and taking good care of their families; (2) single men over twenty-two years of age who have proved to be of thrifty habits; (3) young men under twenty-two years of age and women who are the sole support of some next of kin. In order to be entitled to profit sharing, six months' employment with the company is required.

* * *

Representative E. B. Follette has introduced a bill in the Michigan legislature to limit the prices charged for repairs of automobiles and farm implements. He made the statement that these concerns charge a profit of from 500 to 1000 per cent, and that the customer is helpless once having bought and paid for a machine. The bill provides that the manufacturer of machinery shall file with the secretary of state a schedule of prices on each type of machine sold and the costs of the component parts of the machine sold. The secretary of state will be empowered to refuse to accept this schedule if the total cost of the various parts exceeds by more than 25 per cent the cost of the assembled machine. If the manufacturer should insist on selling goods without registering such a schedule, he will be liable to a fine of not more than $1000, or imprisonment for not more than six months, or both.

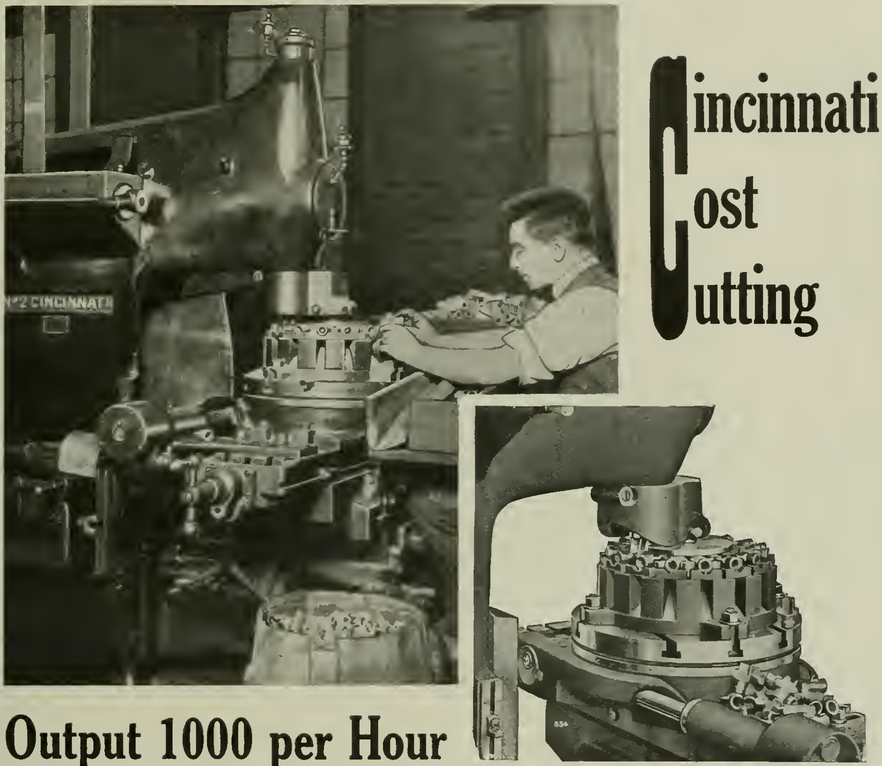
* * *

Not less than fourteen eight-cylinder cars were shown at the Chicago Automobile Show and several other manufacturers have announced their intention of entering this field. There is no doubt in the minds of many automobile engineers as to whether this eight-cylinder fad—as it is termed by many—will last. Although no definite announcements have been made as yet, it is known that several makers contemplate bringing out a twelve-cylinder model, it having been stated by one company that if the public demanded a twelve-cylinder car, this company was prepared to furnish it. At the present time there is but one twelve-cylinder car made, this being a racing model of the "Sunbeam," a British make, which took part in the Indianapolis races last year.

* * *

The patent suit brought against the B. F. Sturtevant Co. of Boston by the Sirocco Engineering Co., which has been in the courts for the past six years, has just been decided by the United States Circuit Court of Appeals for the Second Circuit in favor of the Sturtevant Co. It was claimed that the Sturtevant multivane fan infringed the Sirocco Co.'s patents, and in the lower court this claim was sustained. The Court of Appeals, however, reversed the former decision and held that there was no infringement. The Court of Appeals further decided that the Sirocco patents in suit were void in view of the development of the fan building art prior to the alleged inventions upon which these patents were based.

Cincinnati Cost Cutting



Output 1000 per Hour

These pieces are water meter parts. The milled sections are 1⅜″ long by 1⅞″ wide over all. Enough stock is removed to clean up each surface and give a flat bearing.

The Metric Metal Works finishes 1000 pieces per hour on the **Cincinnati No. 2 Vertical Cone** with this special circular milling attachment. The parts are automatically clamped and released. The operator's energy is confined to continuously inserting and removing pieces. He need not move from his seat for a single adjustment.

The Metric Metal Works is one of the many customers for whom we are saving time and money in their milling department. May we add you to the list? "Cold Chips" gives details.

THE CINCINNATI MILLING MACHINE COMPANY

CINCINNATI, OHIO, U. S. A.

THE SUBMARINE BATTLESHIP

The ultimate development of the submarine war vessel apparently means the doom of the modern battleship, but though the present type of submarine seems to be the invincible enemy of the battleship, its offensive powers are limited to the destruction of ships; it is powerless to act against land fortifications. Does this mean that the battleship of the future will be a vessel that can be submerged? Will it be equipped with heavy guns and turrets so it will be able to destroy land defenses as well as to hide beneath the waters and to creep up to an enemy unseen and unfelt until the deadly torpedo is launched? If the present type of battleship is costly, what will be the cost of the submarine type weighing 30,000 tons and capable of ranging 5000 miles from its base of supplies? Diesel engines, oil fuel and apparatus for extracting oxygen from sea water would mean almost unlimited submergence and freedom of movement. Turrets that withdraw snugly into the shell present no insuperable difficulties of construction. Given unrestricted resources, the possibilities of the war game are unlimited.

* * *

PERSONALS

L. H. Mesker is now connected with the sales department of Kearner & Trecker Co., Milwaukee, Wis., and will act as its representative in the state of Ohio.

James D. Wilson, former president and general manager of the Montague Iron Works Co., Montague, Mich., and Martin Hausler of South Chicago, Ill., have taken over the interests of the Montague Iron Works Co., and will continue the business along the same lines as in the past.

M. A. Sherritt, for several years associated with Manning, Maxwell & Moore, Inc., as manager of the Philadelphia branch, resigned his position to become vice-president and general manager of Sherritt & Stoer Co., Inc., Finance Bldg., Philadelphia, Pa., dealer in machine tools, railway and machine shop equipment.

David A. Wright, for several years connected with the Yale & Towne Mfg. Co., as district manager in the West, has gone into business for himself and opened an office as manufacturer's agent at 140 South Dearborn St., Chicago, Ill. Mr. Wright is specializing on labor saving and pneumatic machinery, cranes, hoists and trolley systems.

Guy E. Marion, secretary-treasurer of the Special Libraries Association, has severed his connection with Arthur D. Little, Inc., chemists, engineers and managers, 93 Broad St., Boston, Mass., where he has been located for the last five years in charge of their information department. Mr. Marion will devote himself to the organization and development of special libraries, or information departments, in business houses, industrial plants, etc. He occupies offices in the Tremont Bldg., Boston, with Warren H. Manning, landscape designer.

The machinery trade will be much interested in the announcement of Walter L. Clark's retirement from the Niles-Bement-Pond Co., followed a week later by the news of his connection with the important banking house of J. P. Morgan & Co. On February 1, Mr. Clark resigned as vice-president and sales manager of the big machinery house at 111 Broadway with the intention of giving up active work, but his retirement was quickly followed by an offer from J. P. Morgan & Co. of such a character that he decided to accept it. His connection with the banking house is in a consulting capacity in the firm's newly organized department for purchasing machinery and war materials for the British Government, the bankers acting as representatives of Great Britain in this country. They are fortunate in being able to secure the services of a man and executive so widely known and so thoroughly experienced in the mechanical field. Mr. Clark was for thirty-one years in the machine tool field—with the Niles Tool Works, Hamilton, Ohio, and with the Niles-Bement-Pond Co. as vice-president since the formation of the concern in 1901.

COMING EVENTS

April 12-15.—Annual convention of the National Metal Trades Association, New York City. Hotel Astor, headquarters. H. D. Sayre, secretary, Peoples Gas Bldg., Chicago, Ill.

April 24-May 1.—Second Efficiency Exposition at the Grand Central Palace, New York City. Organized by the Efficiency Society, Inc., 41 Park Row, New York City.

May 20-21.—Spring convention of the National Machine Tool Builders' Association at Atlantic City. Marlborough-Blenheim Hotel, headquarters. Charles E. Hildreth, general manager, Worcester, Mass.

June 8-11.—Third annual convention of the National Association of Corporation Schools at Worcester, Mass. H. W. Dunbar, general chairman of the convention committee, Norton Co., Worcester, Mass.

June 9-11.—Annual convention of the American Railway Master Mechanics Association, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

June 14-16.—Master Car Builders' annual convention, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

June 19-29.—Annual convention of National Graphic Arts Exposition in the Coliseum, Chicago, Ill. Publicity manager, A. D. V. Storey, National Exposition Co., 200 Fifth Ave., New York City.

July 19-21.—Seventh annual convention of the American Railway Tool Foreman's Association, Chicago, Ill. Hotel Sherman, headquarters. Owen D. Kinsey, secretary and treasurer, 7223 Ridgeland Ave., Chicago, Ill.

August 17.—Annual meeting of the International Railroad Blacksmiths' Association, Philadelphia, Pa. A. L. Woodworth, secretary-treasurer, C. H. & D. Railway, Lima, Ohio.

September 9-11.—Swedish engineering convention in the United States; meeting in Chicago. Secretary, Eastern organization committee, E. Oberg, 183 68th St., Brooklyn, N. Y.; secretary Western organization committee, C. G. Axell, 601 City Hall Square Bldg., Chicago, Ill.

SOCIETIES, SCHOOLS AND COLLEGES

Pratt Institute, Brooklyn, N. Y., announces that Wednesday evening, March 10, will be observed as "Visitors' Night" in the School of Science and Technology, and the shops, laboratories and drawing rooms will be open to the public. All persons interested in industrial education will be given an opportunity not only of viewing the students at work in the various courses, but also of inspecting both the results and facilities of the institute for industrial training.

NEW BOOKS AND PAMPHLETS

Bulletin of the Bureau of Standards. 187 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C.

Annual Report of the Director Bureau of Standards. 99 pages, 6 by 9 inches. Published by the Department of Commerce, Washington, D. C.

Morris Plan of Industrial Loans and Investments. 68 pages, 6 by 9 inches. Published by the Industrial Finance Corporation, New York City.

Industrial Arts Index, 1914. Edited by Marion E. Potter and Louise D. Teich. 434 pages, 7 by 10½ inches. Published by H. W. Wilson Co., White Plains, N. Y.

Measurement of Time and Tests of Timepieces. 39 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular of the Bureau of Standards No. 51.

National Standard Hose Couplings and Fittings for Public Fire Service. 23 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular of the Bureau of Standards No. 50.

Hydration of Portland Cement. By A. A. Klein and A. J. Phillips. 71 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper of the Bureau of Standards No. 43.

Studies on the Silver Voltameter. By G. A. Hulett and G. W. Vinal. 18 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Scientific Paper of the Bureau of Standards No. 240.

Analysis of Coal with Phenol as a Solvent. By S. W. Parr and H. F. Hadley. 41 pages, 6 by 9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill., as Bulletin No. 76. Price, 25 cents.

Absorption, Reflection and Dispersion Constants of Quartz. By W. W. Coblentz. 11 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Scientific Paper of the Bureau of Standards No. 237.

Electrical Resistance and Critical Ranges of Pure Iron. By G. K. Burgess and I. N. Kellberg. 14 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Scientific Paper of the Bureau of Standards No. 236.

Direct-reading Instrument for Measuring the Logarithmic Decrement and Wave Length of Electro-magnetic Waves. By Frederick A. Kolster. 34 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Scientific Paper of the Bureau of Standards No. 235.

Characteristic Equations of Tungsten Filament Lamps and Their Application in Heterochromatic Photometry. By G. W. Middlekauff and J. F. Skogland. 51 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Scientific Paper of the Bureau of Standards No. 238.

Lubrication of the Motor Car Chassis. Chart published by Norman W. Henley & Son, New York City. Price, 25 cents.

This chart shows a plan view of a typical six-cylinder chassis of standard design. All parts that demand oil are clearly indicated. It is a practical chart for all interested in motor car maintenance.

Mechanical World Pocket Diary and Year Book for 1915. 330 pages, 4 by 6 inches. Illustrated. Published by Emmott & Co., Ltd., Manchester, England; distributed in the United States by Norman, Remington Co., Baltimore, Md. Price, 50 cents.

This well-known compilation of useful engineering rules, tables, formulas and data has been issued consecutively for twenty-eight years. The book treats of steam and steam engines, steam turbines, condensers, gas engines, gas producers, boilers, materials for construction, shafting, gearing, machine shop practice, belting, hydraulics, weights and measures, logarithms, trigonometrical tables, etc. A diary for every day in the year is also included, and a complete index makes reference to the matter contained convenient.

Outlines of Lessons. Bulletin No. 10 of the Wisconsin State Board of Industrial Education, containing proceedings of the Conference and Institute of Teachers held at Milwaukee, Wis., September 2-4. 377 pages, 6 by 9 inches. Published by the Wisconsin State Board of Industrial Education, Madison, Wis.

This bulletin should be of general interest to superintendents of industrial, commercial, continuation and evening schools, as it contains the outlines of lessons in English, hygiene, safety, shop drawing, mechanical drawing, shop mathematics, applied mathematics, shop construction, cooking, bookkeeping, shorthand, business practice, practical art, typewriting, printing, advertising, commercial activities, etc., for apprentices and boys and girls in various grades.

Mechanical World Electrical Pocket Book for 1915. 240 pages, 4 by 6 inches. 129 illustrations. Published by Emmott & Co., Ltd., Manchester, England. Distributed in the United States by Norman, Remington Co., Baltimore, Md. Price, 50 cents.

The improvements in the present issue of this handbook pertain largely to the revision and expansion of several of the sections. Many new features have also been introduced; for example a section on electric circuits and switching is now included, as well as matter on synchronizing and phasing out. The section on electricity on shipboard has been re-written and considerably extended, and the matter treating of electric lamps and electric light has been brought up to date.

Drake's Telephone Handbook. By David Penn Moreton. 286 pages, 4¼ by 6¾ inches. 101 illustrations. Published by Frederick J. Drake & Co., Chicago, Ill. Price, $1.

In this volume the author has endeavored to cover the field in such a way that the book will prove of value to all interested in the various phases of the telephone industry. The material is divided into ten chapters on the following subjects: Electrical Circuits and Electrical Units;

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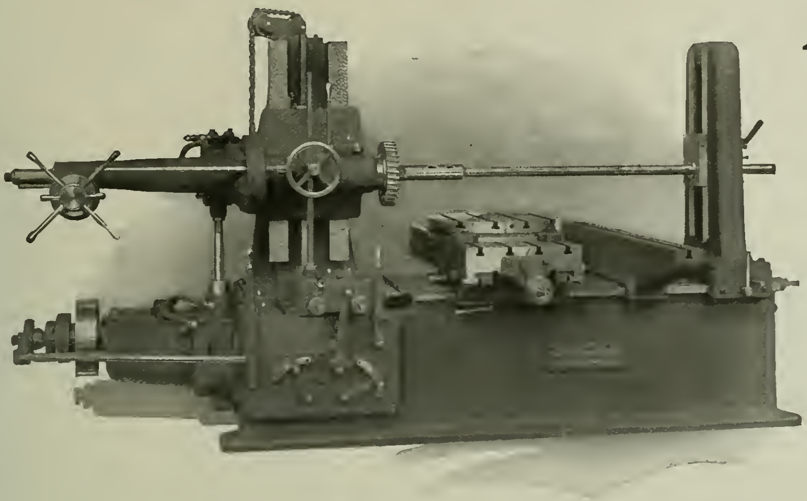

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Installing Efficiency Methods. By C. E. Knoeppel. 258 pages, 7 by 10 inches. 98 illustrations, charts and diagrams. Published by the Engineering Magazine, New York City. Price, $3.

In this book which forms the latest addition to the Engineering Magazine's Works Management Library, are described the methods to be employed to increase efficiency of the manufacturing establishment, and how they may be put into practical effect. It analyzes the work of the efficiency engineer and tells how he proceeds to apply these principles in a manufacturing plant. The work is composed largely of matter published in the Engineering Magazine, and its contents by chapter heads are as follows: The Conditions; The Preliminary Investigation; The Conclusions; Results and Objections; The Self-Examination and Decision; The Business Analysis; The Diagnosis; Prescribing the Treatment; The Engineer, The Management and the Men; The Time Study; The Planning Department—Analysis and Material Control; The Planning Department—The Necessary Machinery; The Planning Department—Auxiliary Devices; Standardizing the Working Conditions; Standardizing the Operations; the Bonus Plan or Wage Payment; The Efficiency Clearing House; Manufacturing Costs.

Official Proceedings of the American Railway Tool Foreman's Association. 145 pages, 6 by 9 inches. Illustrated. Published by the Association. A. R. Davis, secretary-treasurer, 750 Pine St., Macon, Ga.

The official proceedings comprise the papers presented at the sixth annual convention held at the Hotel Sherman, Chicago, July 20-22, 1914, as follows: "Standardization of Reamers for Locomotive Repair Shops," by C. A. Shaffer, E. J. McKernan, J. T. Manger, W. J. Eddy and J. E. Dosser; "Toolroom Grinding," by E. R. Purchas, W. C. Diebert, J. C. Bevelle, Owen D. Kinsey and Thomas F. Eaton; "Safety as Applied to Grinding Wheels," by R. G. Williams; "Machine Tool Repairing," by J. B. Hasty; "Machine Repairs, Methods of Handling, Records, etc.," by George Tothill and G. W. Smith; "Distribution of Tools for Shop Use, Arrangement of Tool Racks, Delivery of Tools," by Henry Otto, W. E. Ross, and J. T. Fuhrman; "Special Tools for Drilling, Reaming and Milling," by J. J. Sheehan, Thomas F. Eaton, H. B. Miller, R. Dolensky, W. L. Stephenson and W. E. Goodwin; "Special Dies for Cold Work—Cold Punching Dies," by B. Henricson and John Ulrich.

The Design of Steam Boilers and Pressure Vessels. By George B. Haven and George W. Swett. 416 pages, 6 by 9 inches. 197 illustrations. Published by John Wiley & Sons, Inc., New York City. Price, $2.50.

With the idea of harmonizing the rational methods of theory and practice, the authors of this book have sought to incorporate in its pages the most direct procedure possible in the design of steam boilers and other pressure vessels. The present practice in boiler making has been kept constantly in view, and wherever possible the results have been obtained by rational rather than by empirical methods. The design of many types of boilers is largely the result of experience and well established precedent, and it is therefore hoped that the definite program followed in working out the problems contained in the work will be of value not alone to students, but to all engaged in boiler making and design. The data and constants assumed have been obtained from safe practice and represent wide margins. The book is divided into eight chapters, dealing with general principles, stresses in pressure vessels, fastenings by riveted joints, general proportions, design of a horizontal return tubular boiler, design of a dry back Scotch boiler with combustion chamber in shell extension, design of a vertical straight shell multitubular boiler, design of a locomotive type boiler for contractors' use, and tank design.

NEW CATALOGUES AND CIRCULARS

Harrison Safety Boiler Works, Philadelphia, Pa. Pamphlet No. 17 on the Sorge-Cochrane hot process system of softening boiler feed water.

Cutler-Hammer Co., Milwaukee, Wis. Circular of [illegible] lamp sockets designed to supersede the [illegible] type.

Cleveland Worm & Gear Co., Cleveland, Ohio. Leaflet advertising [illegible] accurately cut worm gearing and [illegible] reduction cases.

Toledo Scale Co., Toledo, Ohio. Catalogue on Toledo [illegible] automatic scales designed for use in [illegible] warehouses, foundries, etc.

Allen Mfg. Co., Hartford, Conn. Leaflet on "Allen" safety set-screws of the headless and socket head types, made in sizes from [illegible] to 1¼ inch diameter.

Gas Engine & Power Co. and Charles L. Seabury & Co., Morris Heights, New York City. Catalogue 11 descriptive of Seabury marine steam engines for commercial and pleasure craft.

American Blower Co., Detroit, Mich. Bulletin showing the installation of the "Sirocco" heating and ventilating system in the Fletcher Savings & Trust Co. Bldg., Indianapolis, Ind.

Ajax Mfg. Co., Cleveland, Ohio. Circular showing how it is possible to gather profits from the scrap pile by the use of Ajax reclaiming rolls that roll round, square or flat bars from low-priced scrap.

Dillon Electric Co., Canton, Ohio. Circular on the Dillon electric grinder, made for 110 and 220 volts direct current, and 110, 220, 440 and 550 volts, 60 cycles, alternating current, one-, two- and three-phase.

Stow Mfg. Co., Binghamton, N. Y. Bulletin 54, illustrating Stow suspended type direct-connected drill, buffer or grinder, Stow general utility tool for die-sinking, drilling, buffing, grinding, etc., and Stow two-spindle drill.

American Pulley Co., Philadelphia, Pa. Circular advertising "American" pulleys. The stock sizes of these pulleys are from 3 to 72 inches diameter inclusive. All pulleys above 6 inches in diameter have grooved faces.

National X-Ray Reflector Co., 235 W. Jackson Blvd., Chicago, Ill. "Eye Comfort," a monthly publication treating of proper methods of illumination, and describing the "Eye Comfort" indirect lighting fixtures marketed by this firm.

Gas Engine & Power Co. and Charles L. Seabury & Co., Morris Heights, New York City. Catalogue on the "Seabury" water tube boiler for stationary and marine service. Details of construction and instructions for the operation and care of "Seabury" water tube boilers are given.

Adjustable Ratchet Wrench Co., Room A 1651 Marquette Bldg., Chicago, Ill. Circular giving price list of the "Anderson" adjustable ratchet wrench. This wrench is adjustable to any kind or size of nut or bolt, and it works at every angle. It is made in 6-, 8- and 10-inch sizes.

Boston Gear Works, Norfolk Downs, Mass. New 1915 catalogue E8, listing the complete line of gears made by this company. The company makes a specialty of all kinds of steel gears including automobile differential and transmission gears as well as fan, cam, timer and pump gears for engines.

George W. Southwick Co., Stamford, Conn. Circular of twisted round belt lacing manufactured in the American plant of William Burke Sons Co., England, working under the management of George W. Southwick Co. This lacing is noted for its ductility, absence of stretch and great tensile strength.

Buffalo Forge Co., Buffalo, N. Y. Bulletin 182 E treating of the various types of Buffalo blowers and exhaust fans built for direct connection to motors. The line shown ranges from the large ventilating and drying fans down to the "Baby Conoidals" for ventilation of moving picture booths, drying cabinets, etc.

Doane Mfg. Co., Boston, Mass. Leaflet on the "Doctor" ferrules and file handles, which are designed to meet the increasing demand for a non-splitting file handle. The ferrule is made of heavy pressed steel, enlarged at the head, and it firmly locks the wooden portion within the enlarged end, when driven into place.

Willmarth Tool Works, 1516 E. 32d St., Cleveland, Ohio. Circular descriptive of the Willmarth two foot radial drill. This machine is designed to withstand the strains to which modern machine tools are subjected by high-speed steels. It has the rigidity of an upright drill combined with the flexibility of the radial type.

Felt & Tarrant Mfg. Co., Chicago, Ill. Pamphlet on the comptometer as applied to engineering calculations incident to the work of civil, mechanical, electrical, hydraulic and mining engineers, architects, builders, contractors, etc. Some examples of calculations that can be advantageously performed in the engineer's office are included.

Buffalo Forge Co., Buffalo, N. Y. Catalogue 200 on Buffalo "Planoidal" (type L) fans, which are a modification and improvement on the older type of steel plate heating and ventilating fans with a comparatively small number of radial blades. It is expected that under most conditions this type of fan will compete on an equal basis with multi-blade fans.

Fafnir Bearing Co., New Britain, Conn. Catalogue 15 on ball bearings, giving tables of dimensions of Fafnir radial ball bearings, two-row radial ball bearings, self-aligning radial ball bearings, self-aligning two-row radial ball bearings, cone type ball bearings, magneto type ball bearings, ball thrust bearings, ball thrust bearings—self-aligning type.

D. & W. Fuse Co., Providence, R. I. Catalogue on magnetic chucks showing flat and rotary chucks, and attachments for converting flat chucks into the vertical taper or swivelling types. A number of illustrations also show the chucks applied to a planer and internal surface and disk grinders. Price lists of magnetic chucks and direct current generators for operating them are included.

General Electric Co., Schenectady, N. Y., announces that it has standardized the concentrated filament "Mazda" lamps in the 25, 40 and 60 watt sizes which are designed to give greater downward distribution of useful light than is possible with the regular "Mazda" lamp of corresponding wattages. These lamps will be made in the same size bulbs as the regular standard "Mazda" lamps, and will have a rated average life of 600 hours.

H. D. Smith & Co., Plantsville, Conn. Circular advertising the "Perfect Handle" screwdriver. This screwdriver is drop forged from a solid piece of steel and has a wooden handle. The steel is closed in over the wood at each end, protecting it thoroughly. The "Perfect Handle" screwdriver can be supplied with three bits. When equipped in this way, screws can be operated in places that are not accessible by the ordinary screwdriver.

Harrison Safety Boiler Works, Philadelphia, Pa. Catalogue on "Cochrane" multiport valves, describing multiport valves intended for back pressure relief and vacuum service, flow service in connection with mixed flow turbines and check valve service with bleeder or extraction turbines. In addition to the descriptive and tabular matter, the book contains numerous diagrams and layouts as well as data on the effects of air in condensers and on turbine performance.

Buffalo Forge Co., Buffalo, N. Y. Catalogue 201 dealing with "Niagara Conoidal" fans. These fans, besides having all the advantages of the multiblade type in respect to high operating speeds, compact arrangement and rigidity, are equipped with blades which are so shaped and proportioned to the housing that it is possible to convert into static pressure the velocity head, which is much higher in proportion to the total pressure with multi-blade fans than with the older types having few blades.

Ajax Mfg. Co., Cleveland, Ohio. Circular devoted to Ajax taper forging rolls, which are adapted for the rapid and economical production of forged taper pieces. These machines are very rigidly constructed and all gears are enclosed in guards. Some of the forgings that can be produced on these taper forging rolls are pictured as a suggestion of the possibilities of the machines; these are brake levers, brake shoe keys, trolley poles, drag bars for agricultural implements, seat springs, wedges, ship liners, tapered tubes, tongs, etc.

Ajax Mfg. Co., Cleveland, Ohio. Catalogue and reference book on Ajax hot metal-working machines. Among the products of this company are: rivet and bolt headers, axle upsetting machines, bolt bending, upsetting and forging machines, standard and high-speed bulldozers, hot sawing and burring machines, universal forging machines, hot pressed nut machines, taper forging rolls, and reclaiming rolls. The book illustrates the machines, as well as the product produced by them, and explains the points of merit incorporated in the various designs, with the aid of detail views. The descriptive matter is clear and well arranged.

Charles H. Besly & Co., 120B N. Clinton St., Chicago, Ill. Catalogue on Besly patternmakers' grinders, showing illustrations of these grinders in operation in a number of different plants. Some of the important parts, such as adjustable work-table, sliding bevel gage, sizing circle gage, angle-plate, roll-sanding attachment, etc., are shown in detail. These grinders are made in three types, with disk wheels 30 and 40 inches in diameter as follows: Type A, with disk wheel and work-table on one end only; Type B with disk wheel and work-table on both ends; and Type C with disk wheel and work-table on one end and roll sanding attachment on the other end.

Chain Belt Co., Milwaukee, Wis. General catalogue 56, dealing with elevating and conveying machinery, chain belt, sprocket wheels, transmission machinery, etc., for saw mills, cement mills, canning plants, power plants, sand and gravel plants and practically every line of industry. The two chain belts particularly featured are the "Griplock" and the "Chabelco" chain belts which are designed for especially heavy work. The former is made from malleable iron and the latter entirely of steel. The catalogue gives complete information on the company's product and includes tables of useful data, such as horsepower transmitted by cut gearing, weights of materials, weights of steel angles, weight per foot of round and square steel bars, areas and circumferences of circles, etc.

De Laval Steam Turbine Co., Trenton, N. J. Catalogue of De Laval centrifugal pumps, containing 298 pages and over 300 illustrations. It is a catalogue of centrifugal pumps for all capacities and heads, motor and steam turbine driven. Diagrams showing the characteristics of such pumps and explaining the relation between the impeller blades, angles and characteristics are included. The text matter is divided into chapters under headings as follows: The Introduction of the Centrifugal Pump and the Work for which it is Adapted, Features to be Considered in Selecting Centrifugal Pumping Equipment; The Use of the Characteristic Curve, Method of Testing Centrifugal Pumps; System of Manufacture for the Production of Interchangeable Parts; Details of Design and Construction of Single-stage and Multi-stage Pumps; The Speed Question, Particularly Relating to Steam Turbine-Driven Centrifugal Pumps; Helical Speed Reducing Gears; Motor and Belt Drives, High Duty Steam Turbine-Driven Pumps as Compared with Reciprocating Pumping Engines for Water Works Service, The Adaptation of Pumps for Circulating Condenser Water, Feeding Boilers and Other Steam Power Plant Service, Drainage and Irrigation Pumps; Hydraulic Pressure and Elevator Pumps, Pumps for Marine Uses, Mining Service, Power Service and Hot Water and Brine Circulation. Valuable tables and charts are also included.

TRADE NOTES

Ingle Corporation, Rochester, N. Y., maker of gear tooth grinders and special machinery, has changed its name to the Merchants Machine Co.

Standard Welding Co., Cleveland, Ohio, has added seventy-nine men to the working force of its automobile rim department. The added working force will bring the production of rims above normal.

Electric Controller & Mfg. Co., Cleveland, Ohio, announces that the O. H. Davidson Equipment Co.,

APRIL MACHINERY 1915

Shrapnel and Shrapnel Manufacture

Historical Sketch of the Development and Methods of Manufacture

by

Douglas T. Hamilton

IN NAVAL, coast defense and artillery operations, several types of explosive shells are used; the chief ones are: the armor-piercing shell, made to pierce armor plate before exploding; shells exploded by means of a timing fuse; shells exploded by either a timing or percussion fuse; and shells exploded by percussion only. Each different shell has some definite function to fulfill, and is designed for that purpose. For field or artillery operations, the shrapnel and lyddite are the two principal types used. Of these, shrapnel is the most prominent, because of its enormous destructive power and its interesting mechanical construction.

Early Development of Shrapnel

The shrapnel shell was invented in 1784 by Lieut. Henry Shrapnel, and was adopted by the British Government in 1808. As is shown at *A* in Fig. 2, the first shell was spherical in shape and the powder or explosive charge was mixed with the bullets. Although this type of shell was an improvement over the grape and canister previously used, its action was not altogether satisfactory, as the shell, on bursting, projected the bullets in all directions and there was also a liability of premature explosion. In order to overcome the defects mentioned, Col. Boxer (R. A.) separated the bullets from the bursting charge by a sheet iron diaphragm, as shown at *B* in Fig. 2. This shell was called a diaphragm shell to differentiate it from the first shell of this type.

In the shell made by Col. Boxer, the lead bullets were hardened by the addition of antimony, and as the bursting charge was small, the shell was weakened by cutting four grooves extending from the fuse hole to the opposite side of the shell. Shells of spherical shape were first fired out of plain bored guns, and upon the advent of the rifled gun it was necessary to add a circular base, which was made of wood and covered with sheet iron or steel to take the rifling grooves. The first shrapnel shells were made of cast iron, but a later development was to use toughened steel and elongate the body, reducing it in diameter. The diameter of the bullets was also reduced so that a greater number could be contained in a slightly smaller space. The improved shrapnel was also capable of being more accurately directed.

Shrapnel Shells of Present-day Design

Shrapnel shells, as used at the present time by the different governments, vary slightly in construction and general contour as well as in the constituents entering into their different members. As shown in Fig. 1, a completed shrapnel comprises a brass case carrying a detonating primer and the explosive charge for propelling the projectile out of the bore of the gun. The projectile itself comprises a forged shell that carries the lead bullets and bursting charge. Screwed into the front end is the combination timing and percussion fuse which can be set so as to explode the shell at any desired point and from which the flame for exploding the bursting charge is conveyed through a powder timing train and a tube filled with powder pellets down through the diaphragm to the powder pocket.

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* Associate Editor of MACHINERY.

Of these members of a shrapnel, the shell and timing fuse present the most interesting features from a mechanical standpoint. The shell used by most governments is made from a forging, machined to the desired dimensions in hand and semi-automatic turret lathes as well as in ordinary engine lathes. The fuse, a complete description of which will be given later, is an extremely accurate piece of mechanism, and it is largely produced from screw machine parts, some of which, however, are forged previous to machining. The brass cartridge case—the next member of importance—is drawn up from a brass blank by successive operations in drawing presses, and is indented and headed. Following this, several machining operations on the head and primer pocket are accomplished.

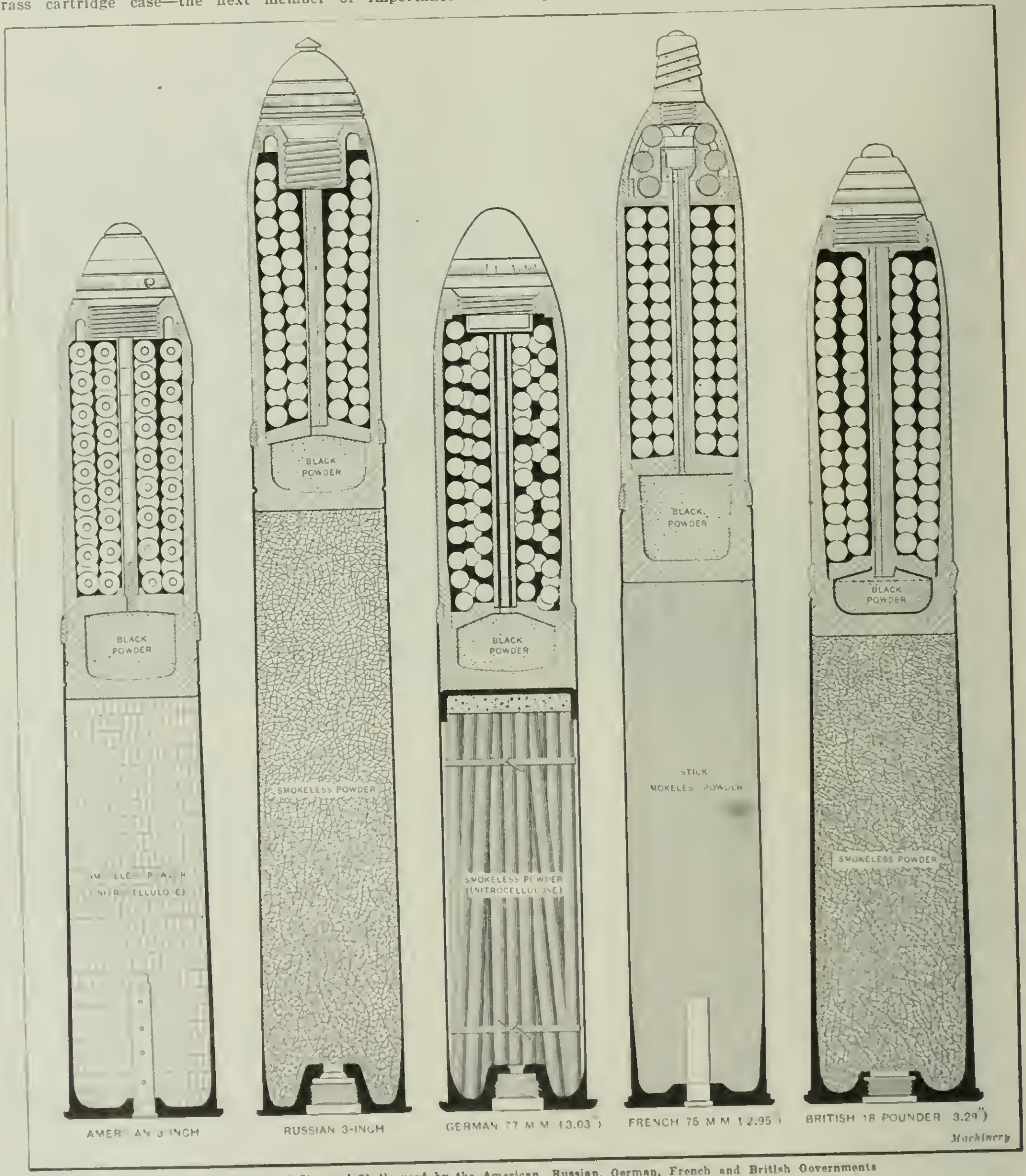


Fig. 1. Types of Shrapnel Shells used by the American, Russian, German, French and British Governments

Construction of Shrapnel Shells

Shrapnel shells are made in two distinct types, one of which is known as the common shell, and the other as the high explosive. The common shell is a base-charged shrapnel, fitted with a combination fuse, whereas the high-explosive shell is fitted with a combination fuse and, in addition, with a high-explosive head, the head also bursting and flying into atoms upon impact. The high-explosive shell is not ruptured upon the explosion of the bursting charge in the base, but the head is forced out and the bullets are shot out of the case with an increased velocity. In the meantime, the head continues in its flight and detonates on impact. This type of shell is not used quite as extensively as the common shrapnel, and for simplicity of description the common shrapnel shell alone will be taken up in the following.

Reference to Fig. 1 will show that as far as the construction of the shrapnel shell and case is concerned, there is very little difference in those employed by the various governments. Starting with the case, it will be seen that these are almost identical, except for length and the arrangement of the head for carrying the detonating primer. There is a marked similarity in this respect between the Russian, British and German and between the American and French. The form of the explosive charge held in the brass case differs in almost every instance, but without any exception smokeless powder in some form or other is used. In the American shell, nitro-cellulose powder composed of multi-perforated cylindrical grains each 0.35 inch long and 0.195 inch diameter are used. In the Russian case, smokeless powder of crystalline structure is used. In the German, smokeless (nitro-cellulose) powder in long sticks and arranged in bundles is held in the case. The French use stick smokeless powder ½ millimeter (0.0195 inch) thick by 12.69 millimeters (½ inch) wide. Two lengths or rows of this powder are arranged in the case. The British use a smokeless powder of crystalline structure somewhat similar to the Russian, but in some cases cordite has also been used, although of late this type of powder has not been quite as commonly employed.

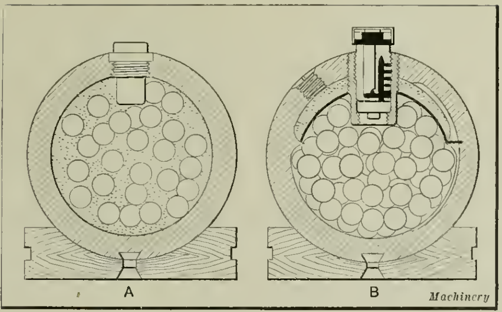


Fig. 2. Original Shell designed by Lieut. Henry Shrapnel and Col. Boxer's Improvement

The detonating agents or primer held in the head of the case varies in almost every type of shrapnel. Practically all primers are provided with "safety heads" so that the shrapnel can be handled without danger of premature explosion. The object, of course, of the detonating agent or primer is to send off the explosive charge in the shell for propelling the shrapnel out of the field gun.

The shell itself, as previously mentioned, is made either from a forging or from bar stock. Forgings, however, are used to a greater extent than bar stock, because the forged shell is more homogeneous in its structure than the bar stock shell, and piping—a serious objection in the bar stock shell—is entirely eliminated. The shells used by the British, Russian, and German governments are made almost exclusively from forgings, whereas those used by the French and American are made both from forgings and bar stock. When the French shell is made from bar stock, an auxiliary base is screwed in to eliminate any danger of piping. Near the base of all shells is a groove in which a bronze or copper band is hydraulically shrunk. This is afterward machined to the desired shape and takes the rifling grooves in the gun so as to rotate the shell when it is being expelled. The body of the shell itself is slightly smaller than the bore in the gun, and the rifling band, of course, is larger and is compressed into the rifling grooves, thus rotating the projectile and keeping it in a straight line laterally during flight. The bursting charge, which in practically all cases is common black powder, is carried in the base of the shell and is usually enclosed in a tin cup. Located above this is the diaphragm which is used for carrying the lead bullets out of the shell when the bursting charge explodes and distributes them in a fan shape. In most shells, upon exploding, the nose blows out, stripping the threads that hold the members together. It will therefore be seen that, in the explosion, the entire fuse, fuse base, tube, diaphragm and bullets are all ejected, the shell itself acting as a secondary cannon in the air.

The range of a 3-inch shrapnel shell is about 6500 yards, and the muzzle velocity of the quick-firing field gun ranges from 1700 on the American to 1930 feet per second on the Russian. The duration of flight ranges from 21 to 25 seconds. When the bullets are blown out of the shell by the bursting charge, they are given an increased velocity of from 250 to 300 feet per second. The velocity of the shrapnel at 6500 yards is about 724 feet per second. The number of lead bullets carried in the 3-inch shrapnel shells ranges from 210 to 360. In all cases, the lead bullets are about ½ inch in diameter, weigh approximately 167 grains, and are kept from moving in the shell by resin or other smoke-producing matrix.

The matrix put in with the lead bullets, in addition to keeping them from rattling, is also used as a tracer. It is of importance in firing shrapnel that the position of the explosion be plainly seen. With large shells this is not difficult, but with shrapnel for field guns at long range certain conditions of the atmosphere make it difficult to see when the shell actually bursts. Various mixtures are used to overcome this difficulty. In some cases fine grained black powder is compressed in with the bullets in order to give the desired effect. In the German shrapnel a mixture of red amorphous phosphorus and fine grained powder which produces a dense white cloud of smoke is used, and in the Russian, a mixture of magnesium antimony sulphide is used.

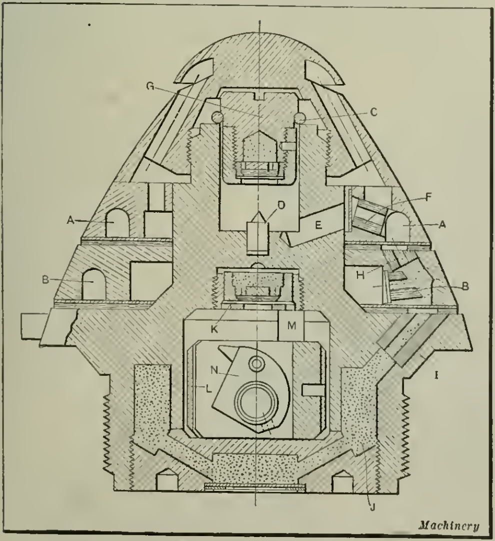


Fig. 3. American Type of Combination Timing and Percussion Fuse used on Shrapnel Shells

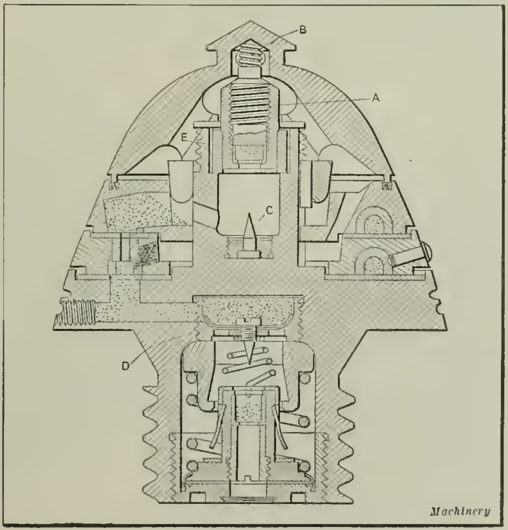


Fig. 4. Russian Type of Combination Timing and Percussion Fuse used on Shrapnel Shells

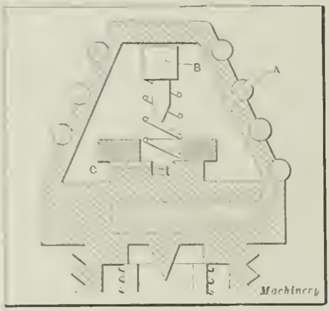


Fig. 5. French Type of Combination Timing and Percussion Fuse

Development of Timing and Percussion Fuses

The first fuses used in field ammunition were short iron or copper tubes filled with a slow-burning composition. These were screwed into a fuse hole provided in the shell, but there was no means for regulating the time of burning. Later—about the end of the seventeenth century—the fuse case was made of paper or wood so that by drilling a hole through into the composition the fuse could be made to burn for approximately the desired length of time before exploding the shell, or the fuse could be cut to the correct length to accomplish the same purpose.

For a considerable time all attempts to produce a percussion fuse were unsuccessful. Upon the discovery of fulminate of mercury in 1799, the chief requirement of a percussion fuse was obtained. About fifty years elapsed, however, before a satisfactory fuse was made. The first percussion fuse was known as the Pettman fuse, and comprised a roughened ball covered with detonating composition that was released upon the discharge of the gun. When the shell hit the desired object, the ball struck against the inner walls of the fuse, exploded the composition and powder charge, thus bursting the shell. There are at the present time three principal types of fuses in use: First, those depending on gas pressure in the gun setting the pellet of the fuse free—this is a base fuse; second, those relying on the shock of discharge or the rotation of the shell to set the pellet free—used in nose and base fuses; third, those depending on impact.

In shrapnel shells advantage is taken of two types of fuses, one of which is the combination timing and percussion fuse used on common shrapnel, and the other the combination timing and percussion fuse of the high-explosive type used on high-explosive shrapnel. These types of fuses are again sub-divided, but only in the manner of construction. The most common fuse is that known as the combination timing and percussion fuse of the double-banked type. This is used in practically all shrapnel fuses except the French. The advantage of the double ring of composition shown at *A* and *B* in Fig. 3 is to give a greater length of composition and more accurate burning. Triple-banked and quadruple-banked fuses on the same principle have been designed, but at the present time have not been introduced.

Operation of Combination Timing and Percussion Fuses

The manner in which the combination timing and percussion fuse is regulated to discharge the bursting charge in the shrapnel shell is interesting and involves extremely difficult mathematical calculations. Before going into the method of setting the fuse, it would probably be advisable to describe briefly just how the fuse operates. As an example of the double banked fuse, Fig 3 shows that adopted by the American government. The following description applies to this type of fuse.

Assume first, that the timing ring is set at zero. The propelling force given to the shrapnel shell in leaving the bore of the gun is such as to sever the wire *C* from plunger *G*. Plunger *G* carries a concussion primer which is discharged by hitting firing pin *D*. The flame passes out through vent *E* igniting the powder pellet *F* and the upper end of train *A*, and then through the vent *H*. From here, the flame is transmitted to the lower timing ring *B* through vent *I* and the magazine *J*, and from there through the tube to the bursting charge in the base of the shrapnel shell.

Assume any other setting, say 12 seconds. The vent *H* is now changed in position with respect to vent *F* leading to the upper timing train, and the vent *I* leading to the powder magazine *J* is also changed. The flame, therefore, now passes through vent *E* and burns along the upper time train *A* in a counterclockwise direction until the vent *H* is reached. It then passes down to the beginning of the lower timing train and burns back in a clockwise direction to the position of vent *I*, from which it is transmitted by the pellet of compressed powder in this vent to the powder magazine *J*. It should be understood that the annular grooves in the lower face of each timing train do not form complete circles, a solid portion being left between the grooves in the ends of each. This solid portion is used to obtain a setting at which the fuse cannot be exploded and is known as the "safety point." As shown in Fig. 6, it is marked *S* on the adjustable timing ring.

The timing fuse shown in Fig. 3 is of the combination timing and percussion type, and if the wire *C* fails to release percussion plunger *G* in Fig. 3, the shell is exploded by means of a percussion fuse which comes into use when the shell strikes. The percussive mechanism consists of a primer *K* held in an inverted position in the center of the fuse body by a cup located beneath the percussive primer. Percussion plunger *L* works in a recess in the base of the fuse body and is kept at the bottom of the recess away from contact with the primer by a light spring in plunger *M*. The firing pin *N* is mounted on a fulcrumed pin, and is normally kept in the vertical position by means of two side spring plungers. When the shell strikes, the impact causes the plunger to snap up against the primer after compressing the spring in pin *M*. This causes the firing of the primer *K* and the explosive charge passes out through a hole in the percussion plunger chamber, not shown, to the magazine *J* and from there down to the powder in the base of the shell.

The Russian fuse shown in Fig. 4 differs only in a few minor details from the American fuse, the chief difference being in the arrangement of the percussive mechanisms. The percussive plunger for the timing arrangement is kept up from the firing pin by means of a spring bushing *E* surrounding the body of the plunger. This bushing is expanded by the plunger which is forced through it due to the force of the shrapnel in leaving the bore of the gun. The spring *B* in the head of the fuse assists the plunger in expanding bushing *E* and in dropping down onto the firing pin *C*. The flame from the exploded primer then travels down to the powder in the shell in practically the same way that it does in the American fuse, except that the magazine chamber is located at *D* and explodes through the impact fuse chamber. The percussive arrangement for setting the shell off by impact is slightly different from that in the American fuse, in that the primer and firing pin are held apart by means of springs, the inertia of which is overcome when the shell strikes an object.

With the exception of a few minor details, the timing fuses used in American, Russian, British, German, Japanese, etc., shrapnel shells are the same. The French timing fuse, however, as shown by the diagram Fig. 5, operates on an entirely different principle. In this fuse the firing for the timing train is contained in a sealed tube of

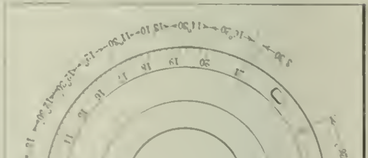


Fig. 6. Diagram showing how Timing Ring on the American Combination Timing and Percussion Fuse is laid out

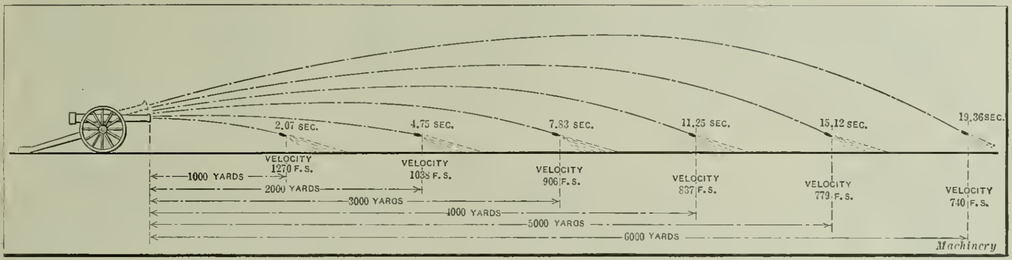


Fig. 7. Diagram illustrating Path of a Shrapnel and the Time of Explosion at Various Distances

pure tin and is wound spirally around the head of the fuse. Inside of the head is the ignition arrangement. To set the timing part of this fuse, it is placed in a fuse-setting machine attached to the field gun and by forcing down a handle on this device, a piercing point is thrust through the outer cap of the fuse, penetrating to the interior space of the head as shown at *A*. Upon the discharge of the shell from the gun, the gas pressure forces firing pin *B* back, hitting the percussive primer *C*. This causes a flame which passes out through the opening previously punched at *A* and ignites the "rope" powder fuse which is wound around the head of the fuse body. This type of fuse is also provided with a fuse which sets off the shell by impact should the timing fuse fail to work. The head of the fuse is covered with a cap with holes for the piercing point, and the whole cap can be shifted around for a short distance and set by the corrector scale marked on the body, as shown in Fig. 1. A projection on the cap engages a recess in the fuse-setting machine and provides for this movement, the machine previously being set to punch the hole.

Setting Combination Timing and Percussion Fuses

The accuracy with which a shrapnel can be exploded in the air at any desired point is remarkable, considering the number of variable quantities that enter into the construction of the timing fuse and powder train, etc. The calculations necessary for finding the correct setting on the timing ring involve the use of higher mathematics and are consequently not within the scope of this article. In the following, however, will be given a brief explanation of how a fuse is set to explode the shrapnel at a certain predetermined point.

Referring to Fig. 6, the timing ring used on the American fuse is shown. Here it will be seen that the ring is provided with twenty-one graduations corresponding to twenty-one seconds in the duration of flight of the projectile. It will also be noticed that the spacing of the graduations differs. For instance, *S* to zero, or safety to zero, occupies 26 degrees. This, as previously mentioned, is required so that the ungrooved surfaces of the timing rings can be swung around far enough to bring them in line with the vents for firing. From zero to 1 is greater than from 1 to 2. The reason for this is also in the relation of the vents. From 3 to 4 will be seen another variation. This takes into consideration the positions of the lower timing train and the trajectory of the flying missile. From 6 seconds around to 18 is practically a constant drop, taking into consideration the decrease of velocity, and from 18 on, the graduations begin to increase for two reasons: the decrease in the velocity of the missile and the action of gravity.

Diagram Fig. 7 shows in an interesting manner just how a shrapnel is fired. The range is approximately obtained by panoramic sights or other means, and a test shell fired, the point of explosion noted and the necessary corrections made. A table which has been worked out for different distances is then used. In Fig. 7 the diagram shown pertains to the American quick-firing field gun having a muzzle velocity of 1700 feet per second and the American shrapnel of 3-inch size. It will be noted that at 3000 yards the terminal velocity of the shrapnel is 1038 feet per second and the time of flight for the projectile 4.75 seconds. In other words, the timing train to explode the shrapnel at this point would be set at *A* in Fig. 6. The range of a 3-inch American shrapnel is 6500 yards and at this point the terminal velocity is approximately 724 feet per second, the time of flight 21.92 seconds. The shrapnel, when exploded, shoots out the bullets at an increased velocity of from 250 to 300 feet per second, covering an area of about 250 by 30 yards, half the bullets falling on the first 50 yards of the beaten zone.

In manufacturing shrapnel shells, a test shell is taken from every 120 and is actually fired out of a quick-firing gun into a bank of sand. If the contour of the shell in the neighborhood of the powder pocket is expanded during this test, the shell is discarded because of the liability of tearing out the rifling grooves in the gun. The examples shown below have been tested in this manner, but hit a rock instead of the sand bank.

Forging Shrapnel Shells

WITHIN the last few months, many methods have been suggested for making shrapnel forgings, but a comparatively small number have been put into use. Practically speaking, no two governments have adopted the same method. The Russian government uses double-acting horizontal hydraulic forging presses in which two operations are performed at the same time on different forgings. For instance, while the punch in one end of the machine is piercing a heated billet, the ram on the return stroke performs the hot drawing operation on another shell located at the opposite end of the machine. In this way a shell is completed at each cycle of the machine—forward and return stroke. The French government, up to a short time ago, used steam hammers for this purpose, and produced shrapnel forgings in practically the same manner as a drop-forging is made, the punch being carried in the ram of the press and the die held on the bed. This is rather a slow process and requires more than one heating to complete the forging. The German government uses a horizontal hydraulic forging press for piercing the billet and a steam driven machine for drawing the forging, which receives its motion from a rack and pinion. This method has the advantage over the hydraulic press of being more economical in the consumption of power.

The practice followed by different concerns in this country and Canada, at the present time, differs to a large extent. Some manufacturers are using a method that dates back as far as 1890, as will be described later. Others are using a more improved method developed about 1895, whereas about three concerns are using a still more improved method developed in the last three months. These methods will be described, as well as other processes using various machines.

Basic Method of Making Shrapnel Forgings

The first method (known as the Caley process) of making shrapnel forgings in this country had its inception about 1890 and was used almost exclusively until 1895. This comprised a slug-forming and billet piercing operation followed by a successive reduction and elongation of the forging through drawing dies. The order of these operations is shown diagrammatically in Fig. 8. The information given herewith pertains to the making of a forging for a 3-inch shrapnel shell. As shown at *D*, a billet of steel 3¼ inches in diameter and 6½ inches long was cut off from a bar with a cold saw, and formed into a cone shape under a vertical hydraulic press having a capacity of 100 tons. The billet was heated in a furnace to about 1900 degrees F., dropped into the impression in the die and forced into shape by a hydraulic plunger having a depression in the lower end which centered the blank. The result of this operation is shown at *F*.

The next step was to anneal the billet, after which it was pierced as shown at *C*, and at the same time slightly elongated. This operation was handled in a hydraulic press of the type shown in Fig. 9. On a 0.70 per cent carbon steel billet the pressure on the punch in the piercing operation was 20,000 pounds per square inch and the machine used was a vertical hydraulic forging press of the type referred to having a capacity of 100 tons. From the piercing operation the forging was taken direct without annealing to the horizontal hydraulic draw press, and as is shown at *H* was located on a punch and forced through a series of drawing dies which gradually reduced the shell to the correct diameter, 3¼ inches, and drew it out to the required length, about 8¾ inches.

A point worthy of attention

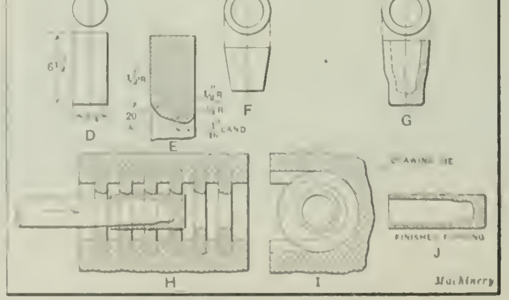


Fig. 8. Diagram showing Caley Process of making Shrapnel Forgings in Hydraulic Forging Presses

is the preparation of the cone-shaped billet. The smallest end was made slightly smaller than the smallest reduction die in the series. The reason for this was that if any drawing were done on the end of the shell the front corner would be drawn over and deformed, increasing the amount of machining required. The drawing dies in this case were six in number, as shown at *H*, and were reduced on a sliding scale of the following proportional reductions. First, 0.100 inch; second, 0.080 inch; third, 0.060 inch; fourth, 0.040 inch; fifth, 0.030 inch; and sixth 0.020 inch. This gave dies of the following sizes, in inches, starting with the largest in the series: 3.355, 3.275, 3.215, 3.175, 3.145, and 3.125.

The shape given to the drawing edges of the dies is of prime importance. The mouth or entering side of the hole was beveled to an angle of 20 degrees leading to a liberal curve which terminated in a land 1/16 inch wide. The shape was finished off with a ¼-inch radius. These dies were made from chilled cast iron and were held in position as shown at *H*, being slipped into a pocket in the frame of the machine, as shown at *I*. The punches for the coning, piercing and hot-drawing operations were made from special hot punching steel. The first drawing die in the series lasted the longest because the metal was hotter at this point than when it was drawn completely through the dies. As a rule, the last drawing die turned out 100 shells before being worn or scored. Then it was reground to a larger size and used again. The drawing punch was lubricated occasionally with graphite. After drawing, the forging is annealed to obtain the proper physical qualities. This method of making forgings for a 3-inch shrapnel shell is capable of producing 400 in ten hours.

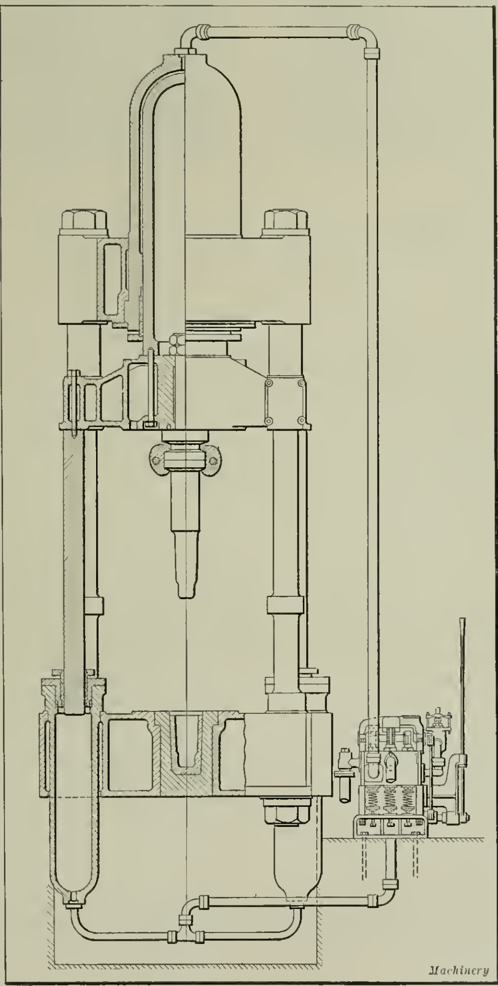


Fig. 9. Watson-Stillman Hydraulic Forging Press of the Vertical Type used for making Shrapnel Forgings

Improved Method of Making Shrapnel Forgings

About 1895 the following method, known as the Holinger process of making shrapnel forgings, was devised. Instead of making the billet conical in shape before piercing, this preliminary operation was dispensed with, and to facilitate the work, as well as to reduce the friction of the flowing metal, the arrangement of the piercing punch and die was changed. This process is shown in Fig. 10, and was accomplished in a hydraulic press provided with two cylinders, one located at the bottom and the other at the top of the press.

The operation was as follows: The die *a* was held in a movable frame *b* and the piston *c* acted first. The first position after the billet was dropped into the die is shown at *B*. Here the die *a* and punch *d* remained stationary while the piston *c* descended, pushing the billet through the die and over the punch. When the piston reached the end of its stroke, as shown at *C*, the lower cylinder began to act and the frame carrying the die was raised. This frame, as shown at *D*, carried a stripper plate *c* which removed the pierced billet from the punch and located it so that it could be picked off with a pair of tongs. A subsequent operation of hot-drawing as shown at *E* was required, which is similar to that described in the first method. The method just described was used chiefly for 6- and 8-inch shrapnel and projectile forgings, and at the present time is still used for 3- and 6-inch shell forgings. It requires much less power and turns out a better and more concentric forging than the method previously described. The production on 8-inch shells is about 180 in ten hours, and 250 on the 3-inch shell.

One of the Later Methods of Forging Shrapnel Shells

The increased demand for shrapnel within the last few months has been instrumental in bringing about a radical improvement in the production of forged shells. Previously, the aim was to get the internal diameter as close as possible to the finished size and to do comparatively little machining on it; in fact, this is still, in a great number of cases, one of the requirements. While at first glance this would appear to be the logical way of handling the work, on further investigation it is found that the forging of the shell to the comparatively correct size is much more expensive than to leave sufficient metal to machine all over. In the first place, a hydraulic machine of 100 tons capacity costs considerably more in initial outlay than a turret lathe, and in the second place it is more expensive to operate. The cheapest method of making a shrapnel forging is to rough-forge it to approximately the correct shape and then finish to exact shape and diameter in turret lathes or semi-automatic chucking machines. This simplifies the forging process and also decreases the production costs.

One of the later methods of making shrapnel forgings is shown diagrammatically in Fig. 11. A billet of steel 6½ inches long by 3 5/16 inches diameter is heated to a temperature of from 1900 to 2100 degrees F., and then dropped into the impression in the die *a* held in a special cast-steel die-holder *b*. To do this, die *a* is drawn out from beneath the punch, punch guide *c* removed and the billet dropped in. Then the guide is replaced and the die-holder slid in until it contacts with the stop *d*. The press is now operated, and as shown at *B*, advances, piercing the billet and making the metal flow up around the walls of the punch.

The punch now retreats, carrying the centralizing guide *c* with it. The die-holder is now drawn out from under the punch onto a bracket projecting from the bed of the press. The high-carbon steel, hardened block *e* then drops out of the die, as is also the case with the finished forging. This block *e*, of course, is heated up to a considerable extent due to the hot metal resting on it so that several blocks of this kind are provided. In the illustration, as shown at *C*, centralizing guide *c* is shown attached to the punch. In actual

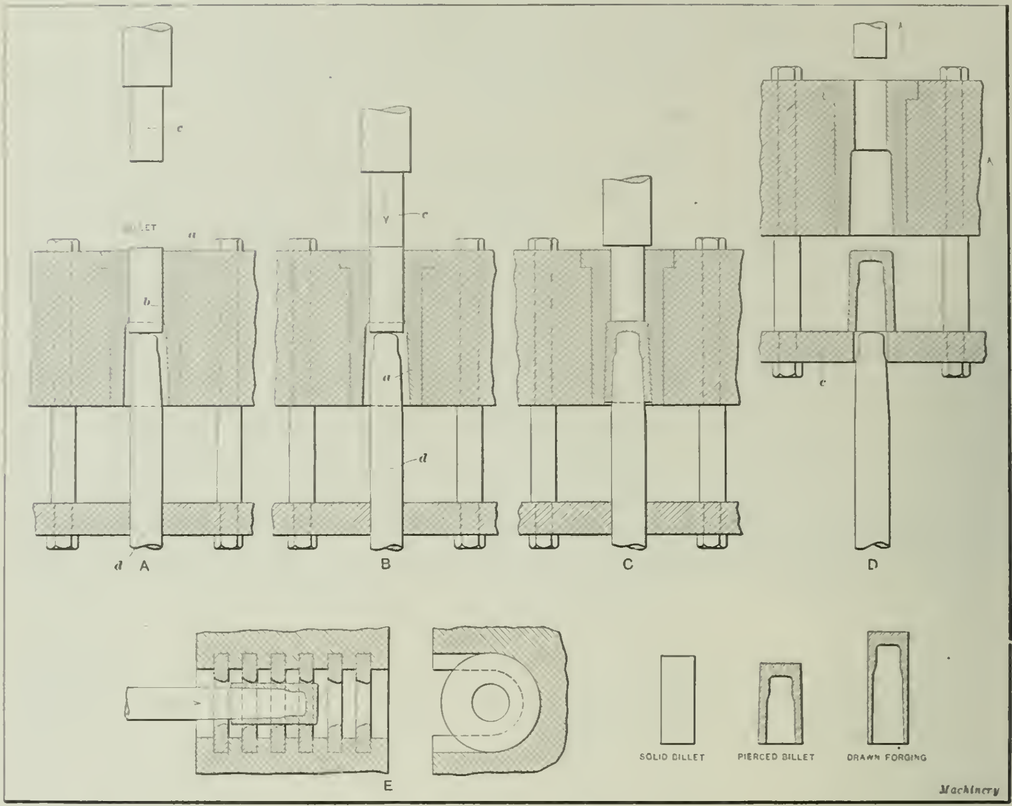


Fig. 10. Holinger Process of making Shrapnel Forgings

operation this is not the case. When the punch rises, guide *c* is stripped from it by stripper plate *f* so that the guide is gripped with a pair of tongs and laid down on the bed of the press until a fresh heated billet has been placed in the die impression ready for the next piercing. The punch is made from special hot punching steel and the die from chilled cast iron. The production of forgings by this method for a 3-inch shrapnel shell is about 600 in ten hours.

The amount of metal left for machining by this method varies from 1/8 to 3/16 inch on the internal and external diameters. The forging after annealing is then machined inside and out on turret lathes, or semi-automatic chucking machines. The accepted method is to first machine the internal diameter and then hold the shell on an expanding arbor and machine it on the external diameter.

Producing Shrapnel Forgings in Hydraulic Presses

In the foregoing description various principles of making shrapnel forgings were described. Owing to the large number of forgings lately required, practically all types of forging presses and power forging machines have been used. The initial illustration on forging shrapnel shells shows how one manufacturer is solving the problem. The machine used is an R. D. Wood Co., 750-ton hydraulic forging press; this performs both the billet piercing and drawing operations.

The forgings turned out on this machine are for the British 18-pound shell, and the billet is 3½ inches in diameter by 4½ inches long. The first operation, piercing the billet, is done by the punches and dies shown in Fig. 12. The billet is heated in a furnace to a temperature of 2000 degrees F., and then quickly removed and placed in the dies. The press is now operated, piercing two billets at the same time. The pierced billet is 3½ inches diameter by 7½ inches long.

A complete batch of pierced billets is first put through, then the pierced billets are taken to the furnace again and heated to 2000 degrees F. The punches and dies in the center of the illustration Fig. 13 are used for finish-drawing the forging by drawing it out to 3½ inches diameter by 11 inches long. This method is only temporary and will be replaced shortly by three R. D. Wood four-post hydraulic presses. The piercing operation will be handled on one press of 350 tons

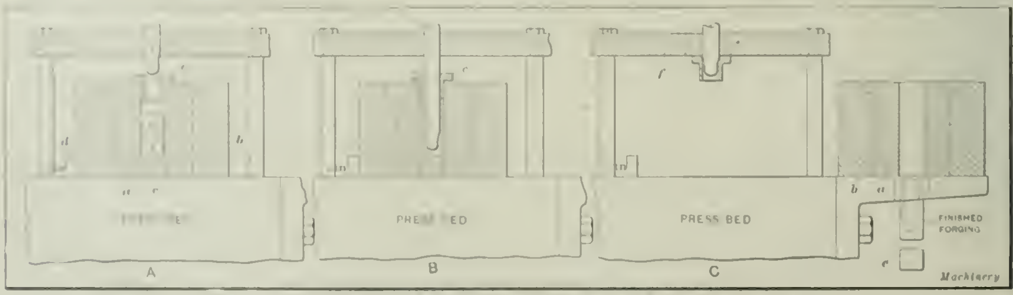


Fig. 11. Improved Method of making Shrapnel Forgings in One Heat and One Operation

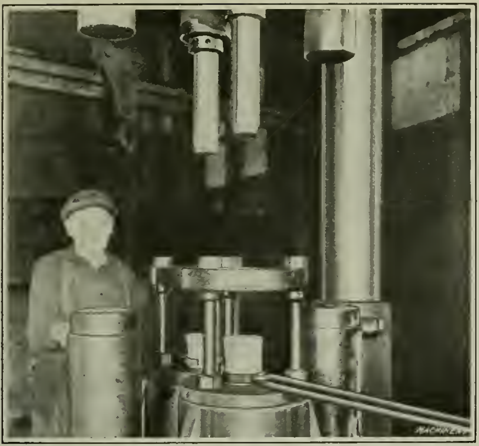


Fig. 12. Piercing Billets for Shrapnel Forgings in a "Wood" 750-ton Hydraulic Forging Press

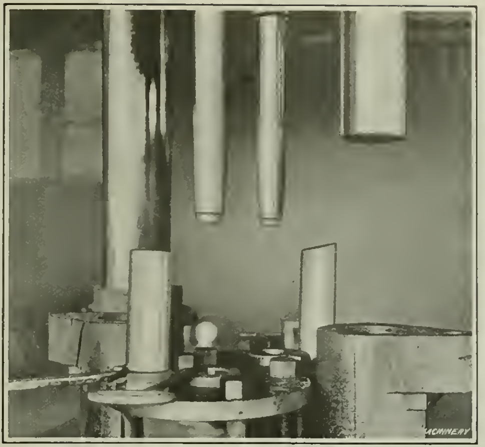


Fig. 13. Drawing Shrapnel Forgings in a "Wood" 750-ton Hydraulic Forging Press

capacity, and the drawing operations on two presses of 200 tons capacity.

Making Shrapnel Forgings in Power Forging Machines

One of the latest developments in the art of producing forgings for shrapnel shells is the adaptation of the power forging machine to this work. As has been previously mentioned, there are several methods of producing shrapnel shells, and as it has been conclusively proved that the forged shell is superior to the shell made from bar stock, it is only natural that several methods for making the forgings would be developed. In the forging machine method, a bar slightly larger than the finished diameter of the forging is cut off, making a billet about 5½ inches long. This billet, for a 3-inch shell, weighs about 9¼ to 9½ pounds.

The billet is heated to a white heat in a furnace, the temperature being about 2000 degrees F., depending on the carbon content and other constituents in the steel, and is then placed in the lower impression of the forging die. The machine used for this size of forging is a standard upsetting and forging machine provided with a special crankshaft. Upon being operated, the lower plunger, which is larger than the diameter of the powder pocket in the shell, advances and pierces the billet. The pierced billet is then raised to the next impression, and the machine again operated. The second punch is longer than the first and smaller in diameter. The billet is forced up on this punch, which reduces it in diameter and increases its length. After the second impression the partially formed shell is then placed in the third or final die impression, where it is given two blows, being given one-half turn after the first blow to form it more perfectly. The operations just enumerated are performed in one heating of the billet, and the production of a 3-inch shell ranges from 400 to 450 in ten hours.

The dies for this work are, of course, constructed upon a somewhat different principle from the ordinary forging die, because in this case it is necessary to make the metal flow up on the punches. The dies, therefore, are so constructed that they recede as the punch advances, which tends to make the metal flow up on the punch. The practicability of this method is well illustrated by the samples shown in Fig. 14. Here *D* is the rough forging just as it comes from the machine, with the exception that the mouth has been trimmed. *C* is a section of a shell made from low-carbon steel about 0.30 per cent carbon; *B* is a shell made from 0.50 per cent carbon, 3½ per cent nickel steel. This has been rough-turned, as the illustration shows. The homogeneity of the forgings is clearly indicated. *A* is a forging made from low-carbon steel, finish-turned.

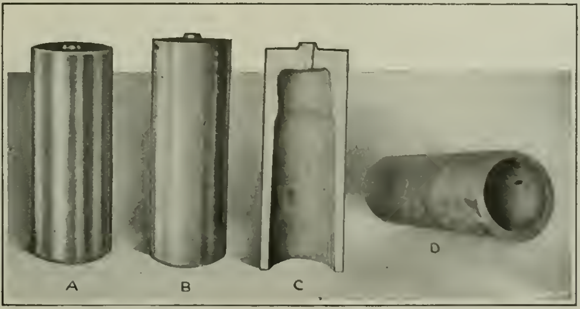


Fig. 14. Examples of Shrapnel Forgings turned out on a Power Forging Machine

One of the most interesting points about this method is its cost as compared with shells made from bar stock. To produce a 3-inch shell from bar stock requires about 22 pounds of material, and on metal costing 10 cents per pound, a bar shell—exclusive of machining—costs $2.20; to produce the same shell on a power forging machine requires about 9¼ to 9½ pounds, and figuring on 10 cents per pound the cost for the material is only $1—a saving of $1.20 on each shell. Furthermore, the production of shells from bar stock on automatic machines is about twelve to fifteen per day. The number of forgings that can be turned out in the same time is 400 to 450, and the number that can be machined in this time varies from forty to fifty for two operations. It is therefore evident that the production of shells by forging is far superior to the bar method, and the forged shell is more satisfactory from every standpoint.

Forging Shrapnel in a Power Press

Another interesting development in the forging line is shown diagrammatically in Fig. 15. This method comprises three operations, and is handled in a No. 80½ Bliss press capable of exerting a pressure of 1200 tons. A billet 3¼ inches in diameter by 3¾ inches long is heated in a furnace to 1976 degrees F. and then quickly placed in the die shown at *A*. The press is operated, and the punch in descending pierces the billet, being guided by the guide *a*, as shown at *B*, which also acts as a stripper. The forging retains its heat to a certain extent after this operation, the temperature being about 1380 to 1425 degrees F. This is sufficient to perform the second minor operation which, as shown at *C* and *D*, consists in forcing the heated billet into the die-block to reduce the diameter of the lower end and facilitate the succeeding operation. This reducing operation is performed with the same type of punch as is used in the succeeding operation, and the die-block is simply laid on top of a bolster while the reducing is being done.

The final forming or drawing of the forging is accomplished as shown at *E* and *F*, the same type of press, *viz.*, a Bliss No. 80½ power press, being used for this purpose.

The pierced billet is now heated to 1976 degrees F., and is then forced through the three drawing dies *b*, *c* and *d*, by the punch *e*. The first die is 3 5/16 inches diameter and reduces the forging from 3⅜ inches to this size. The second is 3 7/32, and the third or last, 3⅛ inches diameter. The forging, after being forced through the dies, is stripped from the punch by plates *f*, and as it still retains a temperature of 1475 degrees F.—sufficient for annealing—is thrown down on the sand to cool off. The billet piercing and drawing dies, shown in the illustration, were made from 50-point carbon steel, hardened. This gave fair results, although chilled cast-iron dies would prove even more satisfactory. The punches were made from several different materials such as chrome-vanadium, 70-point carbon steel and unannealed malleable casting. Of the three materials, the last gave the most satisfactory results, in that pitting was reduced to a minimum. Of course the malleable casting required to be ground to shape.

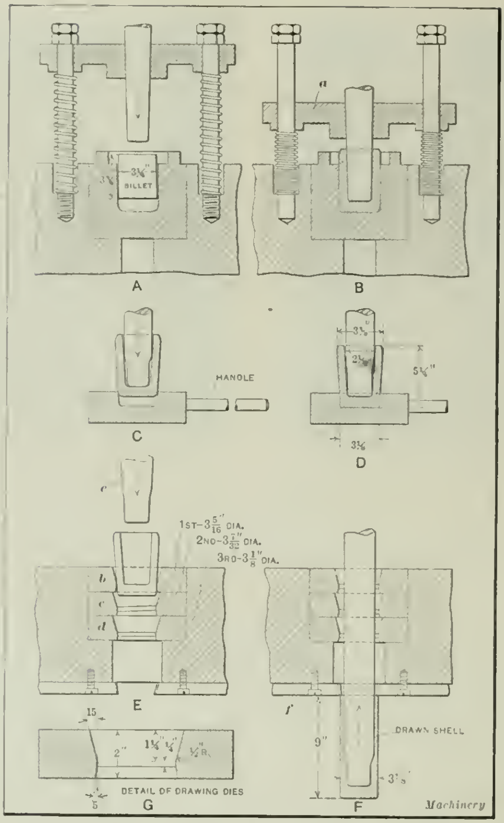


Fig. 15. Diagram illustrating Method of piercing and drawing Shrapnel Forgings in a Bliss Power Press

Flow of Hot Metal when being Pierced

In the manufacture of shrapnel shell forgings, the first operation is that of piercing, and to accomplish this satisfactorily, it is necessary to understand the action of a piercing punch on a semi-plastic billet of steel. There are certain fundamental laws governing the flow of metals under pressure and a study of these is of exceptional interest. An attempt has been made in Fig. 16 to illustrate diagrammatically some of the principles involved, and in the following discussion it should be understood that the billet is made from 50-point carbon, 70-point manganese steel, 6½ by 3 5/16 inches in diameter.

At *A* a round-end tapered punch is shown in contact with the heated billet, and the lines show the possible flow of the metal, *i.e.*, the material commences to "pack" at the end of the punch. In this case the walls of the die are straight. At *B* the billet is being pierced, and the resultant effect on the flow of the metal is indicated. Here it will be seen that the pressure increases as the punch descends, because of the wedging action on the metal and the friction between the surfaces of the sides of the punch and die. The pressure on the end of a punch of this shape is about 20,000 pounds per square inch

By leaving the sides of the die of the same shape as at *B*, but making the end of the punch square instead of round and not tapered, different action is caused. When the flat punch, as shown at *C*, first contacts with the metal, the pressure required is greater than at *A*, but as soon as the metal commences to flow as at *D*, the pressure decreases. For instance, suppose the pressure required at *B* to pierce the billet was 100 tons; on the same material at *D* the required pressure would be only 70 tons—a decrease of 30 per cent. The metal, however, does not follow the sides of the punch as closely at *D* as at *B*, and this accounts in part for the reduction of power required. The action of hot flowing metal on the face of a square punch is just the reverse of what would naturally be expected. Instead of the punch wearing away at the edge, the center first shows signs of wear as indicated at *e*. Seams are opened up in a radial direction caused by the hot metal attacking the softest parts in the face of the punch.

Again, a different condition exists to that shown at *B* and *D*, when both the die and the punch are tapered as shown at *E*. Here the friction of the extruded metal on the walls of the die and sides of the punch is excessive, and it is practically impossible to produce a satisfactorily pierced billet in this manner. From a theoretical standpoint, the conditions shown at *F* are ideal. Here the sides of the punch are straight, the end flat, and the walls of the die taper or increase in diameter toward the bottom. In this case the friction of the flowing metal is greatly reduced because of the lessening of the wedging action. Other considerations, however, make this method impracticable.

A still greater reduction in the pressure necessary to pierce a billet is shown at *G*. Here a square billet instead of a round one is being pierced. In the plan view it will be noticed that the friction on the walls of the die is greatly reduced, and the pressure continues low until the extruded billet contacts all around with the surface of the die. The completed product, however, is inferior to that made from a round billet. From the previous remarks, it will be seen that a punch and die that would best meet the requirements is one having a rounded end as at *B*, straight sides as at *D* and straight walls in the die. The most satisfactory punch and die for piercing shrapnel forgings when all the variable conditions are considered would be as shown at *H*.

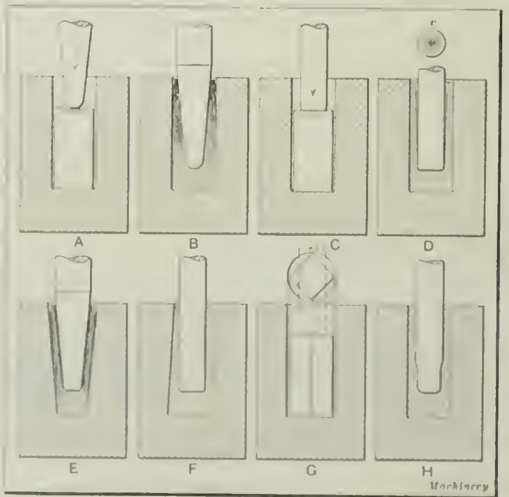


Fig. 16. Diagram illustrating Flow of Hot Metal while being pierced

Machining Shrapnel Shells

SHRAPNEL shells are manufactured either from bar stock or forgings. The bar stock method, however, is not considered as satisfactory as forging because of piping, so that the greater number of shrapnel shells made at the present time are turned out from forgings. The first step, therefore, in the making of a shrapnel is to cut off a billet of the required length from a bar of steel of the necessary constituents. In the making of an 18-pound shrapnel shell, the billet is cut off from a bar of 46-point carbon, 70-point manganese steel in machines of different types. One way of doing this, as shown in Fig. 17, is to use a Newton cutting-off machine having an air clamp for holding the bar in place while it is being cut off. A Hunter duplex saw, as shown in the illustration, provided with high-speed steel inserted teeth, performs the cutting operation. The billet for an 18-pound shrapnel is 3½ inches diameter by 4½ inches long. It is then forged to shape, as has been previously explained.

Assuming now that the forging has been completed, the following is a complete summary of the machining operations on the shell up to the point of assembling. In one plant where this work is being done, the shrapnel shells are put through in lots of 120, forty to a box. Out of every 120, one shell after heat-treatment is tested for tensile strength. The tensile strength before heat-treatment must be 30,000 to 40,000 pounds per square inch, and 80,000 to 90,000 pounds per square inch after heat-treatment. For facilitating transportation, trucks of various designs are used. One type of truck used for this purpose is shown in Fig. 18. This is built by the Chapman Double Ball Bearing Co. of Canada, Ltd., Toronto, Ontario, and has some interesting features, the chief of which are the ball bearing swiveling head, ball bearing wheels, and the means of releasing or raising the load with the handle in any position. This latter feature is especially valuable in handling the truck in a crowded space.

Trimming and Facing the Shell Forging to Length

The first machining operation on the forged shell is to cut off the ragged end, which is generally from ½ to 1½ inch longer than that required for the finished shell. This operation is performed in many different ways, but one of the most common is to place it in a Hurlbut-Rogers cutting-off machine as shown in Fig. 19. For performing the cutting-off operation, two plain forged cutting-off tools made from

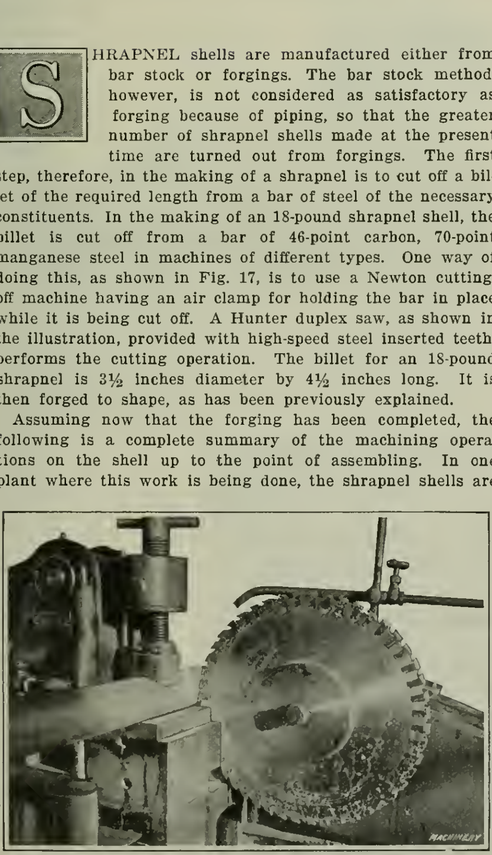


Fig. 17. Cutting off Billets for making Shrapnel Forgings in a Newton Cutting-off Machine

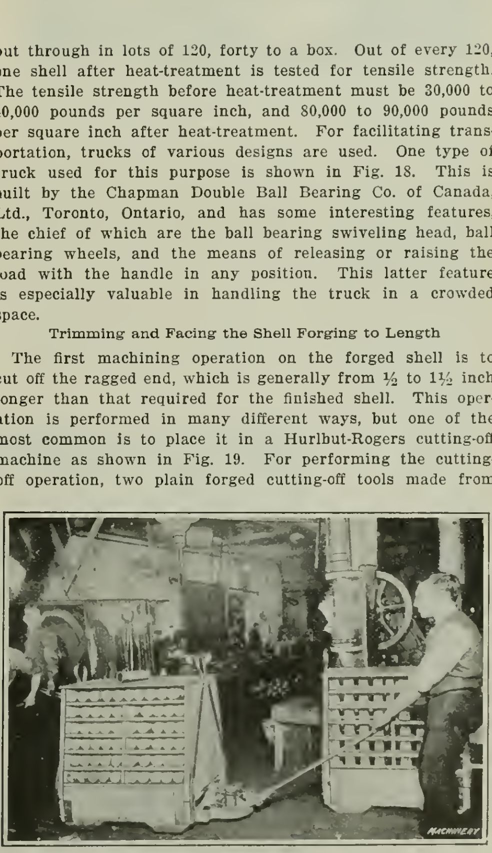


Fig. 18. Truck built by the Chapman Double Ball Bearing Co. for transferring Shrapnel Shells about the Shop

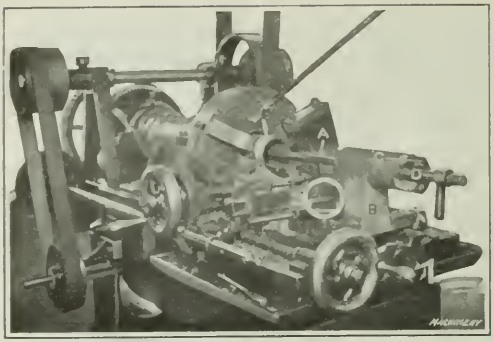


Fig. 19. Cutting off Excess Length of Shrapnel Forging in a Hurlbut-Rogers Cutting-off Machine

"Saben" extra high-speed steel are used. The forging is located in the proper position in the chuck by a plunger or stop *A*, sliding in a fixture *B* clamped to the base of the machine. This plunger locates the shell from the bottom of the hole or powder pocket and forces the shell into the chuck against the resistance of an open-wound spring. The stop is then located by a gage *C* that forms a member of the fixture and fitting ring *D* on the stop. The chuck jaws are now clamped on the work and the cutting off commences. As soon as the excess stock is cut off, the stop is drawn back and the pressure of the jaws on the work released; the spring in the chuck then ejects the forging. The production of an 18-pound shell from one machine is about 140 in eight hours.

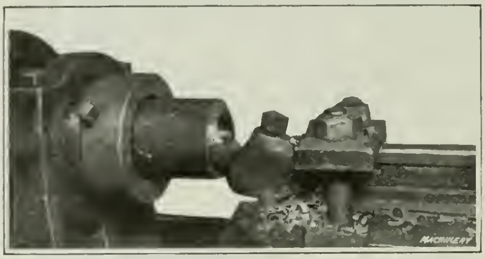


Fig. 20. Facing off Closed End of Shell to Length

The next roughing operation is to face off the bottom or closed end of the forging, bringing the shell to approximately the correct length. There are also many ways of performing this operation. One method is to grip the forging in a chuck, as shown in Fig. 20, in an ordinary lathe and face off the end with a high-speed steel tool held in an Armstrong toolholder. From 1/4 to 3/8 inch is faced off the end.

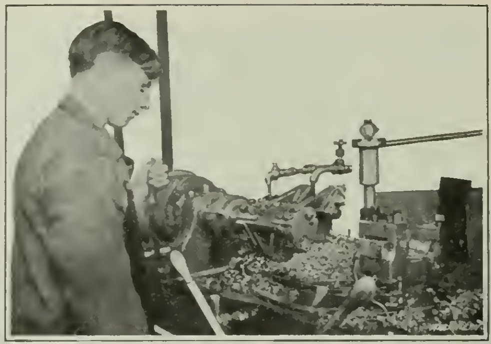


Fig. 21. First Rough-turning Operation on Shrapnel Shell in a Flat Turret Lathe

Rough-turning Operations on Shrapnel Forging

Practically every type of engine lathe and turret lathe as well as special machines are used for turning and boring shrapnel forgings, and in the following each method will be dealt with separately. Before doing this, however, a complete summary of the methods of machining employed in a large Canadian plant turning out shrapnel will be described. In this plant, the first rough turning operation is handled on a flat turret lathe, as shown in Fig. 21. For this purpose, the shell forging is held on an expanding arbor and is driven by a dog fastened to it and driven by the faceplate of the lathe. A multiple tool turner is first brought into position and takes a cut of about 1/8 inch from the diameter for practically the entire length of the shell. The next tool then faces off the end of the shell to length.

The shell forging is now ready for cutting the rifling band groove and producing the waves. This is handled in an ordinary engine lathe equipped with a special fixture, carrying grooving, waving and under-cutting tools. The shell forging, as shown in Fig. 22, is held in a chuck at one end and supported by a revolving center at the other. One part of the fixture is clamped to the bed of the lathe and the other to the carriage. The grooving and ribbing is accomplished with a tool held in holder *A* at the front of the lathe, whereas the two under-cutting tools are held in holders *D* and *E* at the rear of the lathe. In operation, the carriage of the lathe is moved toward the chuck, carrying the fixture to which are fastened cams *C*, *F* and *G*. Cam *C* forces in the holder carrying the combination grooving and ribbing tool, whereas cams *F* and *G* force in the holders carrying the two under-cutting tools, these being presented at an angle to the work. The required oscillations to the slide carrying the grooving and ribbing tool are secured through

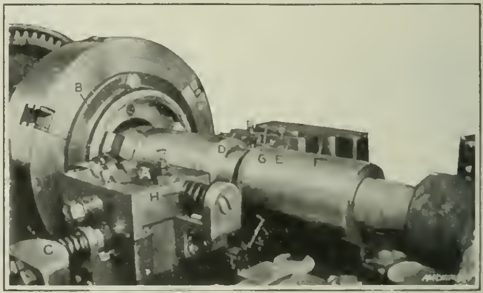


Fig. 22. Cutting the Rifling Band Groove with a Special Grooving and Ribbing Attachment on an Engine Lathe

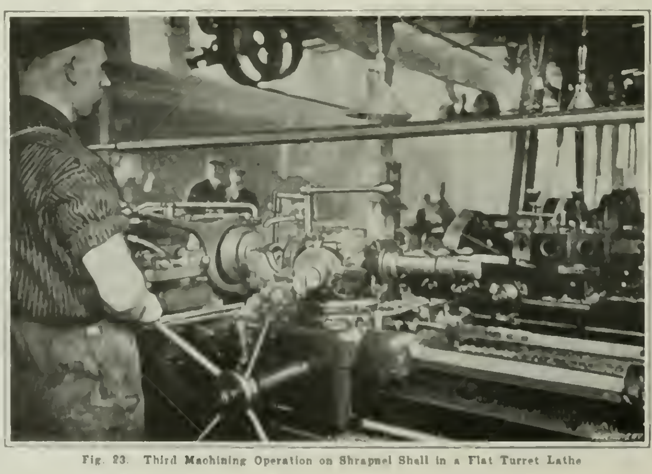


Fig. 23. Third Machining Operation on Shrapnel Shell in a Flat Turret Lathe

a face cam *B* clamped to a "Whiton" chuck. This face cam operates against the tension of spring *H* and gives the required oscillations to the tool-slide carrying the ribbing and grooving tool, shown at *A*.

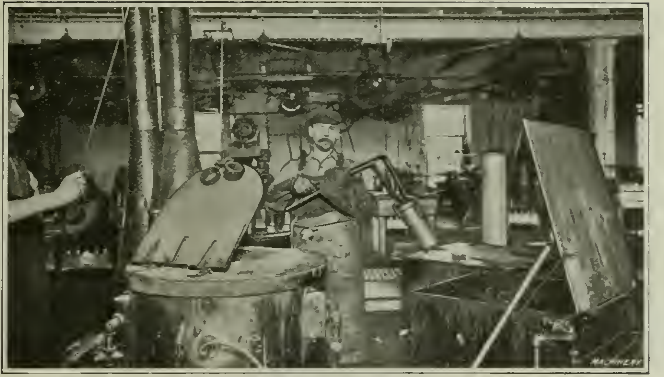


Fig. 24. Heat-treating Shrapnel Shells

The third machining operation is accomplished in a flat turret lathe, as illustrated in Fig. 23. This consists in facing the open end of the shell, boring the powder pocket and facing and boring the diaphragm seat, and also turning the angular surface on the external nose of the shell. First, a roughing drill is brought in to rough out the powder pocket. The turret is then indexed and a tool for turning the angle of the nose is brought into position. The machining on the nose is then accomplished by operating the cross-sliding head. Then a roughing cutter is brought in to rough-bore the powder pocket. The turret is again indexed and a finishing tool is brought in to finish the powder pocket and face the diaphragm seat. This finishes the machining operations on the shell previous to heat-treatment.

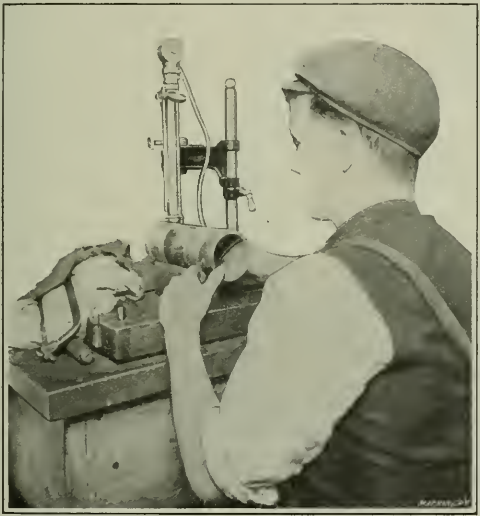


Fig. 25. Testing Hardness of Shrapnel Shells with Shore Scleroscope

Heat-treating Shrapnel Shells

As was previously stated, the tensile strength of a forged shrapnel shell after heat-treatment must be 80,000 to 90,000 pounds per square inch, and in order to obtain the desired physical qualities, it is necessary that the heat-treating operations be properly conducted. Several methods of heat-treating employing different cooling solutions are used in the manufacturing plants making shrapnel shells. One method, as shown in Fig. 24, is to heat the shell in a Hoskins electric furnace that contains a barium-chloride bath, heated to a temperature of about 1480 degrees F. The shells are left in this furnace for a half hour and are taken out and dipped in a bath of cotton-seed oil heated to a temperature of 113 degrees F. The temperature to which the shell is heated varies with the different constituents of the steel and practically every different batch of 120 shells requires a slightly different temperature. The proper temperature is determined by cutting out a section of a heat-treated shell and testing it for tensile strength. The next step is to draw the temper on the open end of the shell for about three-quarters of its length. In this operation an oil bath, heated by a muffle gas furnace to a temperature of about 1000 degrees F., is used. The shell is allowed to remain in the bath until it reaches the heat of the bath.

Fig. 27. Closing in Nose of Shrapnel Shell in Hydraulic Press

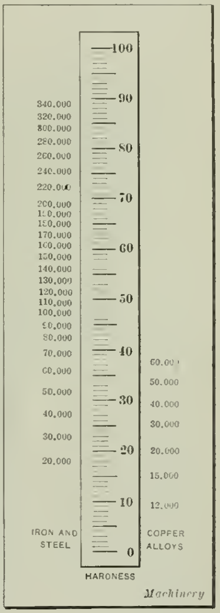


Fig. 26. Relation of Shore Scale to Elastic Limit of Iron, Steel and Copper Alloys

Testing for Hardness and Tensile Strength

One shell from a batch of 120 is now cut open in the proximity of the powder pocket and the cut-out section sent to the government inspectors to test it for tensile strength. Each one of the shells in the batch, in addition, is tested for hardness by a Shore scleroscope as shown in Fig. 25. Before testing for hardness, the shell near the band groove is polished so as to get a true reading, then placed in a fixture, and the hammer of the scleroscope allowed to drop on it. The reading should be between 40 and 50, indicating an elastic limit of 80,000 to 90,000 pounds per square inch. The shell must not be ruptured at the point tested when the charge in it is exploded or when the charge in the case is set off. Should the shell upset near the rifling band groove when it is being propelled out of the gun, it would tear out the rifling in the bore of the gun.

Experience with the scleroscope has disclosed the existence of a definite relation between the hardness and strength of metal. In determining the strength of metal, two stages are recognized: First, the elastic limit, yield point or load re-

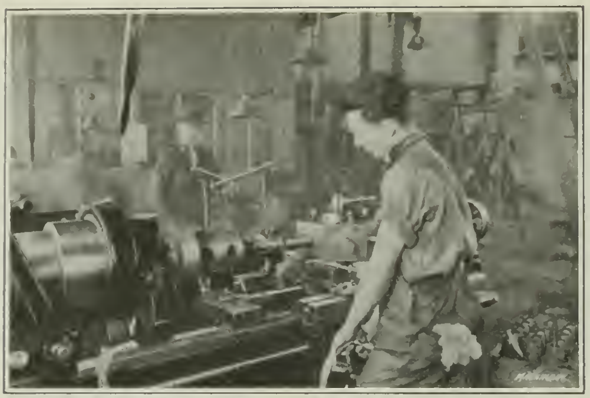


Fig. 28. Third Operation on Nose of Shrapnel Shell—turning, facing and threading

quired to start permanent set; second, the ultimate strength or load required to terminate permanent elongation and reduction of area in rupture. The hardness indicated by the scleroscope is intimately related to the elastic limit, as is shown in Fig. 26. The elastic limit increases more rapidly than the hardness from 43 to 45, this being the minimum index of the strength value required. As an elongation of 8 per cent in 2 inches is also called for, there must necessarily be an upper limit to the hardness. On the steel used for shrapnel which is generally about 50-point carbon, 70-point manganese, the maximum hardness should not be over 60 on the scleroscope.

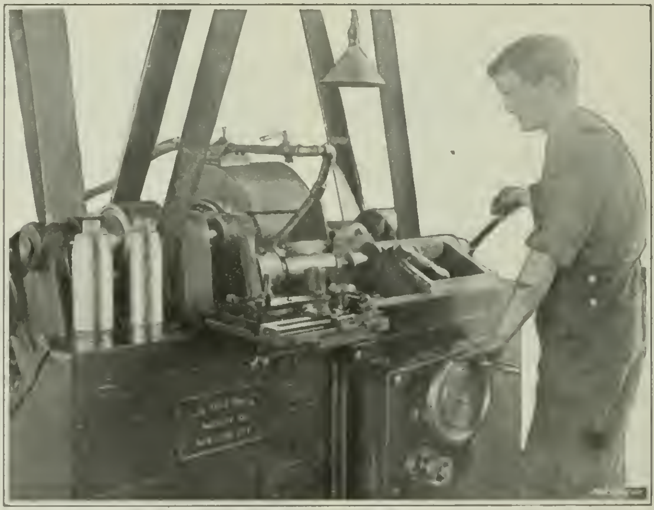


Fig. 29. Grinding Shrapnel Shells in One Operation in a Ford-Smith Grinding Machine

Closing in the End of the Shell

On some makes of shells, particularly the British, the nose is closed in before performing the third series of machining operations. The closing in is generally accomplished in a hydraulic or power press. Fig. 27 shows the closing in operation being performed in a vertical hydraulic press capable of exerting a pressure of 800 pounds per square inch. Before closing the open end of the shell, it is heated in the lead bath, shown to the left of the illustration, which is kept at a temperature between 1450 and 1500 degrees F. The steel diaphragm, which is larger in diameter than the nose of the shell, is first thrown in. Then the shell is placed in the press, and a cone-shaped die descends, closing in the nose to the proper shape and diameter. The third machining operation consists in finishing the radius on the nose, both inside and outside, and cutting the thread. This is done, as shown in Fig. 28, in an ordinary engine lathe with a turret on the saddle. The boring is done with cutters held in boring-bars and the thread cut with a Geometric collapsing tap. The thread on the 18-pounder is 2.91 inches diameter, 14 pitch, Whitworth type.

Grinding Shrapnel Shells

The exterior surface of a shrapnel shell is straight for a portion of the length and then curved on the nose. While the limits required are not extremely close, it is necessary where large production is required, to accomplish the finishing operations on the exterior of the shell in some way by which fairly close dimensions can be secured as well as large production. Grinding has therefore been recommended for finishing the exterior of the shell. One method of grinding shrapnel shells in which a wide faced wheel is used that covers the entire ground surface, is shown in Fig. 29. This machine is built by the Ford-Smith Machine Co., Hamilton, Ont., and carries a wheel about 8¼ inches wide, 20 inches diameter. The grinding wheel is rotated at 1200 R. P. M., and the work at 50 R. P. M. The depth of cut is about 1/32 inch, and the time to complete one shell varies between two and three minutes. For grinding, a plug is screwed into the open end of the shell. This is held on the tailstock center and a chuck holds and drives the shell from the other end.

It is necessary, of course, that the wheel be kept the correct shape, and for this purpose an interesting type of wheel truing device, differing considerably from that shown in Fig. 29, is now used. Referring to Fig. 31, it will be seen that this comprises a combination wheel guard and bracket, the latter being used as a base for the wheel truing device proper. The diamond *A* is carried in a holder *B* that operates in a slide in the face of the traversing wheel truing slide *C*. The diamond holder carries a cam point *D* which is kept in contact with the guide or former cam *E* by means of a spring *F*. The wheel truing slide *C* is traversed by a triple-pitch screw *G* so as to give a rapid movement to the slide in order to produce what might be termed a "rough-truing" of the wheel. For change in diameter, and also for bringing the diamond in contact with the wheel, a vertical slide *H* is provided that is operated by handle *I*. In order to observe the diamond when truing the wheel, a trap door *J* is provided in the wheel guard, which can be dropped down into place when the actual grinding of the shell is being done.

Pressing on the Rifling Band

In order to rotate the shrapnel when propelling it out of the howitzer, it is necessary to put on a rifling band to take the rifling grooves of the gun bore. As a rule, these rifling

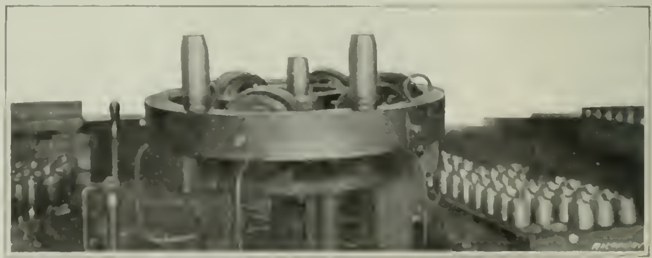


Fig. 30. Closing in Copper Band on Shrapnel Shell

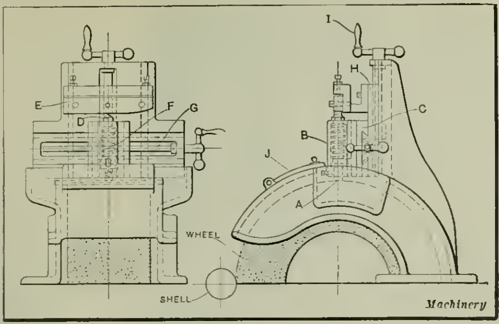


Fig. 31. Special Type of Wheel Truing Device used on Ford-Smith Grinding Machine shown in Fig. 29

bands are made from copper tubing and are simply cut off in a hand screw machine or turret lathe. The next operation is to close in the rifling band on the shrapnel shell. The ring is dropped over the shell and a fixture is used to locate it in the correct relation to the groove in the circumference of the shell. Then a slight pressure is exerted on it to align it properly in the groove. It is now placed in the banding machine shown in Fig. 30. This particular machine is provided with six dies as shown in Fig. 32, and back of each one is a hydraulic cylinder operated by water pressure. Two squeezers are necessary to close the rifling band properly into the groove, the shell being given a half turn after each squeeze.

There are several different machines on the market for performing this closing in operation on the rifling band. Another machine, built by the West Tire Setter Co., Rochester, N. Y., is shown in Fig. 33. The principle upon which this machine operates is almost identical with that previously described, but in this case oil is used as a pressure medium. It is forced into the machine by means of a belt-driven pump shown to the left of the illustration, which drives the oil from the oil tank and carries it to the center of the base of the press. An oil head is located at this point from which the pipes are run to each of the six rams or cylinders. The amount of pressure required for compressing the copper band depends largely upon the width and thickness and the amount that the band must be spread to fill the grooves, rather than upon the diameter of the shell. The machine shown in Fig. 33 is capable of exerting a pressure of 30 tons on each cylinder or a combined pressure of 180 tons on all six cylinders. It has a capacity for compressing at least two bands per minute.

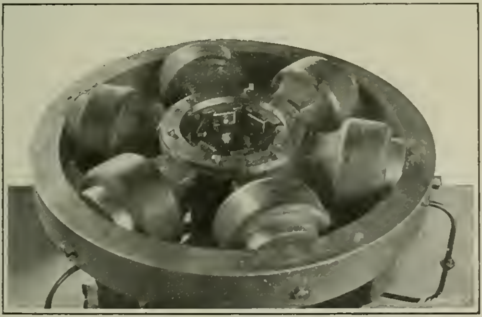


Fig. 32. Close View showing Closing in Dies of Banding Machine shown in Fig. 30

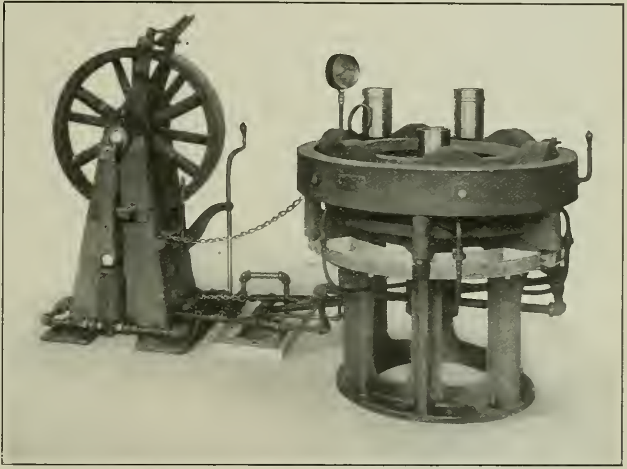


Fig. 33. Shrapnel Banding Machine built by the West Tire Setter Co.

Machining the Rifling Band

One method of machining the rifling band to the correct shape is shown in Fig. 34. Here a Fox lathe is used which is provided with a chuck for holding the shell and which carries in the turret a revolving center for additionally supporting it. The machining is done by form tools which are of the correct shape. Before any other machining operations can be accomplished it is necessary to put in the tin powder cup, brass fuse tube, bullets and resin. The tin powder cup is slipped in past the steel diaphragm, then both parts are allowed to drop to the bottom and the fuse tube is screwed into the diaphragm. The required number of lead bullets, which for the British 18-pound shrapnel is about 375 per shell, is then poured in. The bullets are held in a tank and are allowed to flow out upon the opening of a stop-cock. In order to pack the bullets solidly, a compressed air ramming device forms the base upon which the shell rests while the bullets are being poured in. This is operated three or four times for the filling of each shell and arranges the bullets compactly.

The resin is now poured in, as shown in the center of Fig. 35. This is carried in the tank which is heated by a gas furnace and is poured in almost level with the top of the bullets. The shell is then placed on the scale in the immediate foreground and weighed. One dram plus or minus is allowed as a variation, and in order to secure this, more or less resin is poured in until the correct weight is obtained. The brass fuse socket is now screwed in as shown to the left of the illustration, and upon the completion of this operation the shell is ready for the fourth and last machining operation. This last operation consists in machining the brass socket on the outside diameter to conform to the radius on the nose of the shell and boring on the inside and threading to fit the fuse body. These operations are handled in a Fox brass working lathe. Upon the completion of the machin-

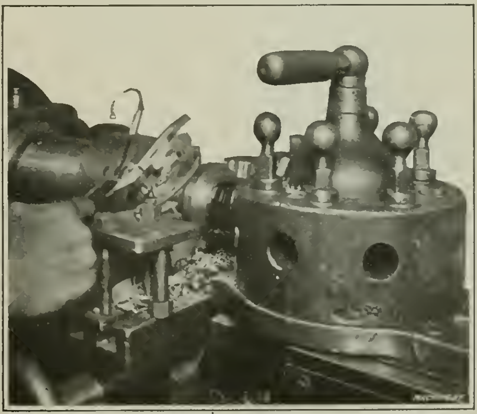


Fig. 34. Finishing Rifling Band on Shrapnel Shell to Shape

ing operations the plug is screwed in, the shell stamped, cleaned, weighed and inspected by government inspectors. After this, the shell is given two coats of paint and a red band is painted around the nose. It is now packed in boxes holding six shells and is ready for shipment. This completes the manufacture of the shrapnel shell.

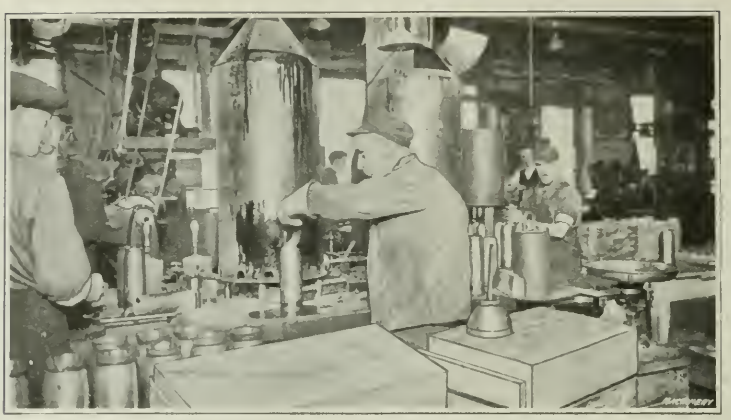


Fig. 35. Assembling Bullets, Resin and Fuse Socket in Shrapnel Shell

EQUIPMENT FURNISHED BY REED-PRENTICE CO. FOR MACHINING FORGED SHRAPNEL SHELLS

In machining the 18-pound British shrapnel shell on the equipment furnished by the Reed-Prentice Co., Worcester, Mass., eight distinct operations are performed as follows: First, drilling a center hole in the closed end of the forging in a Prentice 16-inch ball-bearing sensitive drilling machine equipped with a special centering fixture; second, rough-turning the outside diameter, grooving, squaring the closed end and rounding the corners in a Reed-Prentice 14-inch heavy type automatic lathe; third, machining the powder pocket and diaphragm seat, as well as the internal and external diameters of the nose in a 14-inch Reed extra heavy turret lathe; fourth, under-cutting band grooves and producing wave ribs in a 14-inch Reed engine lathe; fifth, boring, reaming, threading and facing the open end in a Reed 14-inch extra-heavy turret lathe; sixth, finish-turning outside diameter and radius on nose, also form-turning copper band in a Reed 14-inch heavy type automatic lathe; seventh, cutting off center projection on closed end of shell in a Reed 14-inch engine lathe; eighth, finishing brass socket to form, cleaning inside of socket and cutting off excess length of tube in a Reed 14-inch extra-heavy turning lathe.

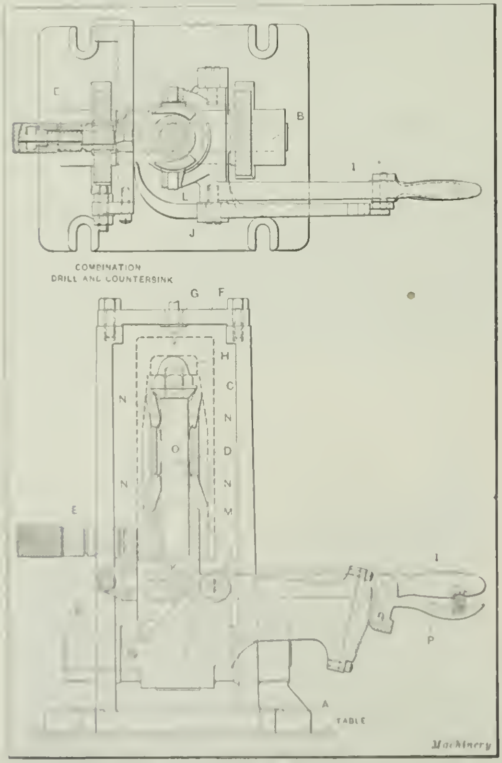


Fig. 36. Fixtures used for holding Shrapnel Shell Forgings when drilling Center Hole in a 16-inch Prentice Ball Bearing Sensitive Drilling Machine

First Operation on Rough Shell Forging

The drilling of the center hole in the closed end of the forging is a comparatively simple operation, and is performed in an interesting fixture held on a 16-inch Prentice ball-bearing sensitive drilling machine.

This fixture, which is designed for handling the work quickly, is shown in Fig. 36, and consists of the base casting *A* clamped to the table of the drilling machine. The entire back part of the jig swings on the trunnion *B* to provide a means for quickly removing the forging *C* from the arbor *D*. A locking pin *E* is used for locating the fixture in its upright position for drilling. Bushing *G* in the top plate *F* of the fixture guides the combination drill and countersink.

The construction of the work-holding arbor is worthy of special attention. This arbor *D* has a cap *H* on its top end that acts as a stop for the inside of the forging, which, in being placed over the arbor, is located centrally and clamped by fingers *N*. To operate these fingers, hand lever *I* is depressed, and as this is fulcrumed at the point *J*, it causes collar *K* to rise on the arbor. Yoke *L* forms a connection between the lever and the collar with which the sleeve carrying fingers *N* is integral. Fingers *N* are fulcrumed in arbor *D* and are thrown outward to grip the forging when sleeve *M* is raised. Light springs *O* tend to keep the gripping fingers in a vertical position against the arbor when they are not being forced outward by the inclined surfaces on sleeve *M*. Handle *I* carries a spring pawl *P* that holds the sleeve *M* stationary while the forging is being center-drilled.

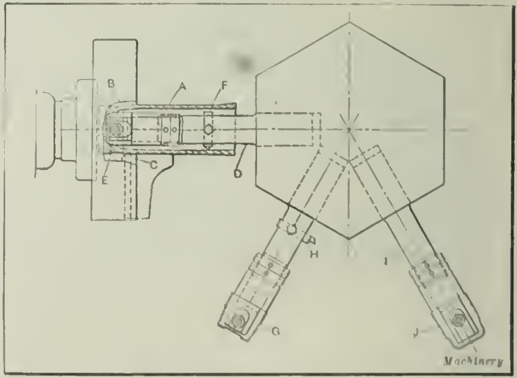


Fig. 37. Tooling Equipment for performing Third Series of Operations on 14-inch Extra-heavy Turret Lathe

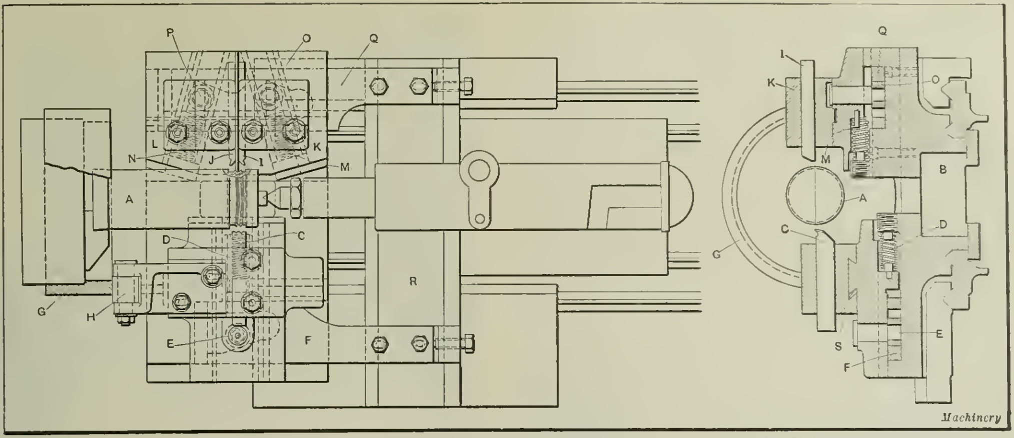


Fig. 38. Tools used for under-cutting and waving Band Grooves on Reed 14-inch Engine Lathe

Second or Rough-turning and Facing Operations

The second operation is performed on a Reed-Prentice 14-inch heavy type automatic lathe, as shown in Fig. 39. The forging *A* is held on an internal expanding arbor *B*, the driving part of which is supported by the head-center. At the closed end, the shell is steadied by the tail-center. The bottom of the shell rests against the end of the arbor which acts as a gage. In this setting, the external diameter of the forging is rough-turned by four tools *F*, mounted on the carriage *G*. This carriage has a travel slightly less than two inches, and an automatic throw-off is provided at the end of the cut that disengages the tools, draws them back and returns the carriage.

At the rear of the carriage on this machine a facing arm is mounted on a heavy bar. Turning tools are carried on this facing arm, as shown, and when the front carriage feeds longitudinally a cam bracket *O*, bolted to the carriage, is carried along with it. Clamped on this bracket is an adjustable cam *N* held in place by screws. Cam roll *M* on the facing arm contacts with cam *N*, causing the facing arm to rock forward as the carriage travels longitudinally.

Referring to the plan view in Fig. 39, tool *H*, held in the arm, faces the end of the forging, tool *I* chamfers the corner, and tool *J* cuts the depression for the wave ribs, leaving a projection in the center from which the ribs are formed. It should be understood that the tools on the carriage and facing arm work together. One man can run two of these machines without trouble, and fifteen pieces are produced per hour.

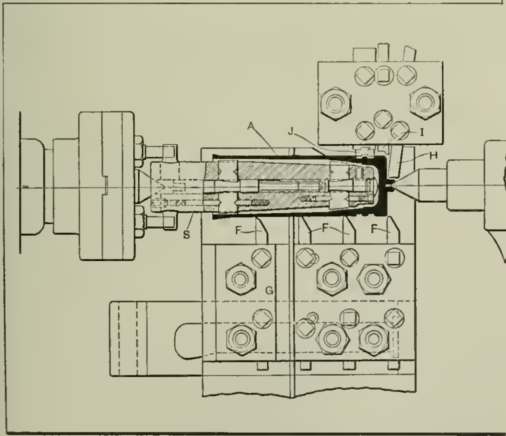
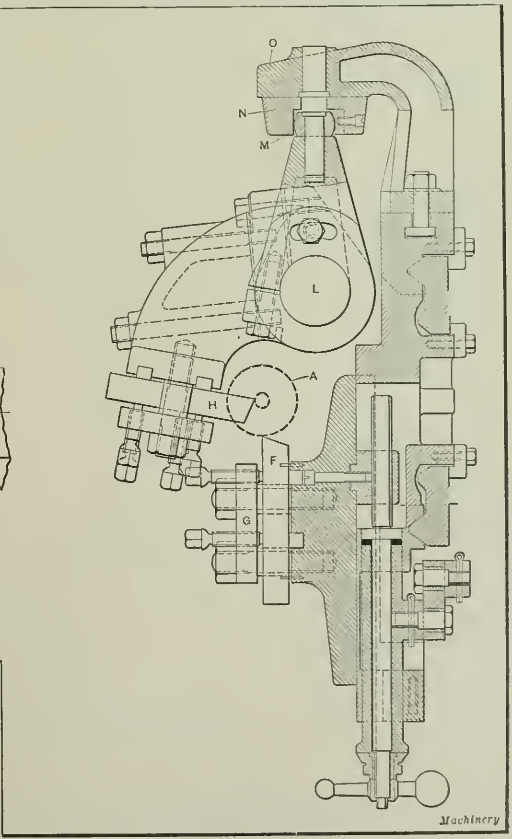


Fig. 39. Tool Layout for performing Second Series of Operations on Reed-Prentice Heavy Type Automatic Lathe

Third Series of Machining Operations

The third series of operations on the shrapnel forging is performed on a 14-inch Reed heavy lathe with a specially large turret, as shown in Fig. 37. This lathe is fitted with a 12-inch three-jaw chuck, bored out to 3½ inches to permit the forging to extend into it. The forging *A* is put in the chuck as shown at *B*, and the jaws grip at *C*. The first operation is performed with a bar *D* carrying a blade cutter *E* that rough-bores the powder pocket, and tool *F* that rough-bores the mouth. The turret is now indexed, and a boring-bar carrying a blade *G* roughs out the diaphragm seat, while an auxiliary tool *H* faces the shell to length. At the next



indexing of the turret the boring-bar *I* that carries the finishing tool *J* finishes the diaphragm seat and powder chamber.

Fourth Operation—Under-cutting and "Waving" Band Groove

For the fourth operation, the forging is held in a 14-inch Reed engine lathe provided with an automatic attachment for under-cutting and waving the ribs for the copper band. The tool equipment used is shown in Fig. 38, where *A* is the forging held by one end in the chuck and supported on the opposite end by the tail center. The tools are all located in holders on the heavy base block *B*, and their operation is controlled from the carriage *R* of the lathe. The cutting of the wave ribs is done by tool *C* at the front, held on a slide that operates on the top of block *B*. Spring *D* keeps the roll *E* on the lower slide of the tool-holder in contact with the cam slot in cam plate *F* that is fastened to carriage *R*. When the carriage is traversed toward the chuck, the irregular surface of cam plate *F* engages the roll and forces the tool-holder forward. Side motion to produce the wave is then effected by face cam *G*, mounted on the chuck and contacting with the roll *H*. This roll is supported on a bracket forming an auxiliary slide *S* that carries the waving tool *C*. A stiff barrel spring keeps slide *S* in contact with the cam *G*. Thus, when the machine spindle revolves, the auxiliary slide is caused to oscillate back and forth far enough to give the desired amount of wave.

The under-cutting in the band groove is accomplished by tools *I* and *J* which are mounted on separate tool-slides *K* and *L*. These slides are fed in at an angle to the axis of the forging, against the action of coil springs *M* and *N*, by the cam surfaces of plate *Q* in which rolls *O* and *P* work. Plate *Q* is bolted to carriage *R* which, in advancing toward the chuck, forces in the under-cutting tools in the manner just described. The tail-center of this machine is fitted with a quick-acting mechanism so that it may be withdrawn quickly to insert a new piece.

Fifth Series of Operations

Before performing the fifth series of operations, the forging is heated and closed in on the nose. It is then handled in the following manner: A Reed 14-inch heavy lathe, equipped with an extra large turret mounted on a special wide-bridge carriage carries tools for boring, reaming, threading and final squaring of the open end, as shown in Fig. 40. The shell forging for these operations is held in a three-jaw chuck provided with special jaws. In the first position the rough-boring of the nose and the rough-facing of the extreme end is performed with tools *B* and *C*. The turret is then indexed and tools *D* and *E* finish-ream the hole in the nose and face the end. The tap *F* is next brought into position, cutting the thread in the nose.

The turret is again indexed, bringing a special form boring tool into position. Here the boring tool *G* is carried in a bar *H* held in a holder of the cross-sliding carriage type that is fastened to two faces of the turret. By means of cross-screw *J*, the boring tool *H* may be drawn in or out at will. This tool operates as follows: As the turret is advanced, handle *J* is operated to let tool *G* enter the nose of the shell, and upon the continued advance of the turret, arrow head *M* is forced in between and gripped by the fingers *N*. The turret is now backed away from the chuck, and while receding acts upon slide *P* through the medium of roll *L* and cam groove *R*. The plate containing cam groove *R* is attached to the arrow head *M* and consequently is held stationary while the turret is being withdrawn from the work. This backward movement of the turret is continued until the tool *G* is withdrawn from the work and slide *S* comes in contact with check-nuts on rod *O*, withdrawing arrow head *M* from fingers *N* and allowing the turret to be indexed ready for the first operation on the next forging.

Sixth or Finish-turning Operations

The sixth series of operations is performed on a Reed-Prentice 14-inch heavy type automatic lathe, similar to that used for the second operation, and the machine is also operated in a manner similar to that previously described. The operations consist in finish-turning the outside diameter of the shell and turning the radius on the nose. In addition, the copper rifling band, put on previous to this operation, is turned to shape. Referring to Fig. 41, the shrapnel shell *A*

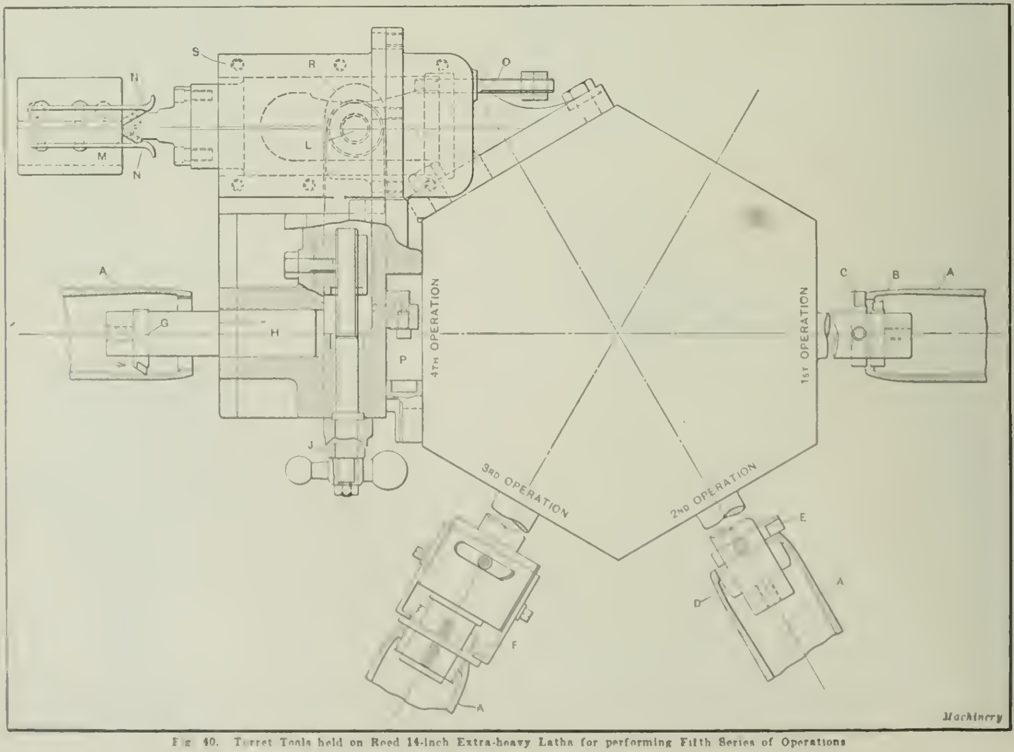


Fig. 40. Turret Tools held on Reed 14-inch Extra-heavy Lathe for performing Fifth Series of Operations

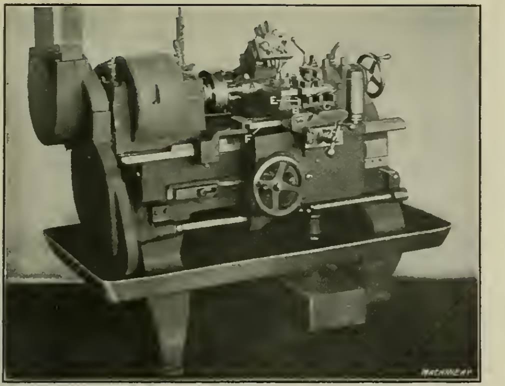


Fig. 41. Reed-Prentice 14-inch Heavy Type Automatic Lathe used for performing Sixth Series of Operations

is held by the tail-center at one end and is supported and driven from the other end by a plug screwed into it. This plug is held on the live center and is driven by an equalizing driver, coming in contact with pins in the special faceplate.

Two slides *B* and *C* are carried on the front of the carriage. Slide *C* carries three tools *D;* two of these start in from the rifling band and turn in toward the nose, and the other works up toward the rifling band from the closed end. Tool *E*, carried in slide *B*, turns the curve on the nose of the shell and is controlled in its action by means of a slot in cam *F*, in which a roller held to the slide operates. At the rear of the carriage is carried a spacing bar attachment, as previously described in connection with the second operation. This attachment carries three tools, as illustrated, for machining the rifling band to shape, facing the closed end and chamfering the corner.

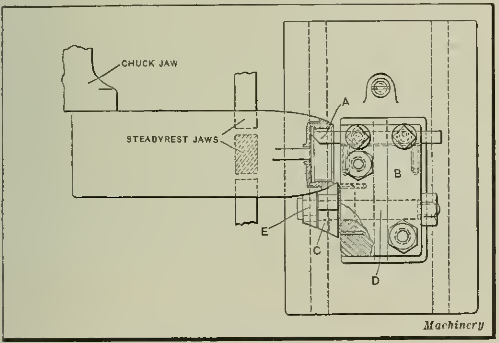


Fig. 42. Tools for machining Brass Fuse Socket on 14-inch Heavy Turning Lathe—Eighth Operation

Seventh and Eighth Operations

After the sixth operation, the fuse tube is threaded into the diaphragm, the bullets put in, and the hot resin poured in to keep them from rattling. The brass socket is then screwed into the nose and the fuse tube soldered to it. The shell is now ready for the seventh operation which consists in cutting-off the center projection. This is accomplished in a Reed 14-inch engine lathe, provided with a faceplate chuck for holding and driving the shell at the open end, and a steadyrest for supporting it close to the point where the cutting is being done. The shell is now ready for the eighth operation, which consists in machining the brass socket to shape in an extra-heavy lathe as shown in Fig. 42. The tools used for machining are retained in a special holder on the carriage. Tool *A*, which is used for facing off the fuse tube and the brass socket, is inverted, starts at the center and is fed out toward the circumference. The external surface of the socket is machined with a circular forming tool *C* held on a stud *D* located in block *B*. The inward travel of this tool is limited by stop *E* coming in contact with the shell.

SET-UP ON WARNER & SWASEY TURRET LATHE FOR MACHINING FORGED SHRAPNEL SHELLS

In Fig. 43 is shown a typical set-up on a Warner & Swasey No. 2A universal hollow-hexagon turret lathe for machining an 18-pound shrapnel shell forging. The arrangement of the various tools for performing the first series of operations is more clearly illustrated in Fig. 44, to which reference should now be made. The forging is located for machining on a special arbor fitted into the spindle and carrying two spring-controlled centering bushings *A*. These serve to locate the shell, which is then gripped by the floating jaws of the chuck on the external diameter, and a stop on the end of the arbor locates the shell from the bottom of the powder pocket.

The first operation consists in taking a cut from the external diameter with a special box-turner provided with a roll steadyrest and carrying two turning tools. The second operation is handled from the cross-slide, the shell forging meanwhile being supported by a roll steadyrest clamped to the turret. In this operation the closed end of the shell is faced with tool *C*, the corner rounded, and the band groove formed with forming tool *D*. The third operation—first chucking—is performed with tool *F* which produces the waves in the band groove, and is operated in the following manner: Referring to the lower left-hand corner of the illustration, it will be seen that a roll *G* is brought in contact with the face cam *B*, thus giving the desired oscillating movement to the waving cutter. The fourth and final operation consists in under-cutting the band groove with a tool clamped to the turret. This tool gages from the end of the shell by a revolving stop *H*, and is provided with two slides, set at

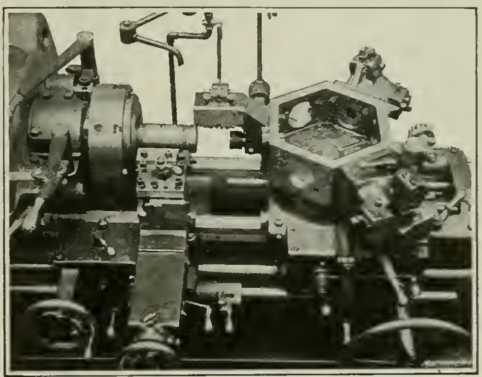


Fig. 43. First Chucking on Warner & Swasey Turret Lathe for machining British Forged Shrapnel Shells

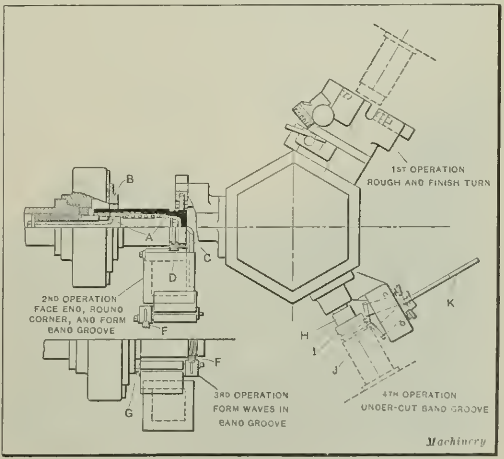


Fig. 44. Diagram illustrating Position and Relation of Tools for First Chucking on British Forged Shell

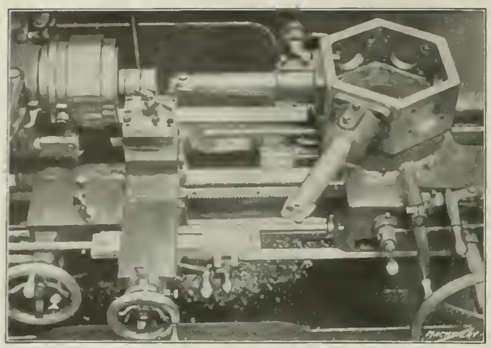


Fig. 45. Set-up on Warner & Swasey Turret Lathe for Second Series of Operations on Forged Shrapnel Shell

the desired angle to each other and the work, carrying undercutting tools *I* and *J*. These slides are operated by handle *K*.

The second chucking on this shell is handled as shown in Figs. 45 and 46 on the same type of machine. As shown in Fig. 46, the shell for this operation is gripped in an automatic chuck, and a stop *A* for locating it is held in the spindle. The first operation consists in roughing out the powder pocket and diaphragm seat with a cutter *B* and rough-turning that portion of the shell held in the chuck in the previous chucking with a tool *C*. This tool is held in the cross-slide toolpost, and is controlled in its movement by a special guide fastened to the regular taper-turning attachment. The second operation finishes the powder pocket and diaphragm seat with a cutter *D*.

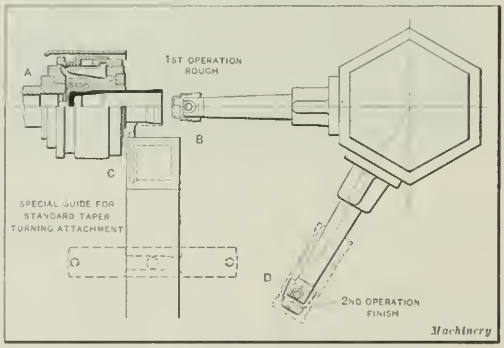


Fig. 46. Diagram illustrating Sequence of Operations performed at Second Chucking

After the second chucking, the shell is heated on the nose, closed in and is then brought back to the turret lathe, when the operations are performed as shown in Figs. 47 and 48.

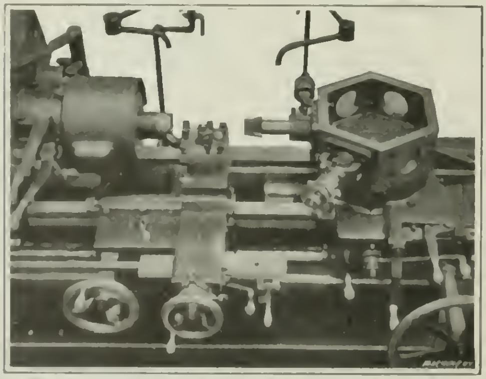


Fig. 47. Third Chucking Set-up an British Forged Shrapnel Shell

Here, again, the forging is held in the automatic chuck and is located by a plug *A* in the spindle. The first series of operations consists in boring, facing and chamfering the nose with a counterbore *B*, and at the same time turning the external radius on the nose with a tool *C*. Tool *C* is held in the cross-slide square turret and is controlled in its movement by a special guide fitting on the regular taper-turning attachment.

The second operation, shown to the left of the illustration, consists in machining the radius inside the nose with a tool *E*, controlled in its movement by the special guide *D* as previously mentioned. The third and final operation consists in cutting the thread with a collapsible tap *F*.

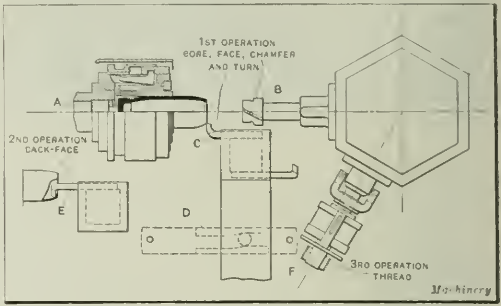


Fig. 48. Diagram illustrating Relation of Tools for performing Third Series of Operations

Set-up on Warner & Swasey Turret Lathe for Machining Bar Stock Shrapnel Shells

The method of machining shrapnel shells from bar stock differs somewhat from that used for forgings, and is handled on a No. 2A universal hollow-hexagon turret lathe. In this particular case the shell blank, previous to machining in the turret lathe, is rough-drilled in a high-powered drilling machine to the bottom of the powder pocket. Assuming that this has been accomplished, the operations for the first chucking are then carried on as illustrated in Fig. 49. Here the shell is held in an automatic chuck and is located by a stop *A*. The first operation consists in counterboring the mouth with the counterbore *B*, and rough-turning the external diameter with tool *C;* second, counterboring with the cutter *D* and turning further along the shell with a tool *E;* third, finishing the bottom with a cutter *F* and facing the end of the shell with a tool *G*.

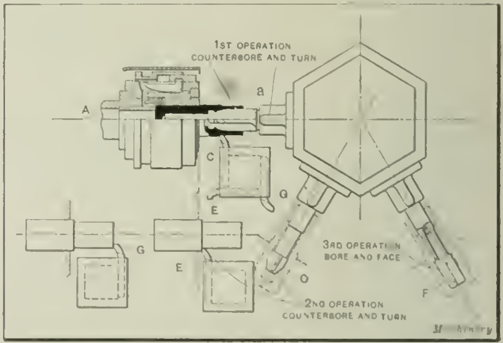


Fig. 49. First Chucking on French Shell made from Bar Stock on Warner & Swasey Turret Lathe

In the second chucking, the operations shown in Fig. 50 are performed. Here the shell is reversed in the automatic chuck and is located, as before, by a stop *A*. The first operation consists in turning that portion of the body held in the chuck in the previous chucking with a roll-supporting turning tool *B*. Second, supporting the shell with a roll-support *C* held on the turret, facing the end with a tool *D* and chamfering the band groove and the end with a cutter *E* held on the cross-slide square turret. The third operation is to support the shell from the turret and knurl with a knurl *F* from the cross-slide square turret. Fourth, taper-turn from the end to the band groove with a tool *G*, guided by the taper-turning attachment.

For the third chucking, the shell, as indicated in Fig. 51, is held in the same manner as for the first chucking. First, it is recessed with a tool *A*, brought into action by operating the special holder which has a cross-sliding movement; second, it is bored and faced with a counterbore *B* from the turret, and taper-turned with a tool *C* operated by a special guide from the taper-turning attachment. In the third operation, the thread in the nose is rough-chased with a tool *D*, controlled in its movement by the chasing attachment of the machine; fourth, the thread is finished with a tap and tap-holder *E*.

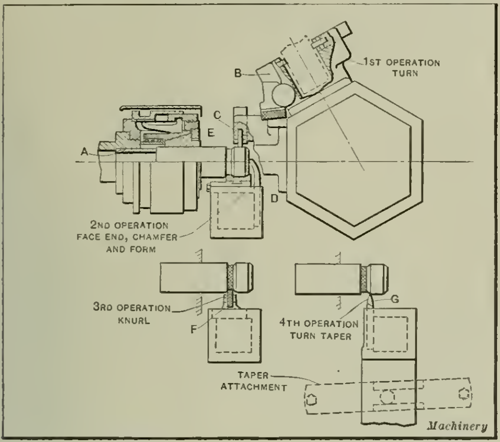


Fig. 50. Second Chucking on French Shrapnel Shell

TOOLING SET-UPS FOR MACHINING SHRAPNEL SHELL FORGINGS ON THE "LO-SWING" LATHE

By adding a simple carriage to its "Lo-swing" lathe, the Fitchburg Machine Works, Fitchburg, Mass., has adapted this machine for machining shrapnel shells of different types. The following data and illustrations refer particularly to tooling used for machining the Russian and French shells. On the Russian shell, after centering, the forging *A* is held on a special arbor *B* shown in Figs. 52 and 54. Placed over this arbor is an expanding collar *C*, the inside surface of which is chamfered to fit against surface *D* on the stem of the arbor. The section of the arbor next to the spindle is threaded and a large nut and handwheel *E* are turned to pull the sliding sleeve *C* along the arbor and thus expand it to firmly grip the inside of the shell forging. Sleeve *C* is connected to the nut *E* by a threaded collar *F*. After the forging is securely located on the arbor, which it should be understood extends to the bottom of the powder pocket to gage it for length, the tail-center *G* is run in to support it.

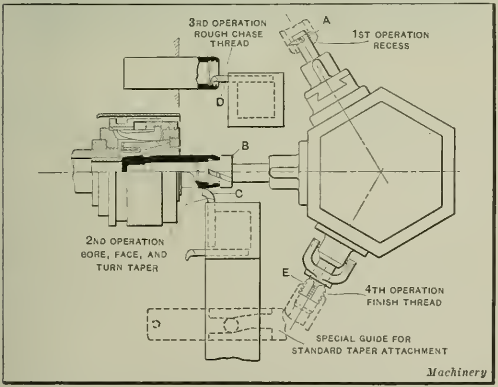

3RD OPERATION ROUGH CHASE THREAD
A
1ST OPERATION RECESS
D
B
C
2ND OPERATION BORE, FACE, AND TURN TAPER
E
4TH OPERATION FINISH THREAD
SPECIAL GUIDE FOR STANDARD TAPER ATTACHMENT
Machinery

Fig. 51. Third and Final Chucking on French Shrapnel Shell

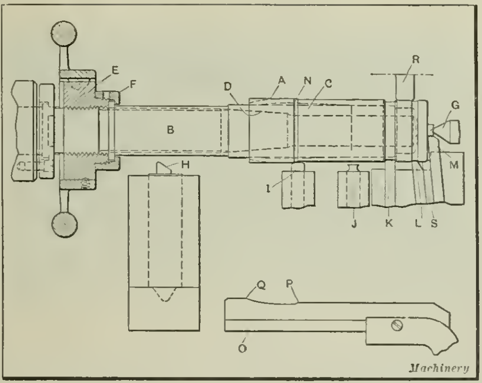


Fig. 52. Diagram showing Method of holding and performing First Series of Operations on Forged Shells on "Lo-Swing" Lathe

To those familiar with the "Lo-swing" lathe, it will be appreciated that its chief efficiency lies in its system of multiple turning tools. Thus on this job, tools *H*, *I*, *J*, *K*, *L* and *M* are all mounted on one slide, and in the illustration are shown in the positions they occupy after taking their respective cuts. At the beginning of the cut, turning tools *K*, *L* and *M* are drawn back clear of the work to allow sufficient clearance for tools *H* and *I* to operate. With the tools drawn back and the carriage at the extreme right of the bed, tool *H* is the first to come in contact with the work. This tool takes a roughing cut over the body of the forging, finishing at the radius on the nose.

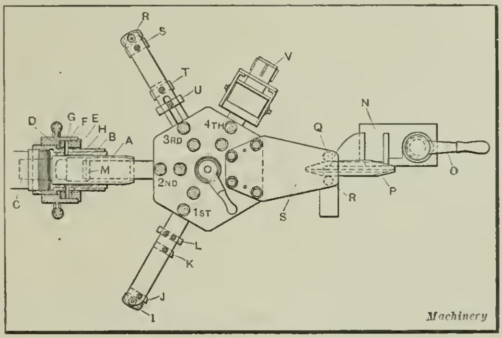


Fig. 53. Diagram showing Method of performing Second Series of Operations on Forged Shrapnel Shells on "Lo-Swing" Lathe

Tool *H* is controlled in its action by a former pin on the tool-slide, held in contact with the face of cam former *O* by a stiff spring. Former slide *O* takes the place of the regular

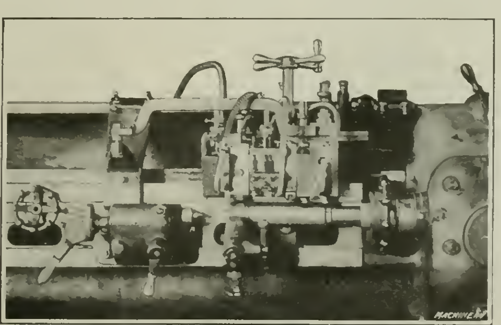


Fig. 54. Set-up for performing First Series of Operations on Russian Forged Shell on "Lo-Swing" Lathe

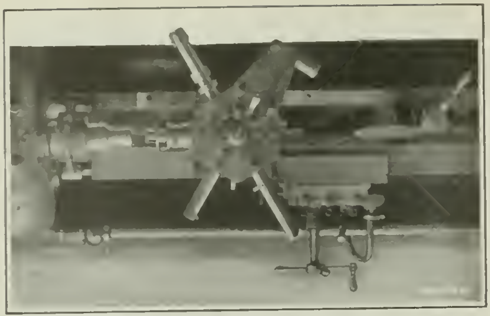


Fig. 55. Set-up on "Lo-Swing" Lathe for performing Second Series of Operations on Russian Shell

taper-turning former ordinarily used on the "Lo-swing" lathe. When the former pin in the slide carrying tool *H* reaches point *P* on former *O*, the tool is withdrawn to conform with the shape shown at *N* on the forging. The tool is then fed in further toward the axis of the arbor, until the former pin reaches point *Q* on the slide, when the radius on the nose is completed. Tool *H* is the only one mounted on a taper-turning block.

Just after tool *H* passes point *N*, tool *I* commences to cut at the end of the forging, taking a finishing cut and ending up in the position in which it is shown in the illustration. After tool *I* reaches this position, the other tools *J*, *K*, *L* and *M* are brought into action. Tools *K*, *L* and *M* are so situated on the carriage that no lateral feeding is required. When these tools are in action, the roller support *R* takes the thrust. Tool *K* roughs out the band groove and is fed into the work by a handwheel. Tool *L* cuts the groove for attaching the brass case to the shell, and tool *M*, carried on the same block, faces the end. Tools *K*, *L*, *M* and *S* are located on the same carriage and are fed in together. Tool *S* rounds the corner of the shell. The carriage on which tools *K*, *L*, *M* and *S* are located is now drawn back out of the way, and the entire carriage moved over so that tool *J* can be used to under-cut the rifling band groove. After cutting off the center projection, the first series of operations on the shell is completed.

Second Series of Operations on the Russian Shell

The second series of operations is performed on the inside of the shell on the "Lo-swing" lathe, which is provided with a special turret for this purpose. As is shown in Figs. 53 and 55, the shell *A* is held in special collet jaws *B* that have a two-point bearing on the shell. Stop *C* in the spindle locates the shell in the chuck. To manipulate the chuck for tightening it on the work, handwheel *D* is turned, carrying with it the nut *E* and ring *F*. Ring *F* carries pins sliding in slots in sleeve *H* and driven into collet *B*, so that when nut *E* is drawn back it also carries collet *B* into the taper in sleeve *H*, closing the collet on the work. Turning handwheel *D* in the opposite direction releases the grip of the collet *B* on the work. The first operation is performed with tools *I*, *J*, *K* and *L*. Tool *I* bores the powder pocket, tool *J* roughs the diaphragm seat, tool *K* rough-turns the thread diameter at the shell mouth, and tool *L* faces the end. The turret is now indexed, and boring-bar carrying tool *M* is brought into operation. This tool turns the curved interior of the shell. To accomplish this, the turret locking-pin is removed, allowing the turret to float on its central axis. Fastened on the ways of the lathe at the rear of the turret by a clamp *O* is the cam bracket *N* carrying the guiding cam *P*. This cam, through pins *Q* and *R* in bracket *S*, controls the float of the turret and guides the cutting tool *M*. In the illustration, the tool is shown at the end of the cut. It will also be noted that one surface of the cam is curved and the other is straight; therefore to compensate for this and also to steady the turret, pin *R* is backed up by a spring. Clamp *O* is now released and bracket *N* moved back to allow the turret to be indexed. Bracket *N* is located, when brought into the operating position, by a stop on the bed of the lathe.

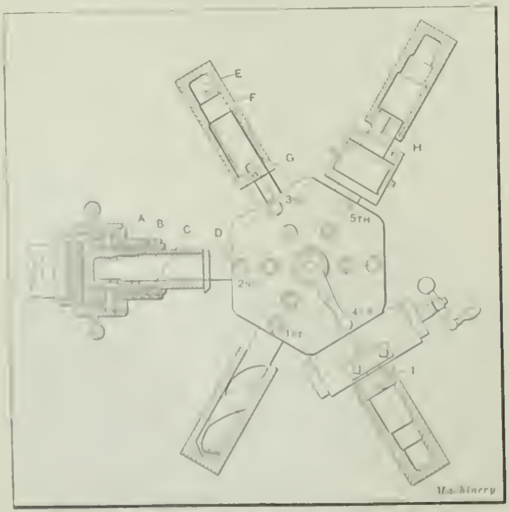


Fig. 56. Diagram showing Method of machining French Shells on Lo-Swing Lathe—First Series of Operations

In the third position, tool *R* finishes the powder pocket, *S* the diaphragm seat, tool *T* the thread diameter, whereas *U* acts as an adjustable stop for the depth of the various tools. The fourth and last operation is tapping with a collapsing tap *V*. This completes the machining of the Russian shell on the "Lo-swing" lathe.

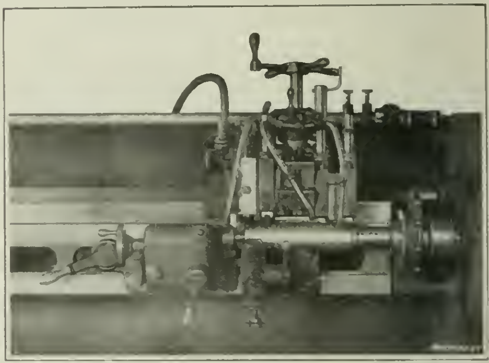


Fig. 57. Set-up on "Lo-Swing" Lathe for performing Second Series of Operations on Straight Type of French Shell

Tooling for Machining French Shrapnel Shell on "Lo-Swing" Lathe

The machining of the French shrapnel shell is particularly suited to the "Lo-swing" lathe. A great many of the French shells are made from solid bar stock, and when this is the case the first operation, performed as shown in Fig. 56, consists in rough-drilling. If the shell is made from a forging, this operation, of course, is dispensed with and the first tool used carries boring and facing cutters, as shown at *A*, *B*, *C* and *D*. These rough-bore the three diameters on the inside of the shell and face off the end to length. The next operation is accomplished with two finishing boring tools *E* and *F*, the depth of which is obtained by an adjusting collar *G* that comes against the end of the shell. Following this, the thread in the nose is produced with a collapsing tap *H*. The turret is then indexed two holes, bringing the special recessing tool into position This tool is of the cross-slide type and carries a back recessing cutter *I*.

Second Series of Operations on French Shell

The second series of operations on a French shell is accomplished as shown in Fig. 58. Here the shell is held in the same manner as described in connection with Fig. 52. The forging is placed on arbor *B* that has an expanding

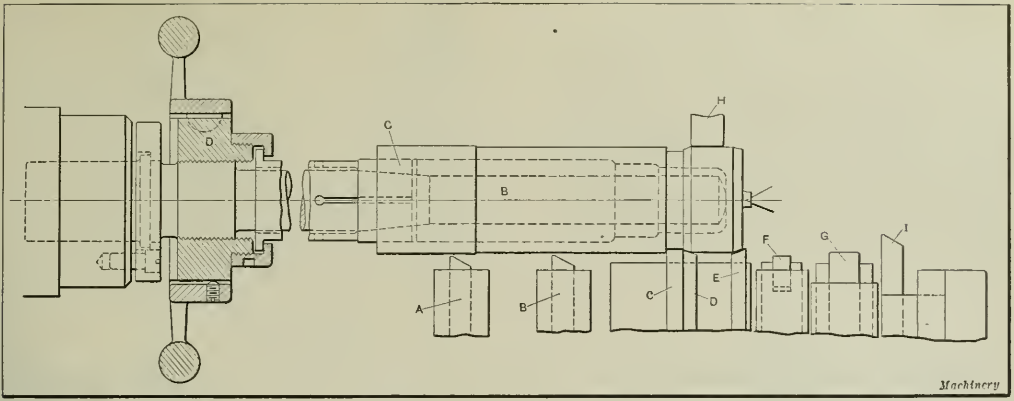


Fig. 58. Diagram showing Method of holding and applying Tools on "Lo-Swing" Lathe for performing Second Series of Operations on French Shell

sleeve *C* operated by the hand clamping wheel nut *D*. Eight cutting tools are located on the carriage. Tool *A* turns the diameter at the open end of the shell, *B* the central part, *C* cuts the band groove, *D* chamfers the section adjacent to the band groove, *E* chamfers the end of the shell and *F* knurls the band groove. Roll *G*, in connection with roll *H*, supports the shell while the knurling is being done, whereas tool *I* faces off the end of the shell. At the beginning of the cuts, tools *C*, *D*, *E* and knurl *F*, also roll *G* and tool *I*, are withdrawn. This permits tool *A* to cut the front end of the shell at the beginning and finish the diameter at the open end of the shell. Tool *B* next comes into action and turns the central part of the shell. Tool *C* is then located in the correct position for the band groove and the carriage on which tools *C*, *B*, and *E* are located is fed straight in, cutting the band groove and chamfering. Knurl *F* is then brought into position to knurl the groove, with roll *G* backing up the work against roll *H*. The last operation is to cut off the center projection with tool *I*.

Fig. 57 shows the tool set-up on the "Lo-swing" lathe for machining the straight type of French shell, in which two tool-blocks are used for doing the straight turning. The leading tool turns the end of the shell a little larger than the main body. The procedure for grooving, knurling and facing the shell is that previously described for the formed shell, which is shown in Fig. 52. On the French shrapnel shell the second operation follows directly after the first, whereas on the Russian forged shell a nosing in operation comes between the two machining operations.

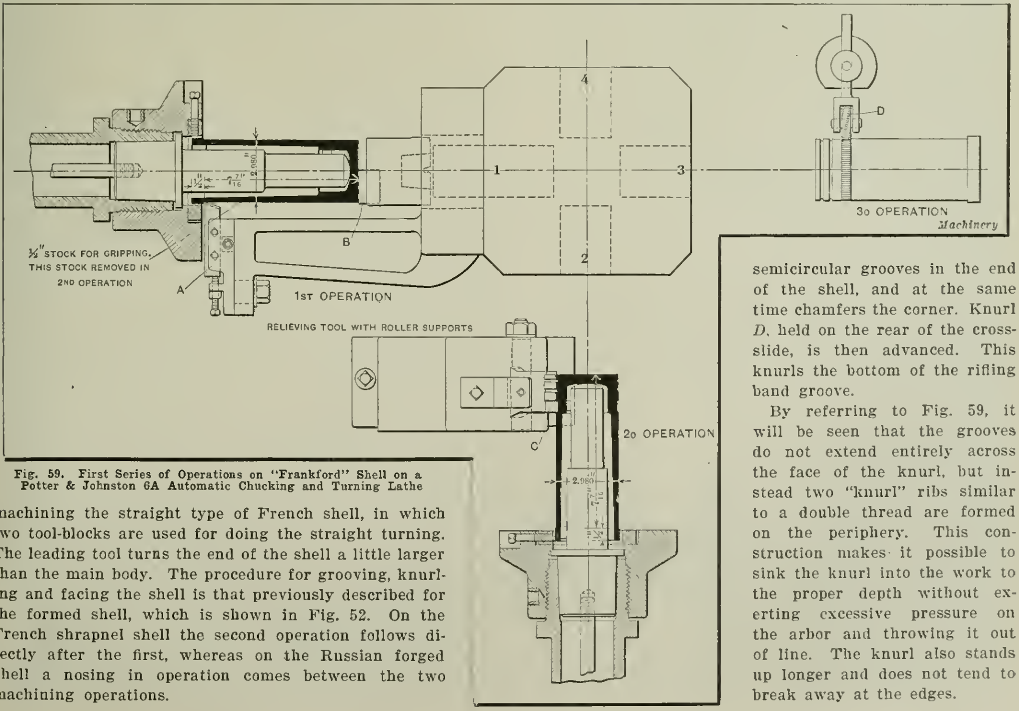

4
D
1
3
2.080"
1½"
7 7/16"
½" STOCK FOR GRIPPING, THIS STOCK REMOVED IN 2ND OPERATION
B
A
2
1ST OPERATION
RELIEVING TOOL WITH ROLLER SUPPORTS
3o OPERATION
Machinery
2o OPERATION
C
2.980"

Fig. 59. First Series of Operations on "Frankford" Shell on a Potter & Johnston 6A Automatic Chucking and Turning Lathe

SET-UPS FOR MACHINING "FRANKFORD" FORGED SHELL ON POTTER & JOHNSTON AUTOMATIC CHUCKING MACHINE

The machining of the American or "Frankford" 3-inch type of high-explosive shrapnel shell is comparatively easy, inasmuch as there is no nosing to be done, and the entire shell may be machined at two settings. Fig. 59 shows the way in which the first operation is taken care of on the No. 6A Potter & Johnston automatic chucking and turning lathe. The forged shell is held on an expanding arbor of the same type as that shown in Fig. 5, which appeared in the article on "Machining Shrapnel Shells" in the March number of MACHINERY. In the first turret position, the operations consist in taking a straight cut across the diameter and facing off the end. The external turning tool *A* is of the relieving type, and *B* is a facing tool that works on the end. Both of these tools are supported and operated from the turret. A roll support, not shown, steadies the work while tool *A* is working. The turret now backs out, and a forming tool, held on the cross-slide, advances, cuts the rifling band and the semicircular grooves in the end of the shell, and at the same time chamfers the corner. Knurl *D*, held on the rear of the cross-slide, is then advanced. This knurls the bottom of the rifling band groove.

By referring to Fig. 59, it will be seen that the grooves do not extend entirely across the face of the knurl, but instead two "knurl" ribs similar to a double thread are formed on the periphery. This construction makes it possible to sink the knurl into the work to the proper depth without exerting excessive pressure on the arbor and throwing it out of line. The knurl also stands up longer and does not tend to break away at the edges.

Second Series of Operations on "Frankford" Forged Shrapnel Shell

For the second series of operations, the "Frankford" shrapnel shell is held in a draw-in collet as shown in Fig. 60. As the shell has been completely machined on the outside, it is let into the collet for a considerable distance. For machining, it is shown gripped in the collet by jaws *A* and is backed up by positive stop *B*. At the first turret face, tool *C* rough-bores the diaphragm seat, tool *D* bores the thread diameter, and tool *E* faces and chamfers the end. The turret is now indexed, and tools *F*, *G* and *H* perform similar finishing cuts. A holder held on the third turret face carries tool *I* that chamfers the powder pocket, and at the fourth turret face a collapsing tap threads the open end.

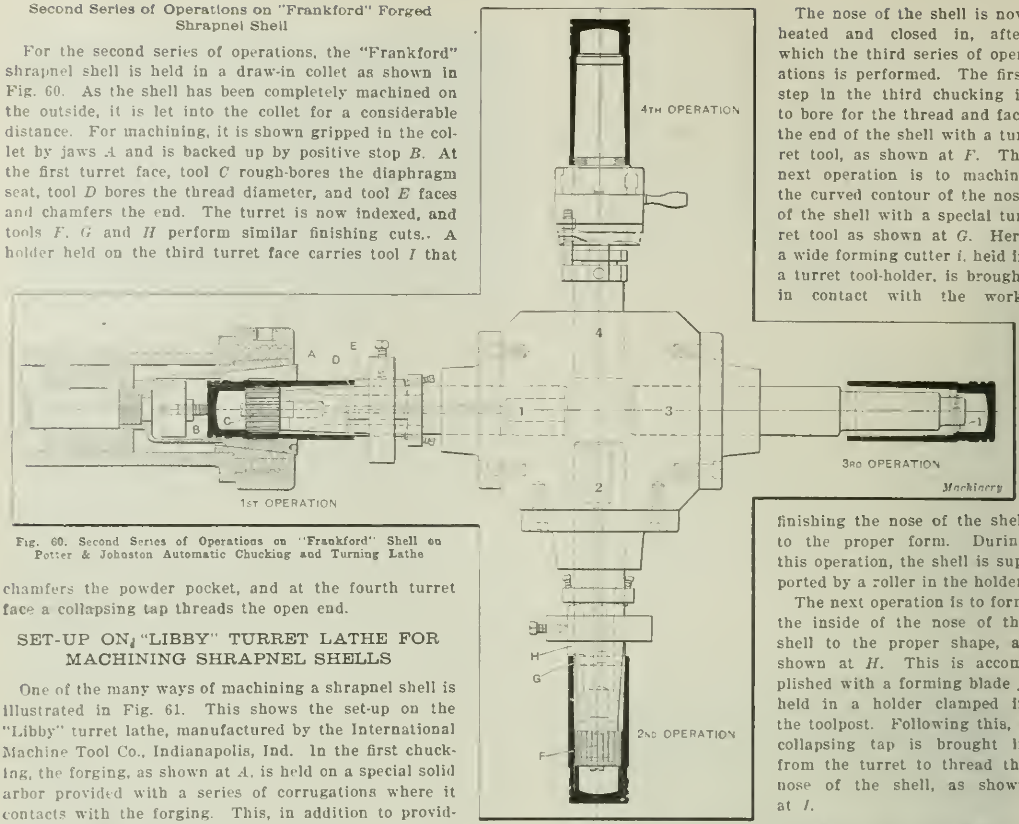


Fig. 60. Second Series of Operations on "Frankford" Shell on Potter & Johnston Automatic Chucking and Turning Lathe

SET-UP ON "LIBBY" TURRET LATHE FOR MACHINING SHRAPNEL SHELLS

One of the many ways of machining a shrapnel shell is illustrated in Fig. 61. This shows the set-up on the "Libby" turret lathe, manufactured by the International Machine Tool Co., Indianapolis, Ind. In the first chucking, the forging, as shown at *A*, is held on a special solid arbor provided with a series of corrugations where it contacts with the forging. This, in addition to providing a rigid support, assists in gripping, and the shell is also gripped by a pair of chuck jaws that act as drivers. First, a gang tool-holder carrying three stellite turning tools o is brought into position, and the cutting is started, continuing for a distance of one-third of the length turned. To provide additional support, a roller back-rest, carrying a facing tool, is brought in to steady the work, and as it is fed forward, the end of the forging is faced off and chamfered.

The second operation on the first chucking is shown at *B*. Here the cutter *a* is brought in first and starts the band groove, after which the under-cutting tool *b* is brought in to under-cut the edges of the groove. In the meantime, roller *c* supports the work. Upon the completion of the groove, the holder carrying cutter *d* is advanced to finish-face the end of the work and chamfer.

The third operation—cutting the waves in the band groove—is of an interesting character and is accomplished as shown at *C*. A cam *e* which is free to rotate with the work is first brought in contact with it; then the cross-slide is advanced, carrying the waving tool *f* and the guide *g*. The guide *g* fits in the cam groove and controls the operation of the waving tool

In the second chucking on the first operation the shell is reversed in the chuck and is held in the manner indicated at *D*. The forging is located in the chuck by a stop collar *h*, and is gripped on the external diameter by the jaws of the chuck. A stepped boring tool carrying five inserted blades is brought in to rough-bore the internal diameters and machine the shell to the proper thickness at the bottom of the powder pocket. This tool also carries a facing cutter that faces off the shell to the proper length. While the boring tool is working, a broad turning tool, held on the cross-slide, is brought in to bevel the nose preparatory to closing in. The next step is to taper ream the internal diameter, as shown at *E*. This completes the operations for the second chucking.

The nose of the shell is now heated and closed in, after which the third series of operations is performed. The first step in the third chucking is to bore for the thread and face the end of the shell with a turret tool, as shown at *F*. The next operation is to machine the curved contour of the nose of the shell with a special turret tool as shown at *G*. Here a wide forming cutter *i*, held in a turret tool-holder, is brought in contact with the work, finishing the nose of the shell to the proper form. During this operation, the shell is supported by a roller in the holder.

The next operation is to form the inside of the nose of the shell to the proper shape, as shown at *H*. This is accomplished with a forming blade *j*, held in a holder clamped in the toolpost. Following this, a collapsing tap is brought in from the turret to thread the nose of the shell, as shown at *I*.

MACHINING SHRAPNEL SHELLS ON A HEAVY 22-INCH TURRET LATHE

Still another method of machining shrapnel shells in a heavy turret lathe is shown in Fig. 63. The shell being machined is an 18-pound British shrapnel shell made from a forging. It is held on an expanding arbor for the first operation, as shown in Fig. 62. The arbor is of the three-point support type and is positive in its grip. Around the periphery of the nose piece are located three pinions *A* capable of being rotated by a square ended wrench. These mesh with teeth in bevel gear *B* which, in turn, is threaded onto arbor *C*. The forward end of this arbor is cone-shaped and operates the three gripping fingers in the open end of the shell, whereas another rod passing through arbor *C* and connected to plunger *D* operates, through the coil spring, the three fingers used in gripping the shell by the powder pocket. This arbor holds the shell securely while the machining operations are being accomplished.

The first operation performed at the first chucking of the work is shown at *C* in Fig. 63. Here a turning tool-holder clamped to the turret and carrying two cutters is advanced and takes a roughing cut from the exterior diameter of the shell for practically its entire length. The shell is supported by three roller supports as illustrated. The second operation at the first chucking is performed from the cross-slide, as shown at *D*. Here a forming tool of the tangent type roughs out the rifling band groove, leaving sufficient metal in the center for the production of the wave ribs. The third operation is facing off the closed end of the shell from the turret as shown at *E*, and the fourth operation consists in machining the waved ribs as shown at *F*. The tool for accomplishing this operation is held on the cross-slide and is operated from a face cam on the nose of the spindle.

In the second chucking the shell is held in a three-jaw scroll chuck. The first operation is to rough-bore the inside

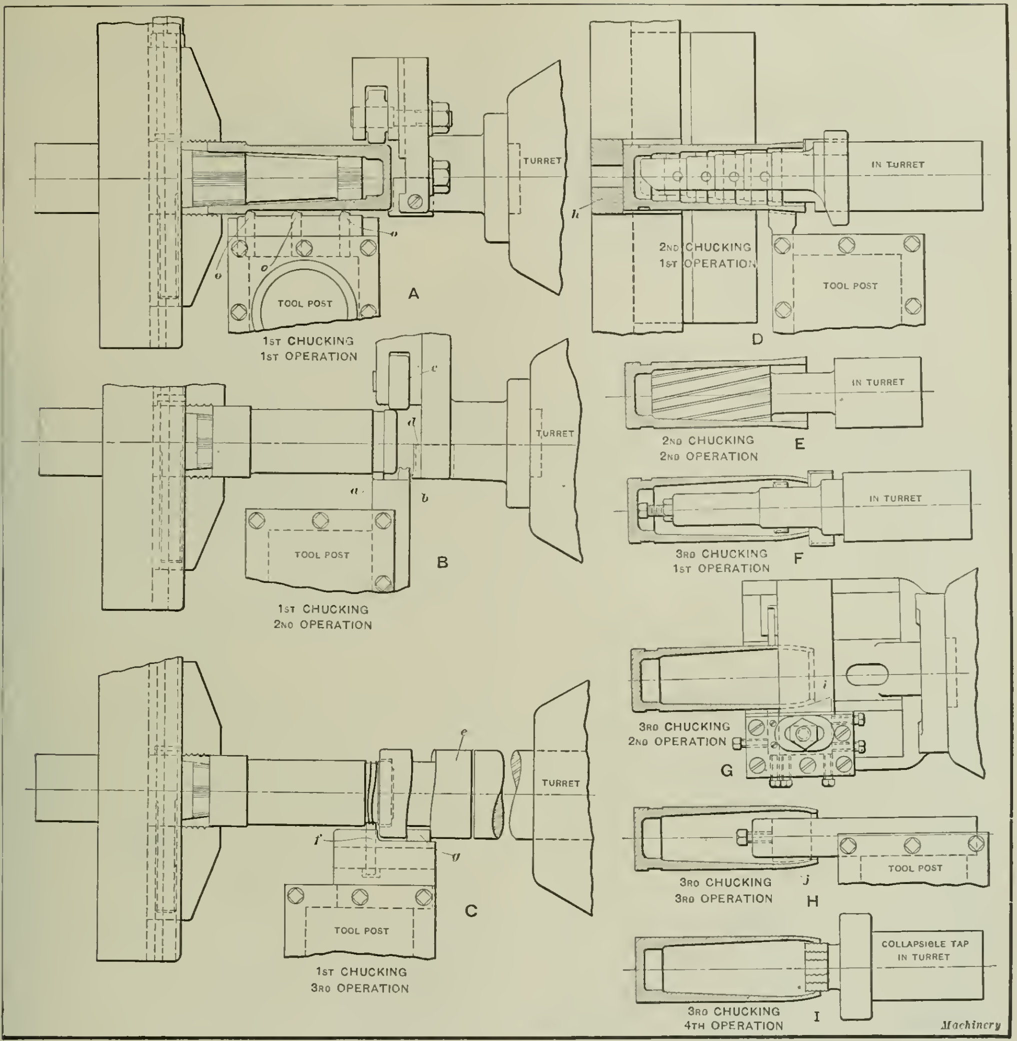


Fig. 61. Set-up and Tool Equipment on the "Libby" Turret Lathe for machining Forged Shrapnel Shells

of the shell and powder pocket with a tool *G* held in the turret; directly after this a finishing tool of the same shape is brought in, finishing the surfaces previously roughed out. The second operation is to face off the open end of the shell and taper-form back of the nose from the cross-slide, as shown at *H*, and at the same time turn that portion of the exterior surface of the shell not machined in the previous operation, with a tool clamped to the turret as shown at *I*.

Previous to the third chucking, the nose of the shell is heated and closed in. The shell is then held in a three-jaw scroll chuck provided with special jaws. The first operation, as shown at *J*, consists in boring and turning the nose of the shell with a tool held in the turret. Following this, the hole is reamed with a standard reamer and tapped with a collapsing tap. Both of these tools are held in the turret but are not shown in the illustration. This completes the machining operations on the shell.

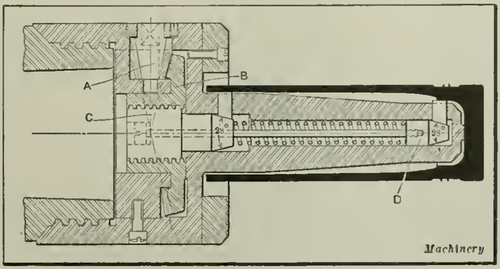


Fig. 62. Method of holding Shrapnel Shells for First Operation on a 22-inch Turret Lathe

THREADING SHRAPNEL SHELLS ON "AUTOMATIC" THREADING LATHES

Considerable difficulty has been experienced in cutting the square thread in the nose of the French shrapnel shell. One method which accomplishes this operation satisfactorily is shown in Fig. 64, and is accomplished on a 12-inch "Automatic" threading lathe built by the Automatic Machine Co., Bridgeport, Conn., and equipped with special tools for this purpose. Referring to this illustration, it will be seen that two tools are used —a roughing tool *A*, and a finishing tool *B*. Tool *A* roughs out the thread to a shape similar to the Acme type of thread, whereas tool *B* squares it up. The roughing and finishing tools are held on the forward and rear

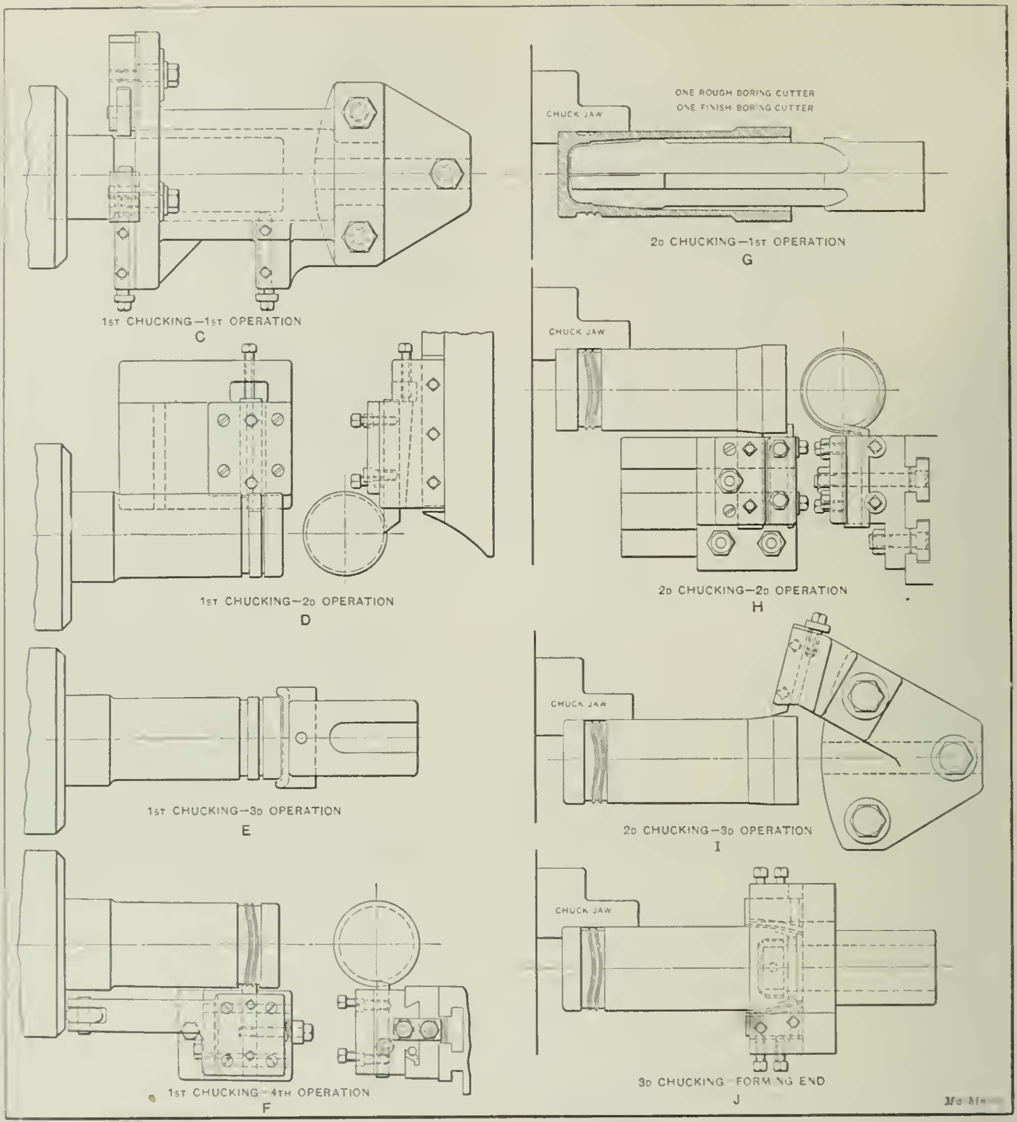


Fig. 63. Machining Shrapnel Shell Forgings on a 22-inch Extra-heavy Turret Lathe

carriages, respectively, and are operated simultaneously, being advanced throughout the length of the thread, withdrawn and returned to start a new cut. The method of operating the tools is one of the chief features of the "Automatic" threading lathe.

The base end of shrapnel shells when made from bar stock is as a rule bored out and a plug inserted to eliminate any piping effect in the bar. Fig. 65 shows the method of accomplishing this operation on a 12-inch "Automatic" threading lathe. The work is held in a three-jaw universal chuck and is supported by a roll steadyrest comprising two rolls that are located beneath the work. On the extended end of the rear roller stud is fastened a swinging stop that is used for locating the base of the shell in the correct position ready for threading. The base of the shell is counterbored in another machine, previous to the threading operation. The threading is done with a circular tool held on a special internal threading tool-holder, the latter being retained in the tool-post carriage. The threading tool-holder can be moved longitudinally to bring it into the proper relation to the work. It is also held so that the cutting edge is turned upside down as this action forces the work down in contact with the roller supports. By handling the work in this manner, a steady-rest of the ordinary type is dispensed with and the operation of the attachment facilitated.

One method of making plugs for the base end of shrapnel shells when made from bar stock is shown in Fig. 66. For this work, a 12 by 4 "Automatic" threading lathe equipped with special tools designed for this purpose is used. The machine is provided with a draw-in collet chuck that holds the rough forged blank. The order of handling the operations on this machine is to use the rear tool A for turning the external diameter of the plug. This is handled at the same rate of feed as that required for threading, so that it is sometimes necessary to take more than one cut, depending on the amount of material left on the diameter. The vertical

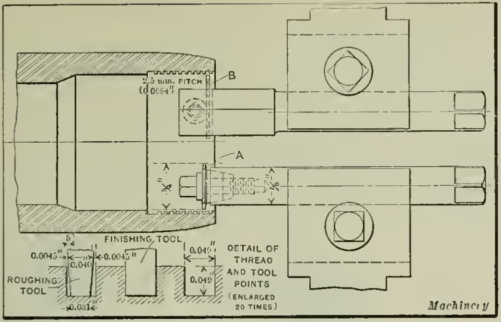


Fig. 64. Cutting Square Thread in Nose of French Shrapnel Shell in "Automatic" Threading Lathe

slide *B* is for facing only and carries a cutting tool *C*. This is supposed to finish the face in one cut, but as the work will spring considerably, a light finishing cut is taken when the tool is being drawn back from the center to the circumference of the work. The threading tool *D* is held on the front toolpost and is of single-point construction. The feed given to this tool is automatically controlled, both as to pitch and depth of cut at each traverse.

In actual operation, both the threading and turning tools are in motion all the time on the work, but the tools are independently controlled so that either one can be operated separately. A stop is provided on the back toolpost so as to turn each plug to the same diameter. The automatic throw-out for the feed of the threading tool is set from the front handle on the ratchet and pawl as regularly furnished on the "Automatic" threading lathes.

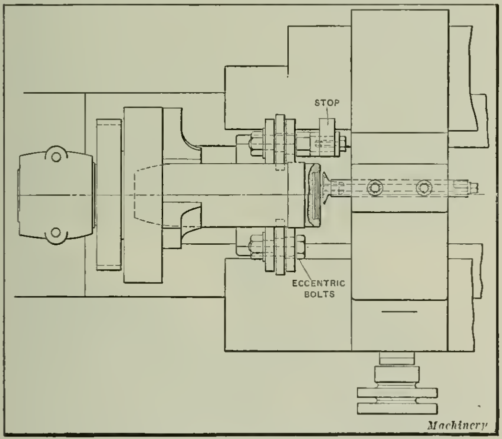


Fig. 65. Threading Base End of Bar Stock Shrapnel Shells in "Automatic" Threading Lathe

GRINDING SHRAPNEL SHELLS ON NORTON GRINDING MACHINES

An increasingly large number of shrapnel shell manufacturers are finishing the steel shell by grinding instead of finish-turning. That is, the exterior surface of the shell is rough-turned to within from 0.030 to 0.080 inch of the finished size and is then finished to the required limits and shape by grinding, as shown in Fig. 67. It is claimed by the advocates of grinding that the finishing operations are more speedily performed in this manner and that a more accurate and concentric shell is produced. They also point out the fact that portions of the shell are so hard that it is extremely difficult, if not impossible, to turn it in the allowable time.

The varied heat-treatment given to the shell on the closed end and nose leaves it harder in some sections than others, as indicated in Fig. 68. The section *E*, 2½ inches from the closed end of the shell, must strike from 42 to 50 on the scleroscope, and the section *A* at the nose must strike between 20 and 25. The section marked *D*, or that part of it to the left of the line that marks the limit of the heat-treating on the closed end, has not been heat-treated at all, and partly on this account and also because of the gradually diminishing thickness of the shell along this section, it strikes between 40 and 45, decreasing as the thickness of the wall diminishes, until at *C* the section strikes but 35. Section *B*, adjacent to the annealed nose of the shell, strikes about 30 on the scleroscope.

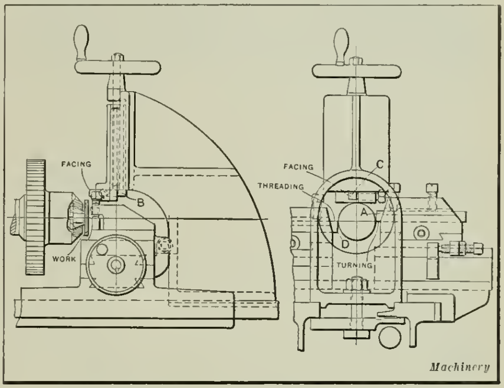


Fig. 66. Turning, facing, and threading Plugs for Closed End of Bar Stock Shrapnel Shells in "Automatic" Threading Lathe

On the other hand, some manufacturers are not putting the shell through this heat-treating and tempering process, and omit the annealing and machining of the nose after the nosing in operation. This leaves the nose with considerable stock to remove and in such a condition as regards hardness that the grinding machine becomes a necessity. In the face of these varying degrees of hardness of the shrapnel shell, it will be seen that it is difficult to secure wheels of the right grain and grade to suit all of these conditions. With this information in mind, we can more intelligently take up the actual grinding of the shell. The Norton Grinding Co., Worcester, Mass., has been actively engaged in developing methods of grinding shrapnel shells and the following illustrations and description apply to the work as done on Norton grinding machines.

Fig. 69 shows the two-operation method of grinding the shrapnel shell. Section *A* at the open end of the shell is covered by a wide faced wheel formed to shape, that finishes the radius on the nose at one in-feeding of the wheel. Sections *B*, *C* and *D* are covered by a wide faced wheel, formed to shape so as to finish these three surfaces at one in-feeding of the wheel. Section *E* at the closed end of the shell is finished completely by turning.

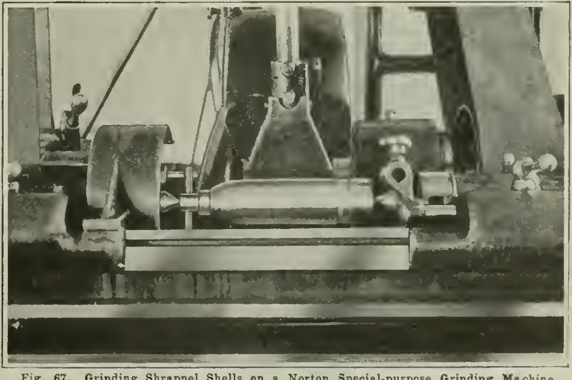


Fig. 67. Grinding Shrapnel Shells on a Norton Special-purpose Grinding Machine

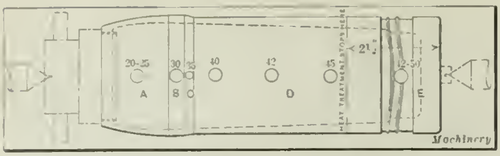


Fig. 68. Diagram showing Scleroscope Hardness Test of Heat-treated Shrapnel Shell at Various Points along its Surface

Some manufacturers use a three-operation method of grinding the shrapnel shell as illustrated in Fig. 70. In this case, the sections *A* and *D* are first ground with the same wheel, as American manufacturers deem it advisable to grind surface *A* rather than to finish it by turning. The second stage in this grinding is the finishing of the nose *E* with a formed wheel, and the third stage is the finish-grinding of the body at points *B* and *C*.

Procedure followed in Grinding Shrapnel Shells

The procedure followed in grinding shrapnel shells by the two-operation method is first to screw plugs into the open end of the shells, as shown in Fig. 69. The outer ends of these plugs are centered, and the projection left on the closed end of the shell with the center intact acts as a means of supporting the shell. Some of the Canadian manufacturers vary this practice by cutting off the center projection on the closed end of the shell and fitting a cap with a center hole over the closed end. Others use a ball bearing cup center to carry the closed end. American manufacturers, however, leave the center projection on the shell until after the grinding has been finished.

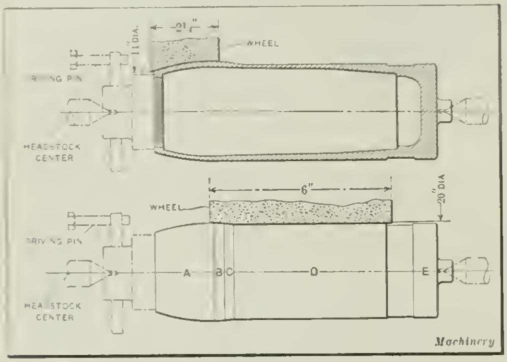


Fig. 69. Two-operation Method of grinding Shrapnel Shells on Norton Grinding Machines

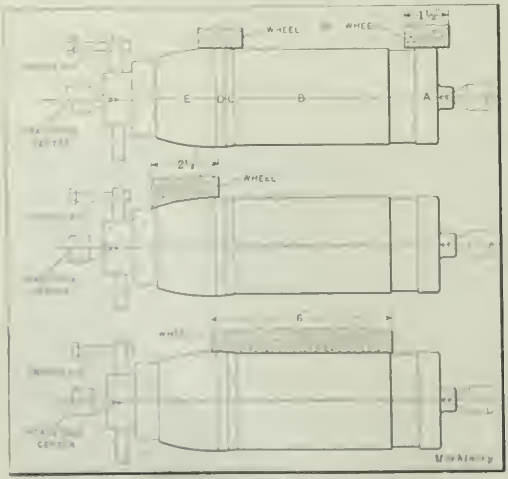


Fig. 70. Three-operation Method of grinding Shrapnel Shells on Norton Grinding Machines

In grinding the nose end of the shell, the amount of metal removed varies from 0.020 to 0.090 inch on the diameter. The grinding wheel operates at from 6000 to 6250 surface feet per minute. The speed of the work is 75 revolutions per minute, or a surface speed of practically 75 feet, and the machine used is a Norton 6 by 32 plain grinder. The wheel used is generally 14 inches diameter by 2¼ inches face. The wheel requires truing for every five to twenty shells, depending upon the amount of metal removed and the hardness of the shell. For truing, a simple radius fixture carrying a diamond is used. Fig. 71 shows this wheel truing device clamped on the grinding machine bed. It is applied in the same manner as the usual steadyrests used for supporting the work. The diamond is mounted in a swinging arm that is operated by a hand lever as shown. By successive cuts across the wheel, the desired shape is attained.

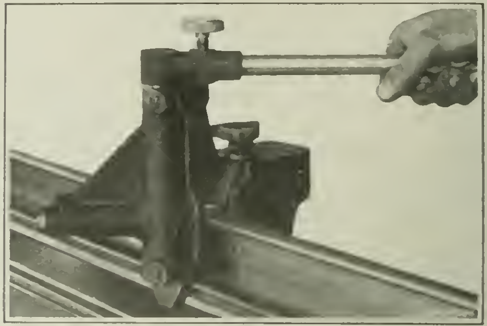


Fig. 71. Radius Wheel Truing Device for forming Grinding Wheel for grinding Shrapnel Shell Nose

For grinding the body either a 10 by 24 special-purpose or 10 by 36 Norton grinding machine is employed. The amount of metal removed from the body varies from 0.030 to 0.075 inch on the diameter, and the limits vary from 0.002 to 0.010 inch, depending largely on the requirements of the plant in which the work is being done. The wheel used on the body is 20 inches in diameter and is of the ring wheel type. It will be noticed in Fig. 69 that the wheel for grinding the body is also formed to shape. The method of truing the wheel for shaping the shrapnel shell body is shown in Fig. 72. This attachment is clamped to the front of the grinding machine bed and at the top of the bracket is fitted a slide *A* operated by handwheel *B*. Upon the face of this slide nearest the grinding wheel is pivoted an angular arm *C* that supports the diamond *D* at its lower end. Under the end of the upper arm is a spiral spring that keeps the diamond normally back from the wheel. A plate former *E* clamped to the bottom face of the bracket is shaped to agree with the form to be given the wheel. Located at the lower extremity

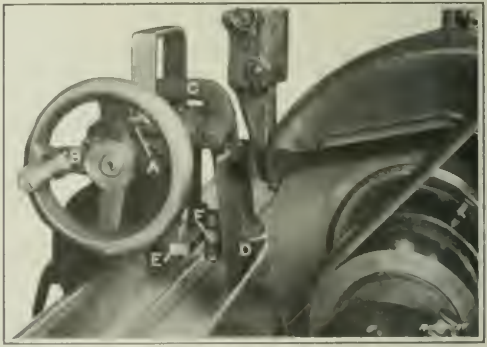


Fig. 72. Norton Special Form Wheel Truing Device for truing Wheel for grinding Shrapnel Shell Body

of the arm and behind the diamond is mounted a roll *F* that bears constantly against form *E*. When the diamond slide is reciprocated by turning the handwheel, the diamond is made to traverse a path conforming with the cam that guides it. By moving the wheel in toward the diamond and making successive traversings of the diamond, the wheel is given the desired shape.

For grinding the body, the wheel must be trued after every ten to twenty-five shells are ground, depending upon the amount of metal removed and the hardness of the shell. In grinding shrapnel shells, the usual method is to fit a lot of the shells with the driving plugs and carry them all through to completion before removing the plugs.

REMOVING CENTER END FROM SHRAPNEL FORGINGS ON BESLY DISK GRINDER

For performing practically all the machining operations on the shell, a center projection is left on the closed end of the shell for supporting it. This, of course, must be removed before the shell is completed. One method of doing this is to use a Besly No. 14 ring wheel grinder equipped with a special fixture. A Besly grinder fitted up for this work is shown in Fig. 73, and the fixture used for holding the shell is shown in Fig. 74. The machine, as furnished, is arranged for wet grinding but is not so fitted up in the illustration. The fixture shown in Fig. 74 is fastened to the geared lever feed table and is of simple design. It is provided with a backing-up stop *A*, the work resting in two semi-spherical groove projections on the fixture. The operator simply holds the shrapnel shell in place by hand and then feeds it in against the wheel and traverses it past in the usual manner. The time for removing a ⅝-inch diameter stub end projecting ⅜ inch from the body of the shell is less than a minute.

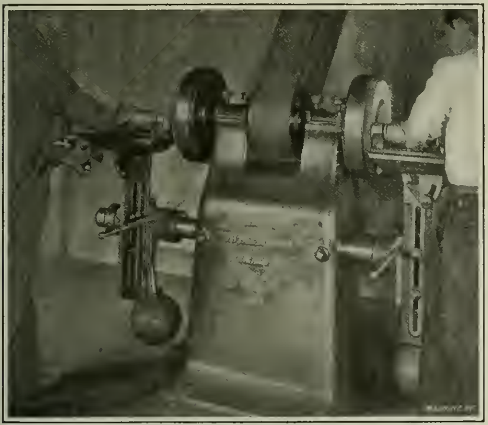


Fig. 73. Besly No. 14 Ring Wheel Grinder equipped for grinding Shrapnel, but shown without Hoods and Water Attachments

FORGING THE SHRAPNEL HEAD

The shrapnel head shown at *A* in Fig. 75, that screws into the end of the shell and into which the fuse body is screwed, is made from a forging of low-carbon steel for the French shell. One method of producing this which is of unusual interest is shown in Fig. 76. A power-driven forging machine equipped with a special set of tools is used for this purpose. A bar of steel of the same diameter as the hole in the finished forging, in this case 1½ inch, is gripped in the dies as shown at *A*, and is upset by means of a plunger *a*, forming an upset on the end of the bar shown to the right.

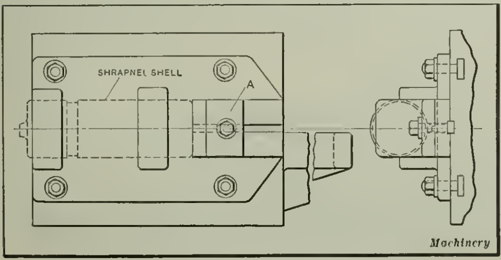


Fig. 74. Fixture used on Besly No. 14 Ring Wheel Grinder for grinding Center End from Shrapnel Forgings

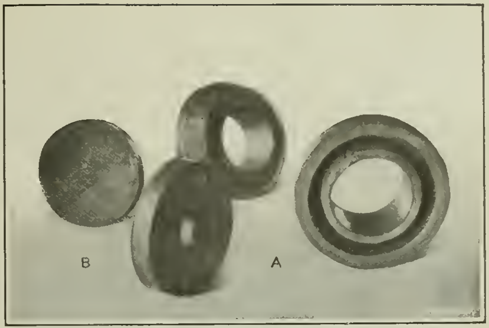


Fig. 75. Shrapnel Shell Head and Diaphragm produced in a Power Forging Machine

The upset bar is now placed in the second impression of the gripping dies, as shown at *B*. By way of explanation, it should be stated that the views of the dies shown at *A*, *B* and *C* are sections taken in a horizontal plane at each stage or die impression. Upon gripping the upset forging in the second impression in the dies, the plunger *b* advances and forms an annular groove in the face of the forging, at the same time increasing its width as shown at *c*.

The forging, still integral with the bar, is now quickly removed and placed in the last impression of the dies. The diameter of the hole in these dies is larger than the bar, allowing it to slip back as the punch advances to punch the hole in the forging. When the punch moves forward it carries with it the spring-operated sleeve *d*, thus finishing the forging in one heat. This method of forging is very satisfactory, producing a homogeneous forging at the rate of 1500 in ten hours.

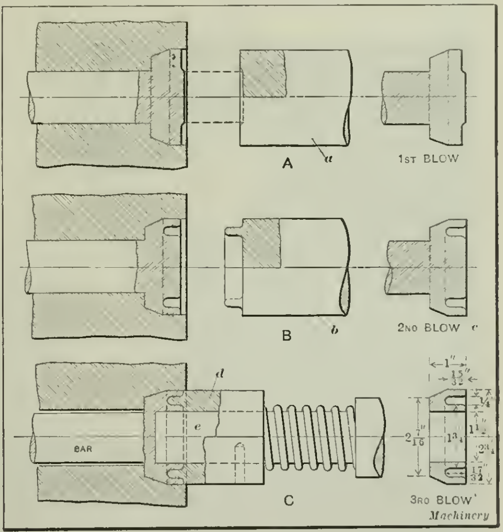


Fig. 76. Diagram illustrating Method of producing Shrapnel Shell Heads in a Power Forging Machine without any Waste of Stock

Forging the Steel Diaphragm

The steel diaphragm shown at *B* in Fig. 75 is made from low-carbon steel in a special type of forging machine operated similarly to a hot-pressed nut machine. That is to say, the bar, instead of being fed in from the front, as in a regular forging machine, is fed in from the side.

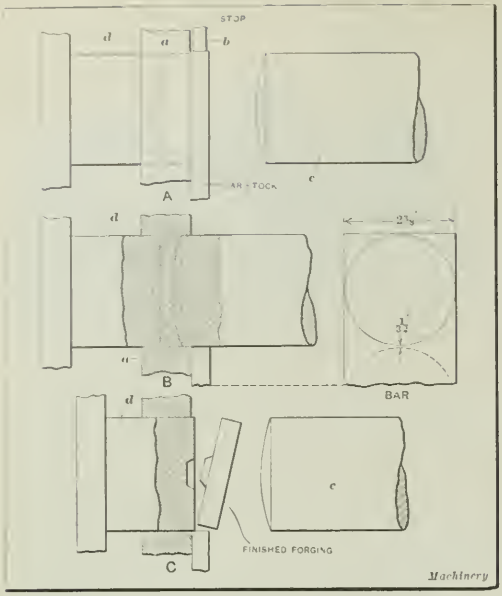


Fig. 77. Diagram illustrating Method of making Shrapnel Shell Diaphragms in a Special Type of Power Forging Machine

The manner in which this is accomplished is shown in Fig. 77. A flat bar of steel 2 3/8 inches wide by 3/8 inch thick, heated to the proper temperature for a distance of three feet, is fed across the face of the die as at *A* and located by stop *b*. Punch *c* then advances and cuts out a blank of the required diameter, forcing it into the die, as shown at *B*. The metal is now confined between the faces of punches *d* and *c* and in die *a*, and is forged to the required shape. The next step is shown at *C*, where punch *d* advances and forces the formed forging out of the die. The production on this diaphragm is in the neighborhood of 8000 to 10,000 in ten hours.

GAGING SHRAPNEL SHELLS

The machining operations on shrapnel shells are required to be held within certain limits, and government inspectors watch these closely. Some of the principal gaging operations on the shrapnel shell body are shown in Fig. 78. Fig. 79 shows the 18-pound shrapnel shell in section, and gives the principal dimensions together with the limits; it will be seen from this illustration that the range allowable is in most cases large. The Wells Bros. Co., Greenfield, Mass., has made a large number of shrapnel gages, some of which are shown in the accompanying illustrations. In the three upper views of Fig. 78, the Wells Bros. standard thread gage is illustrated. This is used for all diameter measurements by substituting flat gaging pins for the V-points used when gaging thread diameters.

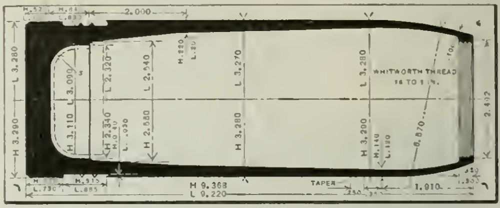


Fig. 79. 18-pound Shrapnel Shell showing Dimensions and Manufacturing Limits

Gages for British Shrapnel Parts

Fig. 80 illustrates typical gages for gaging such parts of the British shrapnel as body diameters, diaphragm seat, powder pocket, fuse socket, thread diameters, and fuse parts. Fig. 81 shows the application of several different types of

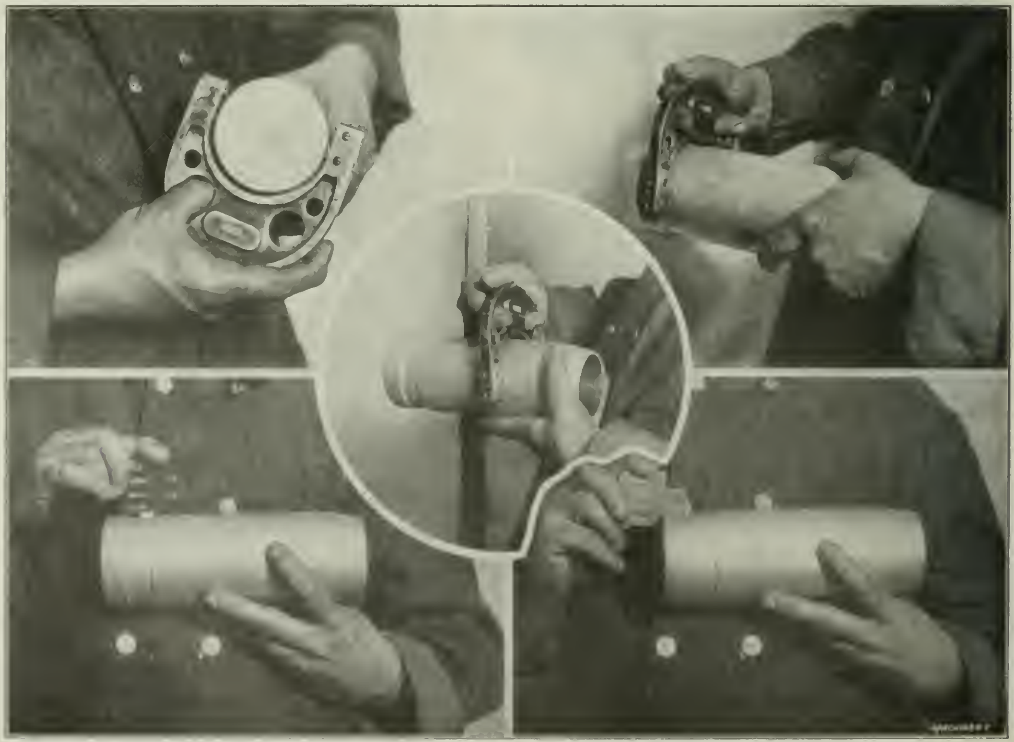


Fig. 78. Illustration showing Some of the Principal Gaging Operations on Shrapnel Shells

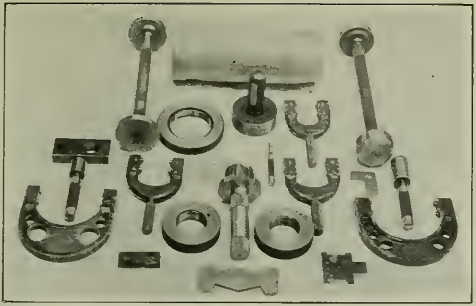


Fig. 80. Group of Gages made by Wells Bros. Co. for gaging British Shrapnel Shells and Parts

shrapnel shell gages. At *A* is the gage for the over-all length. At *B* is the gage used for measuring the thickness of the closed end. The outer arm of this gage can be swung away to allow the placing of the gage on the standard. At the extreme lower left-hand corner of the gaging arm is a slight shoulder on the rod and the height of this acts as the limit. *C* shows the application of outside diameter and thread gages.

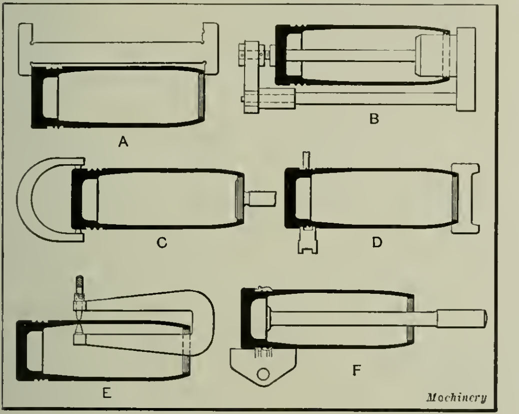


Fig. 81. Diagram showing Application of Wells Bros. Gages

D shows three form gages for checking the shape and dimensions of the wave ribs, the diameter and shape of the under cut in the band groove and the shape of the nose of the shell. *E* shows the gage used for checking the thickness of the wall of the shell at different distances from the mouth. *F* shows the application of a powder pocket gage, and also a gage for checking the shape of the finished rifling band.

Gages for American Shrapnel Shells

Fig. 82 shows a miscellaneous collection of gages used in checking the dimensions of the American shrapnel shell. Gages *A*, *B*, *C* and *D* are for measuring the diameter of the diaphragm seat. *E* is for checking the distance from the diaphragm seat to the mouth end of the shell, and gage *F* is for the outside diameter of the shell. Gage *G* is used for the rifling band groove. Gages *H* and *I* are for the thread in the mouth of the shell, *H* being a "not-go" and *I* a "go" gage.

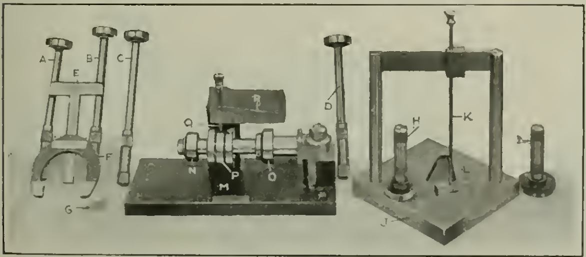


Fig. 82. Collection of Wells Bros. Co.'s American Shrapnel Shell Gages

The gage at *J* performs several gaging functions on the American shell. It consists of a standard having two upright posts across which a bar is mounted. The purpose of the bar is to gage the overall length of the shell, and its lower surface is provided with two steps giving the limits. This gage is also used for measuring the depth of the powder pocket, rod *K* and block *L* performing this function. Two rings are cut around the rod *K* registering with the top surface of the bar, the purpose being to show the accuracy of the work.

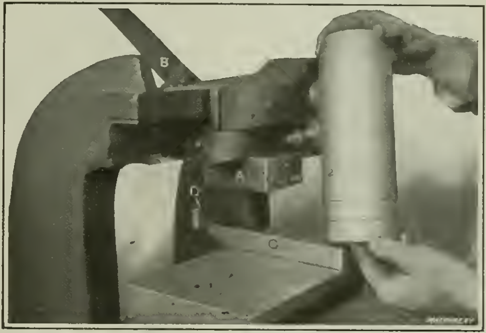


Fig. 83. Dwight-Slate Hand-operated Marking Machine for Shrapnel Shells

Another interesting gage is shown at *M*. This is for gaging the concentricity of the shell and consists of an arbor mounted so that it can be swung on a pivot. The arbor carries two collars *N* and *O* that fit in the shell. Collar *P* is merely a sizing plug and when the gage is in use this plug is removed. A gaging finger *Q* rests against the shell when it is on this arbor, and a standard type of indicator *R* shows the variation in concentricity when the gage, collars and shell are rotated on the arbor.

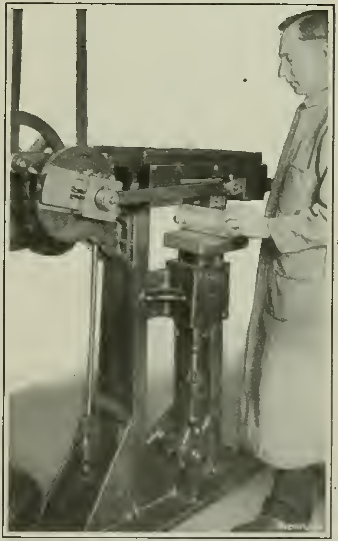


Fig. 84. Power-driven Dwight-Slate Marking Machines for Shrapnel Shells

MARKING SHRAPNEL SHELLS

All shrapnel shells are marked on their circumference with five or six lines of lettering, as shown in Fig. 83. This indicates the size of the shell, the series, muzzle velocity, name of the manufacturer, date completed, etc. Two types of machines for producing the stamping, built by Noble & Westbrook, Hartford, Conn., are shown in Figs. 83 and 84. The machine shown in Fig. 83 is of the hand-operated type. The figure block *A* is held in a slide that is moved longitudinally by pulling down handle *B*, rolling the shell, and at the same time stamping it. The shell is located on the table in the two positions by gages *C* and *D*.

The "Dwight-Slate" stamping machine shown in Fig. 84 is power-driven, and the work is held on an elevating table. The stamp is held in a slide operated by an eccentric and connecting-rod. In this machine the shell is not distorted, as in hand-stamping.

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SHRAPNEL AND SHRAPNEL MAKING

The shrapnel shell, invented by an Englishman, Lieut. Henry Shrapnel, in the latter part of the eighteenth century, was conceded by military experts to be most effective for the purpose intended, even in its early form. As originally made, it was a spherical explosive shell that burst by ignition with a time fuse, the fragments and bullets contained being scattered in all directions. The modern, or "shooting shrapnel," is a thin walled projectile made of high tensile strength steel, cleverly designed to act like a blunderbuss; it blows its charge of bullets out at a still greater velocity than that imparted to the shell by the howitzer.

The design of shrapnel and the machining of the component parts are matters of world-wide interest to manufacturers, toolmakers and mechanics at present. Shrapnel is being used in enormous quantities, and American machine tool builders have been called on to provide machines and tool equipment of the latest and most efficient designs to meet the demand. Many shops are running full force day and night, and are months behind their orders. A small percentage of shrapnel shells is made from bar stock but most of them are made from forgings, formed hollow under hydraulic presses or in forging machines. The forging processes, which are of extraordinary interest, especially to those who know something of the difficulties attending them, are not finishing processes. Whether made from the bar or forged hollow, machining must be done on all.

The articles in this number treat in detail of the construction, forging and machining operations and the tool equipment used for making the shell, fuse parts and the brass case. They constitute as nearly a complete treatise as was practicable to present in one number of MACHINERY. This large space was not devoted to the design and manufacture of a deadly missile for the purpose of glorifying war, but because of its intrinsic mechanical interest and the ingenuity displayed in providing tools for the various operations. It is true, unfortunately, that the making of spears, rifles, guns, ammunition, armor and the weapons used in warfare generally has promoted the development of metallurgy and the metal-working arts as has nothing else. The forging of great gun tubes made possible the production of large hollow shafts used in heavy modern machinery. The alloy steels now so generally used for automobiles were first used for armor plate and other defensive and offensive equipment.

But these articles show, too, something of the cost and folly of modern war. The three-inch, fifteen-pound shrapnel shell made in America costs the European governments, ready to fire, about $18 each. The French army, in one week of its retreat from Belgium toward Paris, fired between 800,000 and 900,000 rounds of shrapnel, the cost of which alone must have been more than $15,000,000! To the peaceful engineer whose aim and purpose—like that of MACHINERY—are to promote efficiency and production, the waste and desolation of war are abhorrent.

* * *

THE TRADE SECRET FALLACY

Some interesting incidents are told us about various manufacturers and their endeavors to keep trade secrets. Apparently it is still believed by many that trade secrets can be kept indefinitely; but a story told by a well-known manufacturer tends to disprove this belief. There are two other manufacturing concerns in the same business, and each probably knows what the other two are doing. The one referred to said that he had two experts in each of the competing plants, employed there as ordinary workmen to keep their eyes and ears wide open and post him about all improvements and matters of interest that developed. He said that probably the others had such workmen in his plant so that the "secrets" of each were really common property.

Trade secrets could be kept by locking the men up and keeping them locked up, but this is hardly feasible. One method of keeping his trade secrets used by a prominent manufacturer is to employ in the experimental department only men who are residents of the town in which the works are located. These men must have worked at least three years for the company, must be married, have a family and homes of their own before they are taken into the laboratory or employed on experimental work. They are paid good wages and are informed that the work they are doing is of little or no importance to any but their own company and that the company's interests are theirs. This method is perhaps as satisfactory as any, but in all such schemes there are weak points. Human nature is averse to domination of this sort. It is practically impossible to keep trade secrets indefinitely, and those familiar with the enterprises which require such methods realize this better than the outsiders.

A fundamental defect of a business based on trade secrets is that its methods become crystallized and progress is stopped. Conditions change, and every concern that would keep abreast of the times must change its practice and product to keep from falling behind. This means that progressive men with keen, alert minds who are able to develop and to assimilate new ideas and apply them to their business must be employed. Secretive methods tend to the retention of men of mediocre ability and unprogressive tendencies.

* * *

MATHEMATICS IN CONTRIBUTIONS

Some writers for mechanical journals seem to believe that the more theory they can bring into a treatise on a practical subject the better; and that formulas and symbols add value to the article, at least in the eyes of the editor, irrespective of the practical usefulness of the mathematical dissertations. This is a mistaken idea. The editor generally looks for a good practical reason for every formula, and objects to the use of algebraic expressions when a few plain words would express the same idea. Most mechanical men lack the training necessary to easily understand or follow the argument in an article containing too much mathematics. A clear, concise statement of the conditions, a definite explanation of processes, and conclusions reached in a logical manner constitute the essentials of a good technical treatise. If formulas are required to make any point clear that otherwise would to obscure, or if mathematical treatment helps to reach a result quickly, then use mathematics to the extent necessary. Certainly mathematics often help greatly—in fact, mechanical engineering would be impossible without that science; but it should be used with discretion, and avoided in articles of a practical nature when not necessary in order to treat the subject comprehensively.

Making Fuse Parts

COMBINATION timing and percussion fuses comprise a large number of small parts made from different metals and alloys, and are produced in various ways. Some of the parts are made from rod brass or alloys of copper and aluminum, whereas others are made from hot-pressed forgings and are machined after being formed to shape. In the following, a brief description of several different methods of making the most important fuse parts will be illustrated and described, together with details regarding the forging tools used for the socket and plug.

Forging the Fuse Socket

The fuse socket, which screws into the nose of the shrapnel shell and acts as a base for the fuse, is made from a special forgeable alloy casting containing 40 per cent copper, 58 per cent zinc and 2 per cent lead. The first step in this process is to melt the above constituents in the usual manner and then to cast the slugs in sand molds, six to eight being gated together. These castings are made 2 11/16 inches diameter by 11/16 inch thick, as shown in Figs. 85 and 86. There are several methods in use for forging the plugs, but the general principle is the same. In this particular case, a No. 23 Bliss press capable of exerting a pressure of 250 tons is used. The castings are placed in the furnace where they are allowed to "soak" at a temperature varying from 1200 to 1300 degrees F., or in other words, until they reach a dull red color. One casting at a time is then quickly removed and placed in the impression of the die shown to the right in Fig. 85 and in detail in Fig. 86. The working parts of these dies are made from Jessop's high-carbon tool steel and one blow of the press completes the forging, turning out about 3000 in ten hours. The tools used for this purpose are of interesting construction, as shown in Fig. 86. They comprise a lower die *A* machined out to the shape of the finished forging and carrying an ejector and lower former *B* operated by plunger *C* which ejects the forging if it sticks in the die. The top member or punch comprises a holder *D* into which the punch *E* is screwed. This is bored out to fit an ejector *F* which ejects the forging as the ram of the press ascends. Punch *E* and stripper or ejector *F* are made from high-speed steel, hardened. *G* shows the cast blank and *H* the completed forging.

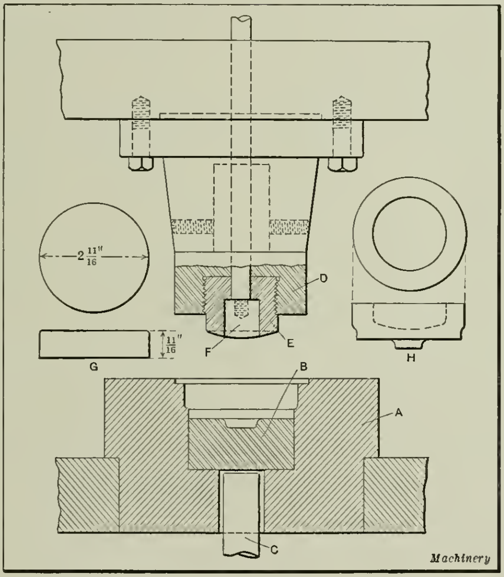

Fig. 86. Diagram showing Construction of Tools used in forging Fuse Socket

Forging Brass Plugs

The brass plug shown in Fig. 87 is used as a temporary cap for the shrapnel to protect it during transportation. It remains in the fuse socket until the shrapnel shell reaches the field of operations, when it is removed and replaced by the timing fuse. This member is made from a special forgeable alloy casting 2 inches in diameter by ⅞ inch thick and is cast in sand

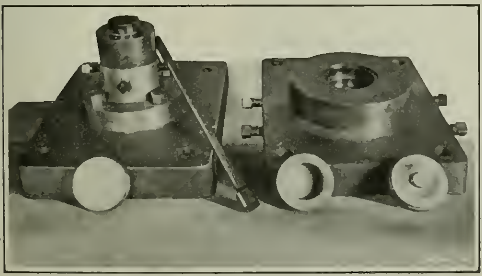

Fig. 85. Tools used in forging Brass Fuse Socket

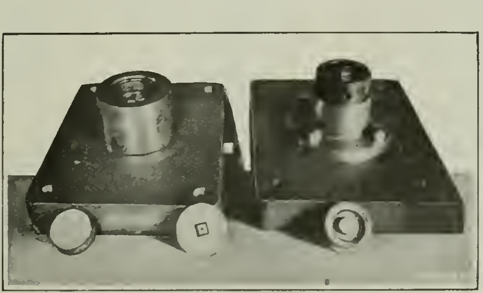

Fig. 87. Tools used for forging Brass Plug

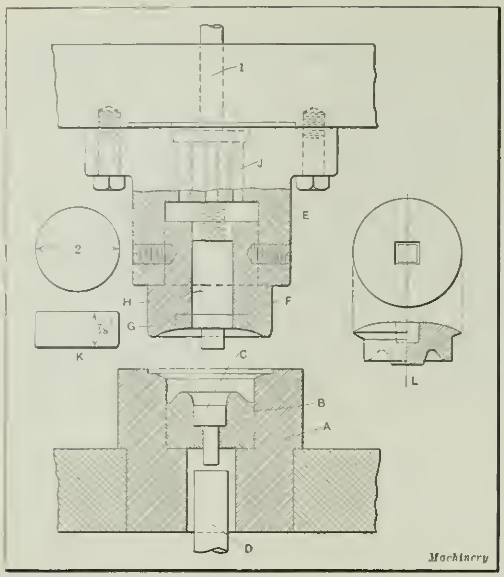

Fig. 88. Diagram showing Construction of Tools for forging Brass Plug

molds in a similar manner to the fuse socket. It is also composed of the same constituents as the socket and is forged in the same type of press. The construction of the tools, however, varies somewhat from that of the tools used in making the socket, as will be seen upon reference to Figs. 87 and 88. The tools for the plug comprise a lower die *A* carrying a combined ejector and forming die *B*. Inserted in this lower forming die is a secondary ejector *C* which is operated by plunger *D*. The upper member of this forging tool consists of a punch holder *E* carrying forming punch *F* which is counterbored to receive an ejector ring *G*. Passing down through the center of punch *F* is a center punch *H* that is made in two parts. The lower member is made of high-speed steel, hardened, whereas the upper portion is ordinary carbon steel. This center plunger is operated to eject the forging by a plunger *I* on the up-stroke of the press through the action of three pins *J* coming in contact with the flange on punch *H*. *K* shows the rough casting and *L* the completed forging.

TOOLING SET-UPS ON NEW BRITAIN AUTOMATIC CHUCKING MACHINES FOR SHRAPNEL FUSE PARTS

The automatic chucking machine referred to in the following, consists essentially of a multiple-chuck turret with capacity for holding five or six pieces of work, acted upon simultaneously by four or five tool-holding spindles. The sequence of operations is similar to that of a multiple spindle screw machine. A finished piece is removed and a rough blank inserted at each indexing. The machine is not idle while chucking, there being one more chuck than spindles.

Tooling for Machining Brass Socket

The shrapnel socket which, as previously explained, is made from a brass casting and pressed into rough shape, is machined in two settings in the New Britain No. 24 chucking machine shown in Fig. 89. This machine has four spindles and at the first spindle position, as shown in Fig. 90, reamer *A* cleans out the hole in the pressed brass blank, counterbore *B* cleans out the inside, and tool *C* faces the end. At the second spindle position, reamer *D* finishes the central hole, counterbore *E* faces the bottom, and tool *F* chamfers the hole.

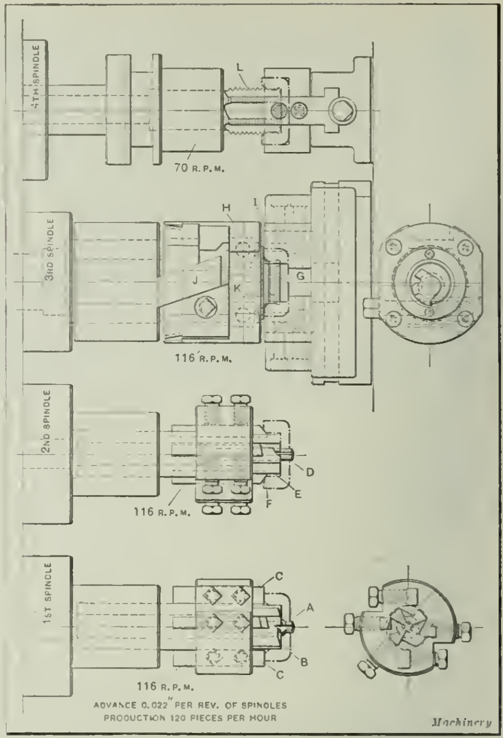

Fig. 90. Diagram showing First Series of Operations in the New Britain Automatic Chucking Machine on Fuse Socket

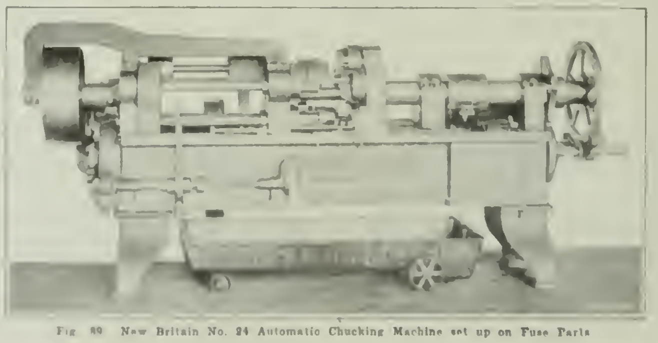

Fig. 89. New Britain No. 24 Automatic Chucking Machine set up on Fuse Parts

The under-cutting preparatory to threading is done at the third spindle position. The operation is performed with tool *G* working on the cross-cutting head *H*. When the pressed blank is fed in and reaches stop *I*, it commences to push the housing *H* of the cross-cutting head backward. A pair of stationary fingers *J* operate in oblique slots in the housing *H*, and as the housing presses down on these fingers, the motion gives a cross movement to the under-cutting tool *G* and its arbor *K*. In this manner, the under-cutting of the piece is performed. The fourth spindle operation is simply that of tapping the threaded interior with a tap *L*.

Second Operation on Shrapnel Socket

Fig. 91 shows the order of operations performed on the shrapnel socket at the second chucking, the work being screwed on threaded arbors. At the first spindle position, pilot *A* engages the central hole, while tool *B* turns the external diameter, tool *C* chamfers the corner, tool *D* turns the thread diameter, tool *E* faces the shoulder, and counterbore *F* finish-forms the nose of the piece. At the second position, these same surfaces are machined with finishing tools of the same design as those just described.

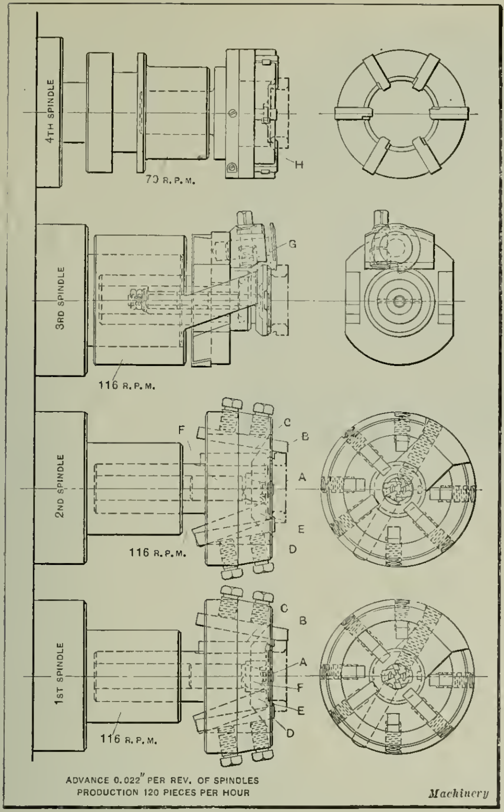

Fig. 91. Diagram illustrating Second Series of Operations on Fuse Socket on New Britain Automatic Chucking Machine

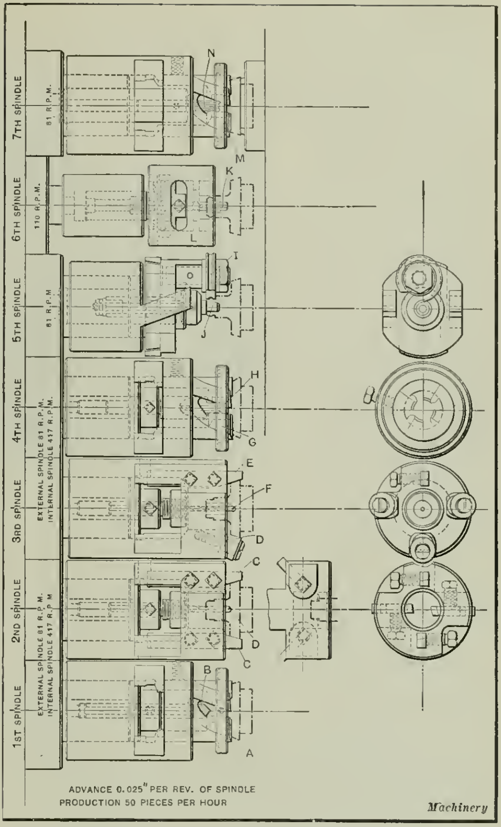
N
7TH SPINDLE
81 R.P.M.
M
K
6TH SPINDLE
110 R.P.M.
L
I
5TH SPINDLE
81 R.P.M.
J
H
4TH SPINDLE
EXTERNAL SPINDLE 81 R.P.M.
INTERNAL SPINDLE 417 R.P.M.
G
E
F
3RD SPINDLE
D
C
2ND SPINDLE
EXTERNAL SPINDLE 81 R.P.M.
INTERNAL SPINDLE 417 R.P.M.
D
C
B
1ST SPINDLE
A
ADVANCE 0.025" PER REV. OF SPINDLE
PRODUCTION 50 PIECES PER HOUR
Machinery

Fig. 92. First Series of Operations on Fuse Body on No. 73 Seven-spindle New Britain Automatic Chucking Machine

At the third spindle position, the shoulder at the end of the threaded section is under-cut. This is done by a cross-cutting head, similar to that shown in Fig. 90 and carrying the cutter *G*. At the fourth spindle position, the final operation—threading—is performed with die *H*.

Machining Fuse Bodies on No. 73 New Britain Automatic Chucking Machines

In Fig. 92 is illustrated an interesting tooling set-up for machining a fuse body. This is done on the No. 73 seven-spindle New Britain automatic chucking machine shown in Fig. 93. The operations in this set-up are performed on one end only of the fuse body, as shown in Fig. 92. Strictly speaking, this is a seven-spindle machine, but the first four spindles carry internal spindles running at high speed that cooperate with the external spindles in machining the work, making this virtually an eleven-spindle machine. At the first spindle position, the broad face and stem are machined with cutters *A* of the hollow mill type, and the centering tool *B*, carried in the inner spindle, centers the work for drilling.

In the second spindle position, tools *C* bevel the external diameter of the flange at the same time that drill *D* is producing the hole in the stem. In the third spindle position, roll *D* supports the work against the thrust of beveling tool *E*, and the small drill *F* held in the internal spindle deepens the hole. At the fourth spindle position, the external spindle carries a hollow mill *G* that finishes the stem diameter, and a counterbore *H* is carried in the internal spindle to machine the central hole.

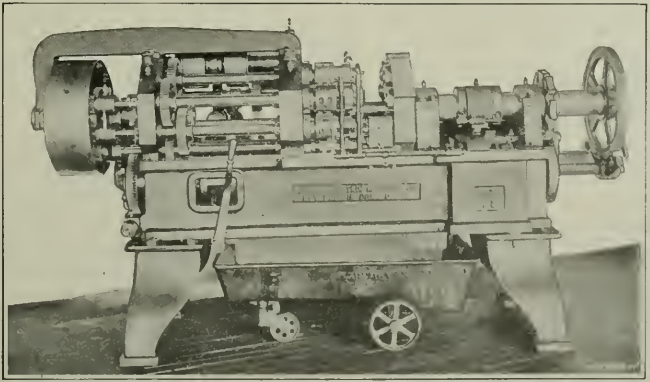

Fig. 93. New Britain No. 73 Seven-spindle Automatic Chucking Machine

A cross-cutting head in the fifth spindle position carries a circular tool *I* that machines on both sides of the section sphsequently to be threaded, and while this operation is being performed the pilot *J* steadies the work as well as the tool-holder. In the sixth spindle position, the small hole is threaded with tap *K*, and the exterior is threaded with a die, tap and die being of different pitches. In the seventh spindle position, a holder carries the forming tool *M* for cutting the grooves in the face of the flange, and the same spindle carries a reamer *N* that finishes the hole in the stem.

Machining Steel Shrapnel Heads

Heads for shrapnel shells made from cold-drawn steel stampings are machined in two settings on a No. 24 New Britain automatic chucking machine of the four-spindle type, shown in Fig. 94. This piece, shown in Fig. 95 in its sequence of operations, is especially difficult to machine on account of the stringy nature of the metal. The work is held for the first chucking with the small end out, and in the first spindle position the facing on the end is distributed between tools *A* and *B*, while counterbore *C* roughs out and chamfers the hole. In the second spindle position, tool *D* faces the end, and counterbore *E* finishes the hole.

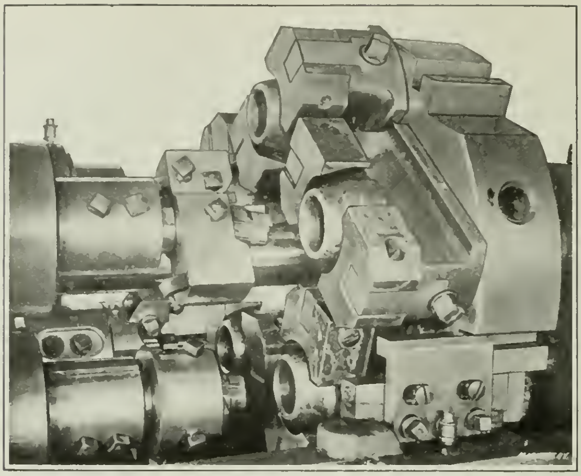

Fig. 94. Machining a Shrapnel Head on the New Britain No. 24 Automatic Chucking Machine

A cross-cutting head of a type similar to that previously described is carried in the third spindle position. This retains a tool *F* which produces an annular groove in the nose of the head, the work being supported with pilot *G*. The fourth and last operation consists in threading the hole with the tap *H*.

Second Series of Operations on Shrapnel Heads

The set-up for the series of operations performed at the second chucking is shown in Fig. 96, the work being held on threaded arbors. In the first spindle position, tools *A* and *B* face the shoulder, and counterbore *C* machines a seat in the inner flange. In the second spindle position, counterbore *D* finishes the part roughed out by *C* in the previous operation, tool *E* faces the end, and tool *F* chamfers the inner edge. In the third spindle position, a cross-cutting attachment carrying external cutting tool *G* is utilized for recessing the external diameter next to the shoulder. The threading on the external diameter is accomplished with the die *H* in the fourth spindle position.

Machining Shrapnel Fuse Noses

The time fuse nose for a shrapnel shell, which is made from a brass forging, is machined as shown in Fig. 97 on a No. 33 New Britain automatic chucking machine at one setting. In this case, an extra spindle designated as No. 0 is added to the machine for equalizing or properly locating the forging in the chuck when it is being tightened. At the first spindle position, tool *A* takes a cut from the external diameter, tool *B* cuts an angular recess in the face, and counterbore *C* roughs out the center portion. In the second spindle position, the same operations are performed with finishing tools. In the third spindle position, a cross-cutting head carries a recessing tool *D* that forms a recess back of the tapped portion. The hole is then tapped in the fourth spindle position, and in the fifth spindle position a special counterbore *F* takes a light finishing cut from all the surfaces previously machined. The external surfaces of the fuse nose are machined on a turret lathe.

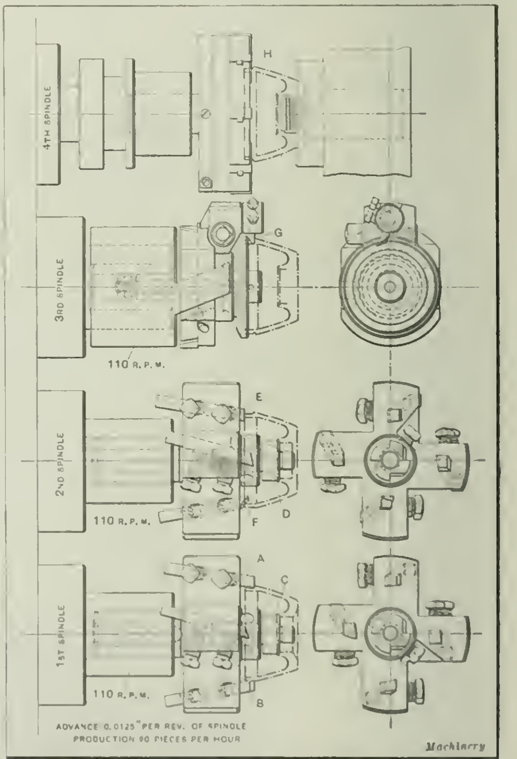

Fig. 96. Second Series of Operations on Shrapnel Head on the New Britain Automatic Chucking Machine

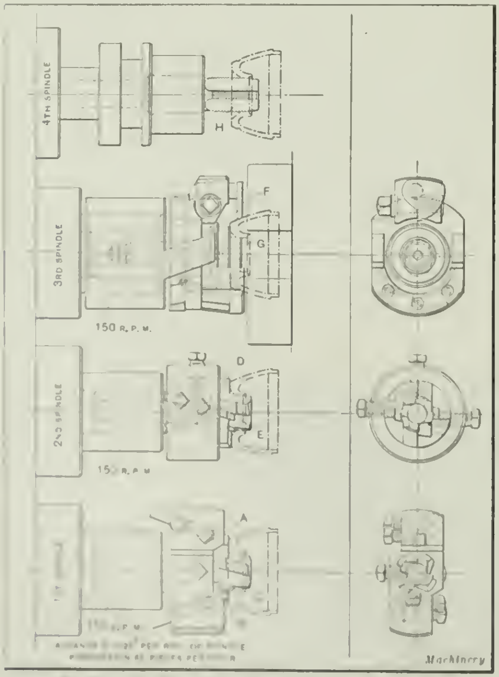

Fig. 95. First Series of Operations on Shrapnel Head on the New Britain Automatic Chucking Machine

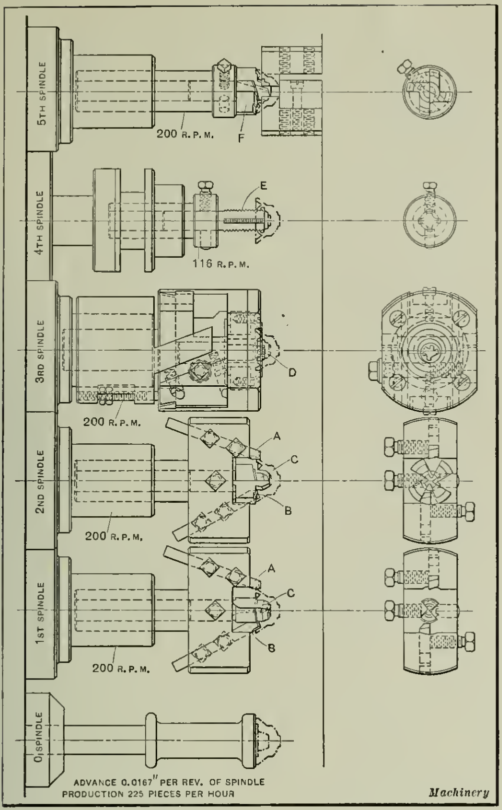

Fig. 97. Diagram showing Tooling Set-up for machining Fuse Nose on New Britain Automatic Chucking Machine

MACHINING SHRAPNEL FUSE PARTS ON "GRIDLEY" AUTOMATICS

The machining of fuse parts for the British shrapnel shell on "Gridley" single- and multiple-spindle automatics, made by the Windsor Machine Co., Windsor, Vt., forms the basis of several interesting tooling equipments. A number of the parts are machined from hot-pressed brass forgings, so that they must be handled separately.

Machining the Brass Fuse Socket

The fuse socket, as has been previously described, is made from a brass forging and is machined complete in two operations on a 3¼-inch "Gridley" automatic turret lathe of the single-spindle type. The manner in which the work is loaded in the chuck and held for the first series of operations is shown at *A* in Fig. 98. The rough blank *a* is first placed over the spring fingers *b*, which are held in a holder clamped in the turret, but are free to rotate. When the work is pushed into the chuck, it forces back spring-ejecting stud *c*, which, as soon as the pressure of the chuck is released, ejects the work.

As the loading device operates on the first slide of the turret, the first machining operation takes place on the second slide. This is a comparatively simple operation and consists in boring the central recess with tool *d* and chamfering with tool *e*. The turret is then indexed, bringing the internal necking tool *f* into position. This is held in a holder and is operated by the forward motion of the forming slide. Following this, tap *g* is brought into position to thread the recess in the socket. The operation of the turret is now stopped automatically until the operator loads a new piece in the chuck. The tapping is done with the spindle running in the forward direction on slow speed. After the hole has been tapped, the spindle is reversed and operated at a higher speed. The spindle continues to run backward for loading, and is still running backward, but slowed down, at the time of the second operation. It is for this reason that the boring tool *d* operates on the reverse side of the hole, and tool *e* is mounted upside down. At the third operation, the spindle is still running backward but is speeded to its highest speed while the internal necking is done with the tool working on the reverse side of the hole.

Second Operation on Fuse Socket

The method of holding the fuse socket for performing the second operation on the 3¼-inch "Gridley" single-spindle automatic turret lathe is shown at *B* in Fig. 98. The socket *h*, which has now been threaded, is screwed onto the body of special arbor *i*, fitting in sleeve *j* that is gripped by the spring collet. On the reduced end of arbor *i* is a nut which serves to clamp the work up against the face of sleeve *j*. The method of using this arbor is as follows:

To chuck the work, sleeve *j* and its auxiliary members are removed from the spring collet, and the work is screwed onto the nose of arbor *i*, the position of which is locked by means of a nut on the stem of the arbor. The entire arbor is then replaced in the collet and the machining operations performed on the work. This type of arbor is necessary because of the heavy cutting with the wide forming tool which would tighten the piece on the threaded nose to such an extent that it could not be removed when finished. With this device, it is only necessary to hold the square end of arbor *i* in a vise, and loosen the work by relieving the nut on the arbor. In order to facilitate the work, two arbors of this type are provided.

The operations performed in the first position consist in forming the external diameters with tool *k*, facing with side tool, and drilling with drill *m*. The second turret face is now skipped and the third brought into position, presenting self-

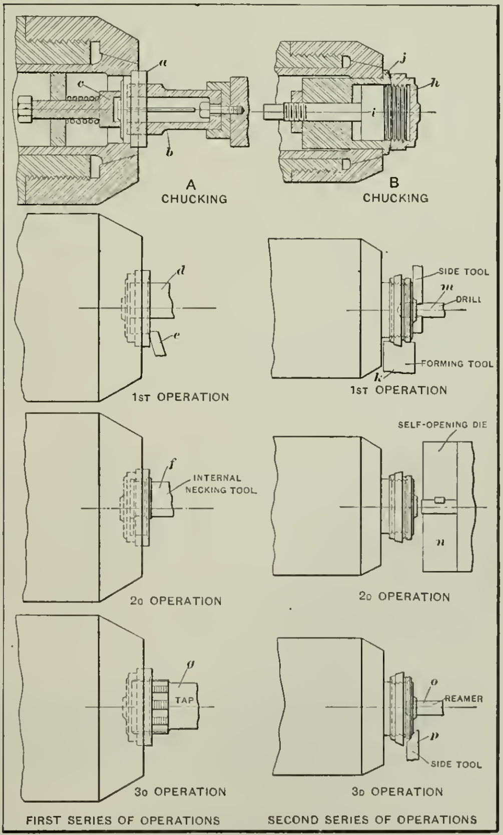

Fig. 98. Machining Brass Fuse Socket on 3¼-inch "Gridley" Automatic Turret Lathe—First and Second Series of Operations

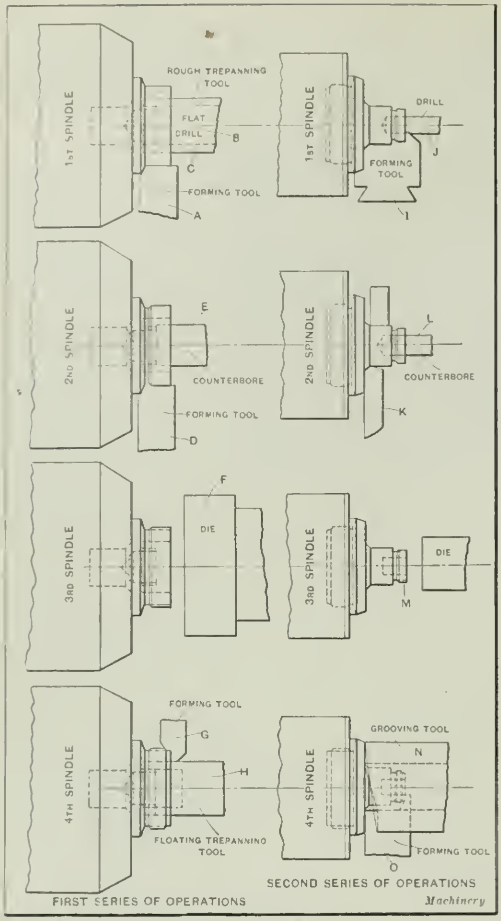

Fig. 99. Diagram Illustrating First and Second Series of Operations on Fuse Body on "Gridley" Automatic

opening die *n* which threads the work. At the fourth indexing of the turret slide, the hole is reamed with reamer o and tool *p* chamfers the face, completing the work. The forming done at the first indexing of the turret slide is performed on slow speed; the spindle speed, however, changes to high at the third position and back to slow just before the fourth position.

Machining the Fuse Body—First Series of Operations

The fuse body is made from a hot-pressed brass blank, and is machined in two chuckings in "Gridley" multiple-spindle automatics. The first series of operations is performed in a "Gridley" $1\frac{3}{4}$-inch multiple-spindle automatic in the order shown to the left in Fig. 99. The work is loaded in the chuck by hand. Forming tool *A* now advances and rough-forms the outer diameter, whereas flat drill *B* and trepanning tool *C* combine to drill the central hole and trepan the narrow channel. At the second spindle position, tool *D* finish-forms and necks the outer surface, while tool *E* counterbores the surfaces of the recess. Die *F* at the third spindle position now threads the body, and at the fourth spindle, forming tool *G* turns down the outer end of the thread while a floating trepanning tool *H* finishes the counterbored and trepanned surfaces. It should be mentioned here that the hot-pressing of this brass part makes it extremely difficult to machine, so that the edges of the tools dull rapidly.

Second Series of Operations on Fuse Body

The method of holding the fuse body while the second series of operations is being performed is shown in Fig. 100. The work-spindles *A* of the machine are fitted with special nose pieces *B*, the inner surface of which is chamfered to receive the spring collet *C*, which is threaded to the end of draw-back rod *D*. The work is not gripped directly by the spring collet, but is first screwed into a special bushing *E*, having thin walls as shown. This bushing is not split but springs sufficiently to permit it to be closed in on the work and released when the collet pressure is removed. A flange *G* attached to the end of the spindle nose serves as a stop for the work and a gaging point for the operations. The

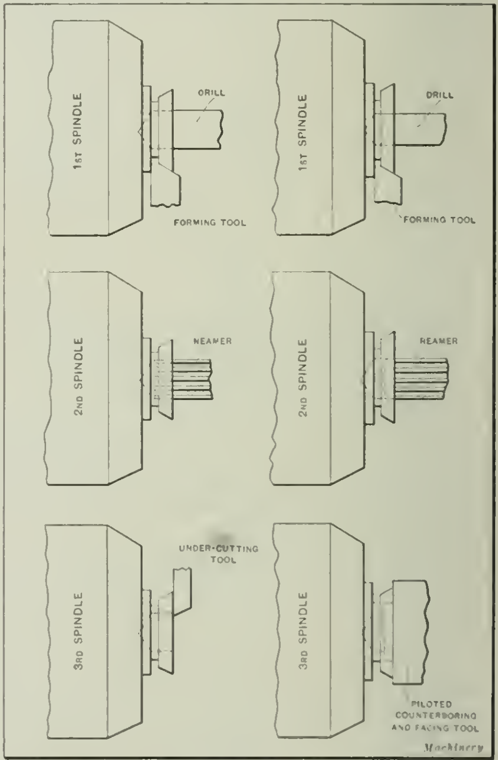

Fig. 101. Diagram illustrating Set-up for machining Timing Train Rings on "Gridley" Automatic

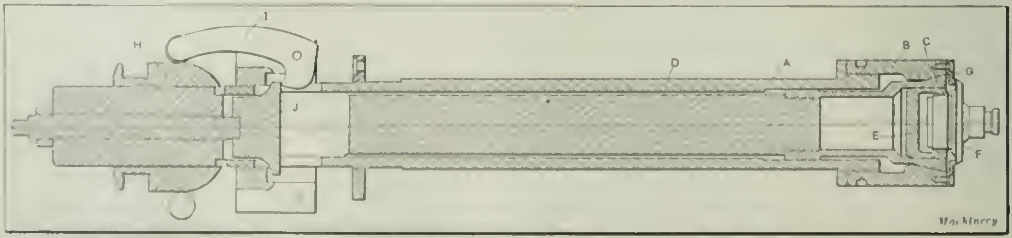

Fig. 100. Section through a "Gridley" $3\frac{1}{4}$-inch Automatic Turret Lathe Spindle showing Method of chucking Shrapnel Fuse Body

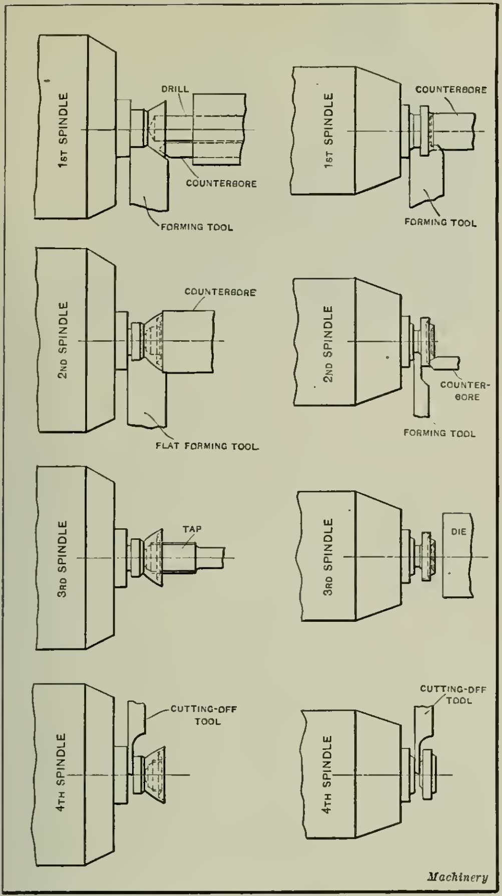

Fig. 102. Diagram illustrating Set-ups for machining Closing Cap and Bottom Closing Screw on "Gridley" 1¾-inch Multiple Spindle Automatic

regular collet closing mechanism is used, but as may be seen in the left-hand end, the finger holders are reversed. When the clutch ring *H* is pushed forward by the chuck-closer, gripping fingers *I* swivel and draw rod *D* backward through contact with flange *J*. When the clutch ring *H* is moved backward, the gripping fingers release rod *D*, relieving the pressure of the collet on bushing *E* and the work.

Referring again to Fig. 99, the second series of operations on the fuse body are shown to the right of the illustration. At the first spindle position, forming tool *I* advances and forms the exterior diameters, while drill *J* drills the hole in the end. At the second spindle position, the rear part of the work is supported by a roll back-rest, while the regular turner *K* takes a cut across and chamfers the shoulder. At the same time counterbore *L* comes in, cleans up the drilled hole and faces the bottom. At the third spindle position, the diameter *M* is threaded with a plain die. At the fourth spindle position, a tool *N* operated from the turret cuts a series of concentric grooves in the flange of the fuse body. The grooving tool is cut away to clear the forming tool *O* which takes a light cut over the grooved face, finishing the body as illustrated.

Machining the Stationary Timing Train Ring

The machining operations on the stationary timing train ring are shown to the left in Fig. 101, and as can be seen are of a comparatively simple nature. This fuse part is made from a tobin bronze bar in a 2⅜-inch "Gridley" multiple-spindle automatic. At the first spindle position, a drill held on the turret drills the hole, and a forming tool on the cross-slide forms it to shape and breaks it down for the cut-off tool. At the second spindle position, the piece is reamed, and at the third position it is faced off with an under-cutting tool. In the fourth spindle position, not shown, the finished piece is cut off, and the stock is fed out.

Machining the Graduated Timing Train Ring

The machining operations on the graduated timing train ring are almost identical with the stationary ring and are shown diagrammatically to the right in Fig. 101. This part is also made from a bar of tobin bronze in a 2⅜-inch "Gridley" multiple-spindle automatic. The only difference in the operations on this part is in the use of a combination floating counterbore, and facing tool provided with a roller pilot.

Machining the Closing Cap and Bottom Closing Screw

The closing cap and bottom closing screw for the shrapnel timing fuse are made from brass rod with a comparatively simple tool set-up as shown in Fig. 102. The machine used is a 1¾-inch "Gridley" multiple-spindle automatic. The machining operations on the closing cap are shown to the left of Fig. 102, and consist in drilling, counterboring, forming, threading and cutting off. The operations on the bottom closing screw, shown to the right of this illustration, are counterboring, forming, recessing, threading and cutting off.

MAKING FUSE PARTS ON BROWN & SHARPE AUTOMATIC AND HAND SCREW MACHINES

A brief description of two of the many interesting set-ups on Brown & Sharpe automatic and hand screw machines for making timing fuse parts is given in the following. Timing fuse parts are made from several different materials. The screws and other small members as a rule are made from rod brass, whereas the parts such as the capsules, primer cups, etc., are made from sheet brass. Other members such as the fuse body or stem are made from different alloys and metals such as copper, copper aluminum, aluminum, etc.

Set-up for Making Fuse Hammer

The method of making a fuse hammer on a No. 2 Model G Brown & Sharpe automatic screw machine provided with a special eight-hole turret is shown diagrammatically in Fig. 103. This part is made from ⅞-inch round rod brass and is

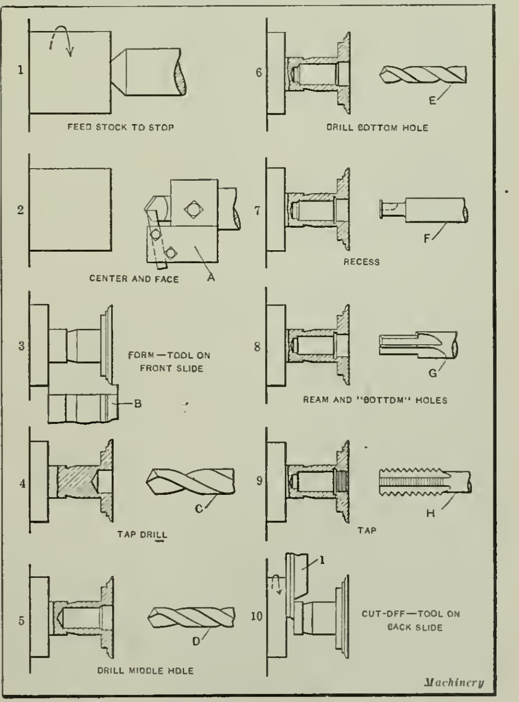

Fig. 103. Method of machining Fuse Hammer on a No. 2 Model G Brown & Sharpe Automatic Screw Machine equipped with an Eight-hole Turret

finished complete in the screw machine. First the stock is fed out to the stop in the turret. Second, the end is centered and faced with tools held in tool-holder *A*. The body is then formed with a circular tool *B* working from the front cross-slide; at the same time the turret is revolved, bringing tap drill *C* into operation. The forming tool is working at the same time as the drills. The turret is again revolved and drill *D* for finishing the middle hole is brought in and completes its operation. At the next index of the turret, drill *E* finishes the bottom hole. The turret is now indexed and a recessing tool-holder carrying tool *F* advances and is brought into operation to recess the work by a pusher on the cross-slide. The turret is again indexed and a reamer *G* is advanced to bottom and ream the holes. Upon the next index of the turret, tap *H* threads the work, which is finally cut off with circular tool *I*. The stock is rotated at 973 R. P. M. forward and backward and at 421 R. P. M. forward and backward. The stock is cut off rotating backward. The surface speed for the forming tools is 220 feet per minute and 31 feet per minute for the tap.

Tool Set-up for Making Fuse Nut

The fuse nut on the Russian timing fuse is made from 1⅞ round brass rod in a No. 6 wire feed Brown & Sharpe hand screw machine as shown in Fig. 104. First the stock is fed out to length, being gaged by a stop in a vertical slide, which is held in the turret. The turret is then indexed and drill *A* drills the large hole. The turret is now revolved and the combination drill *B* is advanced. The turret is again revolved and counterbore *C* faces and counterbores the work. Upon the next index of the turret a vertical slide tool-holder carrying recessing tool *D* is advanced. This tool-holder is operated by a handle attached to the holder. The turret is again indexed and tap *E* threads the work. After this the turret is indexed and the work is recessed with a tool-holder *F* carrying two cutters which balance each other in cutting. The seventh operation is performed from both the front and rear cross slides with tools *G* and *H*. The eighth operation is cutting off. This is performed with a special vertical slide tool holder held in the turret and operated by a handle. The stock for these operations is rotated at 352 R. P. M., giving a surface speed for the forming tools of 180 feet per minute and 66 feet per minute for the tap.

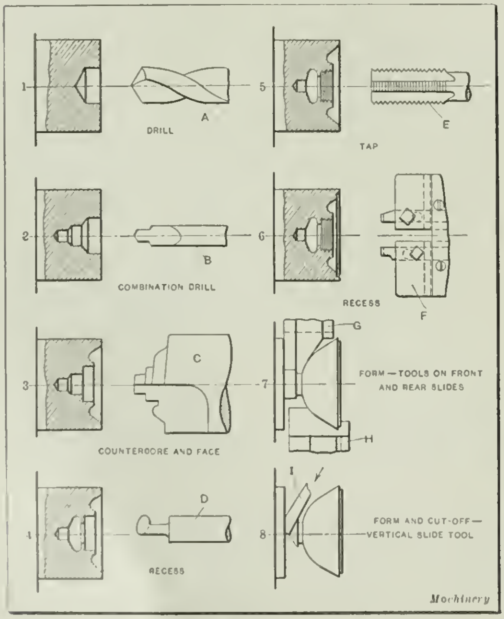

Fig. 104. Diagram illustrating Method of machining a Fuse Nut on a No. 6 Brown & Sharpe Hand Screw Machine

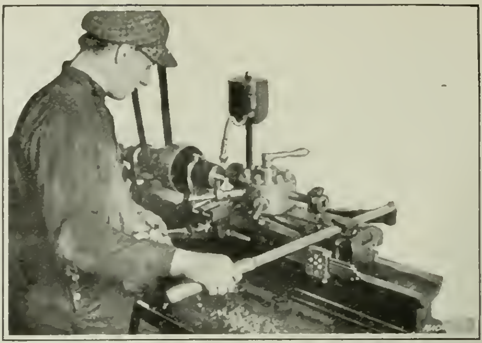

Fig. 105. Machining Fuse Parts on F. E. Wells & Son's Hand Screw Machine

MAKING FUSE PARTS ON F. E. WELLS HAND SCREW MACHINES

The demand for shrapnel fuse parts has been so great that time has not been taken in all cases to tool up automatic screw machines before production has been started. In order to get parts out quickly while automatic machines are being tooled up, hand screw machines have been made use of. Also these machines are used to a large extent on small orders and to help out production in general.

Fig. 105 shows an F. E. Wells & Son Co. hand screw machine working on shrapnel fuse parts. The capacity of this machine is for ⅞-inch diameter rod and it will tap or drill ½ inch diameter. Shrapnel fuse parts are produced on this machine at the rate of from 25 to 100 pieces per hour.

DRILLING PERCUSSION PRIMERS FOR AMERICAN FUSES

The percussion primer, used in the American combination fuse shown in Fig. 3, is made in a Brown & Sharpe automatic screw machine from rod brass in two operations. Following the screw machine operations, four holes about 1/32 inch diameter are drilled through this bushing, employing a special "snap index" jig in a high-speed ball bearing drilling machine made by the Leland-Gifford Co. of Worcester, Mass. (See Fig. 106.) The extremely small size of this part makes it difficult to handle, so the jig was designed with a special

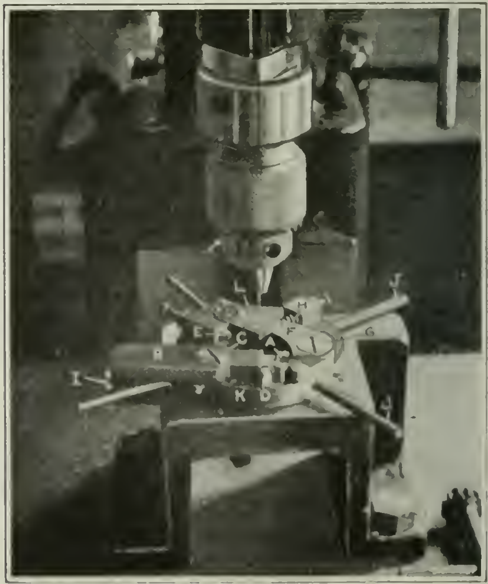

Fig. 106. Drilling Percussion Primers on a Leland-Gifford Ball Bearing Sensitive Drilling Machine

loading arm to facilitate rapid handling. The jig consists of a platform base bolted to the table of the drilling machine. Upon this is the index ring, which is turned by handles *J* and indexed for the four drilling positions by spring plunger *I*. The center of rotation is in the center of the four holes in the part. *B* is the loading lever, with a nest *A* at the end into which the work is slipped. This lever swings on stud *C*. The work is located in the swinging arm *B* when it is in the position shown in the illustration, with the arm *B* resting against stop *D*. The arm is then swung under the drill until it reaches stop *E*. It is maintained in this position by spring plunger *H* that bears against lever *F*, fulcrumed on stud *G*. The side of this lever bears against the work and holds it firmly while the drilling is proceeding. The drill is guided by four bushings in plate *L*, mounted on the index ring.

The operation consists in rotating the index ring to the four stations for drilling the respective holes. By means of this quick-indexing rig, and the high speed at which the Leland-Gifford drilling machine runs, it is possible to drill as many as 6000 pieces, or 24,000 holes in ten hours.

DRILLING TIMING FUSE PLUGS ON "AVEY" DRILLING MACHINE

An application of a regular No. ½ "Avey" drilling machine, built by the Cincinnati Pulley Machinery Co., Cincinnati, Ohio, to the drilling of brass timing fuse plugs is shown in Fig. 107. The requirements are to drill three No. 55 (0.052 inch) holes through the dome of the plug; a number of pieces are shown on the table of the machine. These three holes practically run together at the inside of the dome, making it necessary to drill one hole at a time.

The fixture used for this purpose is of unique construction. The body *A* is made of an aluminum casting, whereas the operating mechanism is of hardened tool steel. The drill spindle is operated by a foot treadle, connection being secured through rod *B*, passing down through the fixture and fastened to the spindle sleeve by the L-shaped piece and yoke *C*. The work *E* is held on a special work-spindle located inside the fixture that is indexed one-third revolution through the medium of rod *B* upon the raising of the drill spindle sleeve. The work holding-down and ejecting mechanism is supported in aluminum bracket *F*. Attached to this bracket is a supporting arm for the lower crank of lever *G*, which holds a segment gear. Bracket *D* carries the drill bushing.

After drilling the third hole, the operator depresses lever *G*, rotating the segment gear meshing in rack teeth in rod *H*, which lifts the latter up to eject the work and at the same time through a connection, not shown, raises the holding-down rod. The ejector, not shown, which is spring controlled returns to a neutral position immediately upon the ejection of the work, while the holding-down rod is still raised. The work, after being discharged, falls into a chute and is carried to the rear of the machine. The operation of this fixture is rapid, the production being 9000 to 10,000 pieces in ten hours.

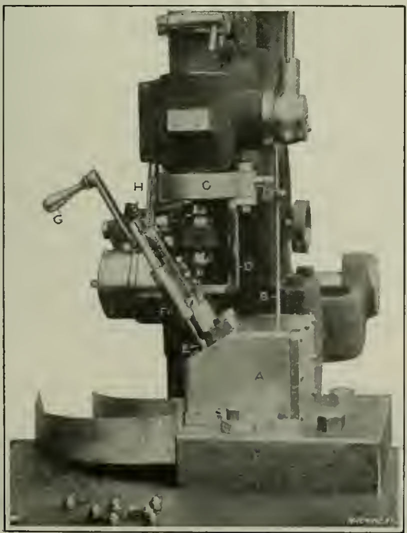

Fig. 107. Drilling Fuse Plugs on "Avey" Drilling Machine

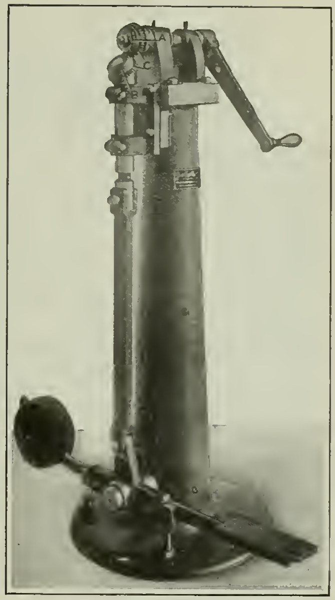

Fig. 108. Graduating Timing Fuse Rings on Dwight-Slate Marking Machine

GRADUATING FUSE TIMING RING

As has been previously stated in this article, the adjustable ring on the timing fuse is graduated in seconds, starting at zero and running to twenty-one seconds. As shown in Fig. 108, the graduating of this timing ring is performed in the Dwight-Slate marking machine built by Noble & Westbrook, Hartford, Conn. The main arbor of the machine carries the stamping roll *A* and is turned by the handle shown. The timing ring to be graduated and marked is held at *B*. The two gears *C* prevent the stamp from "creeping" ahead or slipping on the work. The work-holding arbor, as shown, is held in a bracket and is raised to the stamp roll by pressure on the foot treadle. Two operations are required for stamping and graduating the timing ring. The first is marking the graduations and the second is putting on the figures.

MAKING SHRAPNEL BULLETS

The most deadly and effective parts of a shrapnel are the lead bullets which are held in the shell. When the timing fuse explodes the powder in the base of the shell, the nose is blown off and the bullets are thrown out in a cone shape. The range covered by these bullets in the 18-pound shrapnel shell is about 250 square yards. The lead bullets, which in most shrapnel are ½ inch in diameter, are made from several different compositions, but consist chiefly of 87½ parts lead and 12½ parts antimony. The number of bullets carried in shrapnel shells of the different governments varies. There are 252 in the American 15-pound shell, and 235 or 236 in the British 15-pound shell. The bullets used by the U. S. government have six flattened sides, to facilitate packing, whereas those used by foreign governments are spherical.

There are several methods of making shrapnel bullets, two of which are in use at the present time. One is to cast the bullets in iron molds, which are split in the center, so that the bullet can be removed when cast. Another is to cut off slugs from lead wire and strike these between dies in a heading machine. The bullet heading machine takes the wire from a reel, cuts it off, forms it and trims off the resultant flash automatically. In making the American bullets, a second operation follows, consisting in flattening the sides. The Waterbury Farrel Foundry & Machine Co. furnishes unit equipments for doing this work. For the flattened bullets, the unit consists of one hydraulic wire extruding press and fourteen heading machines capable of giving a production of 850 bullets per minute. For the spherical bullet, the unit equipment consists of one hydraulic extruding press and eight heading machines, giving a production of 950 bullets per minute.

The method of casting lead bullets is antiquated to a cer-

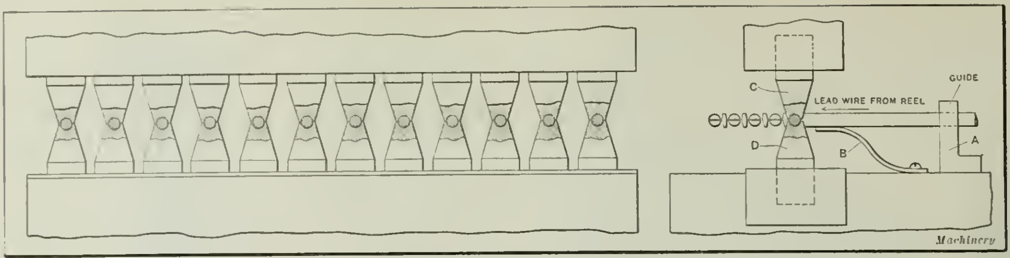

Fig. 109. Diagram illustrating "Twelve-punch" Method of making Shrapnel Bullets from Lead Wire

tain extent and another method somewhat similar to that described has taken its place. The first step is to produce the wire from which the bullets are eventually made. This is accomplished in two ways. The first is the hot metal process and consists in pouring the molten lead into a cylinder, from which it is extruded through a die by a plunger advanced into the cylinder. By this method, it is necessary to allow the metal to settle before the press can operate. An improvement over this is utilized in presses built by a hydraulic lead press manufacturer of Brooklyn, and consists in first casting ingots of the required diameter and length and then charging the press with these instead of pouring the molten lead into the press chamber. Two presses have been designed for this process. One has a capacity of 700 tons and is charged with ingots weighing 150 pounds, whereas the other has a 900-ton capacity and is charged with 200-pound ingots. The product from these two machines is 1800 pounds of lead wire from the small and 2500 pounds from the large press per hour. The operation of these presses is somewhat similar to that which was described on page 642 of MACHINERY, April, 1914. The wire as it is extruded from the die is wound on a reel carrying 2000 pounds of wire.

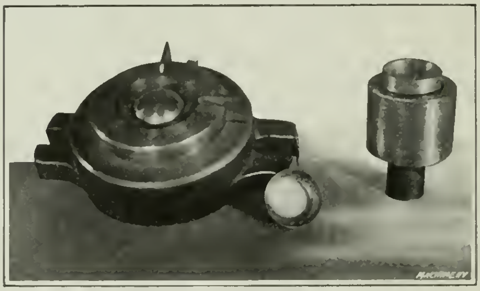

Fig. 110. Tools for making Base of Powder Cup

There are two principal types of swaging machines used for making these lead bullets from wire. One carries a single set of dies, whereas the other carries twelve sets of tools. The operation of the latter will be described. Referring to the diagram, Fig. 109, twelve reels of lead wire—not shown—are arranged in tandem on stands behind the press, six reels in a row. The wire is conveyed from these reels to the dies by a feeding mechanism, being guided to the individual tools by a plate *A*, having twelve U-shaped impressions in its top edge. The wire now passes over a spring *B* which serves to lift it up slightly at each stroke of the press. The tools *C* and *D*, as shown, are provided with half-spherical depressions in their adjacent faces and are set so that they come within 1/64 inch of meeting. The dies are guided and controlled in action by a special mechanism, and the press in which they are carried operates at 70 revolutions per minute. This gives a rated production of 840 bullets per minute. As is clearly indicated in Fig. 109, considerable scrap is formed in making lead bullets by this process—in fact the scrap is about 33 per cent of the reel of wire; also owing to the setting of the punches a slight fin is formed around the periphery of the bullet, which is removed in a subsequent operation.

After forming, the bullets are taken to a tumbling machine where they are tumbled for one hour. No other material is put into the tumbling barrel, but the action of the bullets working on themselves satisfactorily removes all the fins. Both the swaging and tumbling operations must be carefully watched because of the necessity of having the bullets a certain weight. The allowable variation on one pound of bullets is one dram, and there are forty-one bullets to the pound. Ten pounds of lead rod make 6½ pounds of bullets, and the scrap resulting from the swaging operation is remelted and used over again. After tumbling, the bullets are inspected and are then ready for use.

PRESS TOOLS FOR MAKING POWDER CUP

In the British shrapnel shell, the powder in the base of the shell used for exploding it and ejecting the lead bullets, etc., is held in a tin-plate powder cup. This is completed in the punch press in the manner shown in Figs. 110 and 111 and comprises two parts, a base and a top. The base is made from tin-plate 0.022 inch thick, whereas the top is made from 0.036 inch thick tin-plate. The bottom of the cup is completed in one operation with the punch and die shown in Fig. 110 which is held in a single-action press. It is turned out from a blank 3 7/32 inches diameter and is cut out and formed in one operation. The completed size is 2¼ inches diameter in one operation. After cupping, the top edge is trimmed in a turret lathe. The press operations on the top, as shown in Fig. 111, are a little more complex. The first operation consists in cutting out a blank 2 19/32 inches diameter. Then the edge is turned up with another punch and die shown in the center of the illustration. The next operation is piercing the center with the punch and die at the right, and the last operation is drawing out a flange around the pierced hole. The tools for this operation are shown to the extreme right, as is also a completed powder cup. The final operation on the cup consists in soldering the top to the base.

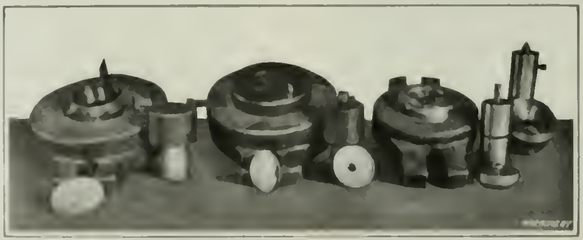

Fig. 111. Tools for making Top Member of Powder Cup

Making Cartridge Cases

THE brass cartridge case that contains the powder charge for propelling the shrapnel shell from the bore of the quick-firing gun is drawn up from a blank of sheet brass. The number of operations necessary to complete the case depends on its size and the method of handling. Some shell manufacturers prefer to do more or less drawing at one operation, but in all cases the sequence of operations is practically the same. The material used for shrapnel cartridge cases generally consists of a composition of 2 parts copper and 1 part zinc. This alloy has been found to possess the best physical qualities, that is, high tensile strength and a large percentage of elongation when properly annealed. The drawing operations through which the cartridge case passes increase the hardness, and the ductility of the metal is restored by annealing. The annealing temperature in most cases is from 1150 to 1200 degrees F. On reaching this temperature, the work is either cooled off in water or allowed to cool off gradually, as the speed of cooling does not affect its physical qualities. In the following, two methods of handling the various operations will be described.

WATERBURY FARREL FOUNDRY & MACHINE CO. METHOD OF MAKING CARTRIDGE CASES

Fig. 112 shows the sequence of operations—blanking, cupping, redrawing, indenting, trimming, heading and tapering, as advocated by the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn., for making cartridge cases for 18-pound shrapnel. The first operation consists in cutting out a blank from ⅜-inch sheet brass 6¼ inches in diameter. The next operation is cupping. This is handled in a short-stroke geared straight-sided press. Before re-drawing, the cup is annealed, and the third operation, which is handled in a longer stroke press, is then performed. Annealing follows this operation, and then the fourth drawing or second re-drawing operation is performed. This consists in reducing the fillets slightly at the corners, decreasing the diameter of the cup to 4⅛ inches and increasing its length to 4½ inches. The dimensions given here are approximate.

Indenting Operations

The fifth operation or first indenting operation, which consists in indenting the bottom, is handled in a press similar to that used for the cupping and re-drawing operations. This shortens the length of the case by ¼ inch and forces the indentation about half way through the thickness of the stock. The second indenting is then accomplished. This again shortens the case by an additional ¼ inch and squares up the corners. The case, without annealing, is now passed through the third re-drawing or seventh operation, reducing its diameter to 4 inches and increasing its length to 5½ inches. It is annealed after this operation, and is then drawn out to 8 inches long by 3⅞ inches diameter and the wall decreased in thickness to 1/16 inch. The case is then annealed and passes through the fifth re-drawing operation. The machine used for handling the fourth, fifth and sixth re-draws is a long-stroke straight-sided rack and pinion press. After the fifth re-draw or ninth operation, the case is trimmed and about two inches cut off the end. This leaves the case in better condition for the succeeding operations. The trimming machine is of the horizontal type.

Final Re-drawing Operations

The sixth re-draw or eleventh operation is performed in a horizontal drawing press of the hydraulic type provided with automatic reversing valves. This operation increases the length of the case to 13¼ inches and reduces its diameter to 3¾ inches. After this operation, the case is annealed and then 1¼ inch is trimmed off the open end. The thirteenth and fourteenth operations consist in heading the case. These are practically of the same nature, and combine to form the head of the case as shown in the illustration. The heading operations each reduce the length of the case ¼ inch, and are performed in a 1000-ton hydraulic heading press operated by a geared compound power pump and having a working pressure of 5600 pounds per square inch on the ram. After heading, the case is annealed and the fifteenth operation, which consists in tapering, is performed. The first tapering or fifteenth operation reduces the mouth of the case to 3 9/16 inches diameter and gradually tapers it for a distance of 5⅞ inches—half the length. The case is then annealed, pickled and washed and a second tapering operation is performed. This reduces the mouth of the case to 3⅜ inches and tapers it completely to the head. The case is not annealed after the last tapering operation, but ¼ inch is trimmed off the end.

TOOLS FOR DRAWING CARTRIDGE CASES—SUPPLIED BY FERRACUTE MACHINE CO.

The various operations through which a cartridge case passes in drawing and forming to the correct length have previously been described, and in the following particular attention will be given to the type of tools used for this purpose. These tools have been designed and built by the Ferracute Machine Co., Bridgeton, N. J., and are used with its presses for making cases for 3-inch projectiles.

Cupping and First Series of Re-drawing Tools

The cutting out of the blank is frequently omitted because the specified thickness and size can be furnished by the

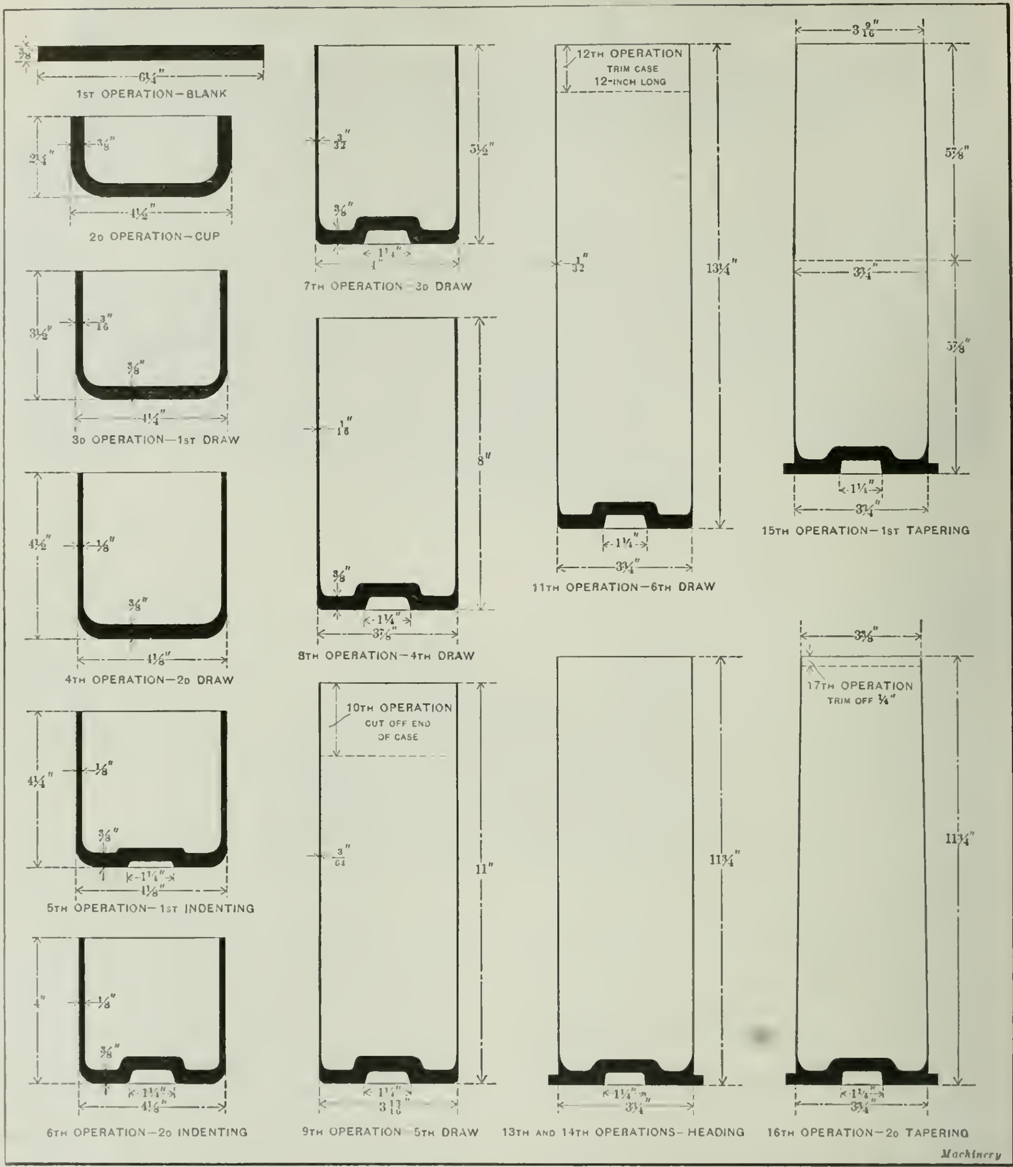

Fig. 112. Sequence of Operations in making an 18-pound Cartridge Case—Waterbury Farrel Foundry & Machine Co.'s Method

mill. Before cupping, the dies and blanks are well greased, as this assists in drawing. Olive oil or soapy water is used, depending on the stage at which the drawing operations have arrived. The first cupping operation is accomplished with a punch and die as shown at *A* in Fig. 113. This operation is accomplished in a Ferracute 100-ton ram press equipped with a dial feed. The die consists of a hardened ring of tempered steel having an interior shape similar to a truncated cone. The punch is slightly tapered on the lower end and has an air vent hole drilled up through it to facilitate the drawing and produce a cup free from wrinkles.

The second operation, or first re-drawing operation is shown at *B*. Here the type of die used differs somewhat from that shown at *A*, in that the drawing angle is 15 instead of 45 degrees. The cup, after this operation, is reduced in diameter to 3.877 inches and is 2⅞ inches long. After the first cupping operation, the case is annealed.

The second re-drawing operation is accomplished as shown at *C*. The die in this case is the same as at *B*, as is also the punch, except for an increase in the taper and change in shape on the end. The object of this, of course, is to keep the case thick at the head but reduce the walls further up along the section. The case, after this operation, is also drawn out to a length sufficient to necessitate using a stripping device for removing it from the punch. This is accomplished by six spring-operated stripper pins as shown, which slip over the top edge of the case as it is forced through the die, stripping it from the punch. The cup now passes through the third annealing operation and is ready for the third redraw, shown at *D*. The press used for performing this operation is similar to that described, and the die and punch is similar in construction to that shown at *C*.

Final Re-drawing Operations

For the final re-drawing operations, horizontal double ended screw presses instead of the horizontal hydraulic pressses formerly used are employed. Horizontal presses are used because the length to which the cartridge case is drawn after the third re-draw is such that it exceeds the stroke of the vertical presses. The cartridge case, after each drawing operation, is annealed. *E* in Fig. 113 shows the fourth re-drawing tools, which are handled in a horizontal screw press. The die used is similar in shape to that shown at *D*, but the holder in which it is held differs, of course, owing to the difference in the type of press used. The stripping arrangement for removing the case from the punch is also of a different type. In this case five spring-operated stripper pins are held in a holder which is free to oscillate within certain limits in the block in which it is retained. The reason for having this oscillating stripper is that it accommodates itself to the irregular shape on the end of the case and gives practically a constant pressure all around the circumference of the case, assisting in removing it from the punch. The case is now annealed and is finish-drawn as shown at *F*. Here the same type of die, stripper arrangement, etc., is used as that shown at *E*. The case in the fifth re-drawing operation is 14⅜ inches long by 3.186 inches outside diameter.

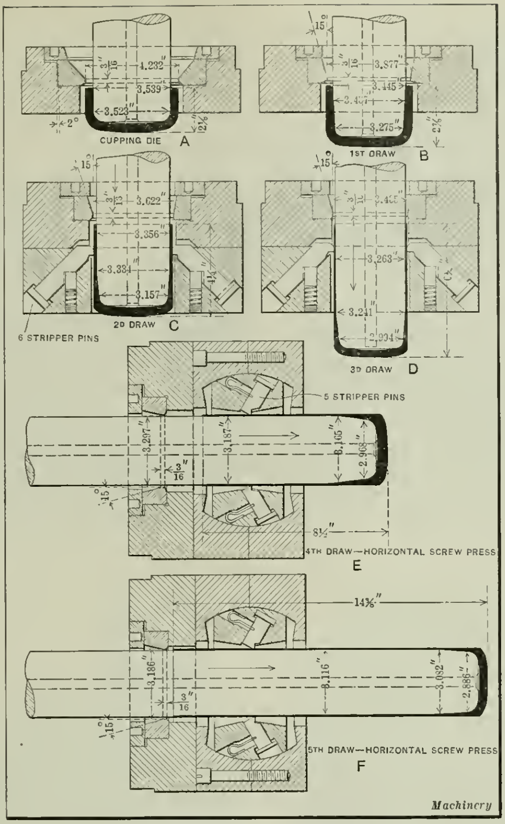

Fig. 113. Tools for drawing a 3-inch Shrapnel Cartridge Case—Ferracute Machine Co.'s Method

Annealing and Washing Cartridge Cases

As was previously stated, the cartridge case, after practically every re-drawing operation is annealed, being subjected to a temperature of about 1150 to 1200 degrees F. and then allowed to cool off or dipped in water which, of course, forms a scale on the surface of the case. This must be removed before any subsequent operations can take place. Several different solutions are used for this purpose, but a common one comprises the following: Sulphuric acid diluted with water to a strength of 1 to 4. This pickling solution is held in lead-lined wooden troughs and the case is allowed to remain in the bath varying from eight to fifteen minutes, according to the strength of the solution. The cases are then washed in lead-lined wooden troughs through which a stream of water is circulated to remove all traces of the acid.

TESTING HARDNESS OF CARTRIDGE CASES

The hardness of a cartridge case must be up to a certain standard. When too soft, a permanent set will occur from the pressure of the firing charge and the case will stick in the breech of the gun. When the hardness is too high for a given composition of brass, it is too brittle and will split or the head may blow off. There is, therefore, a certain hardness which must be adhered to as closely as possible. Some manufacturers hold the standard to within 20 to 25 on the scleroscope and reject cases striking 15 as being too soft, and 30 to 35 as being too hard.

Owing to the thinness of the walls of the case, it is impossible to take a reading without rigidly supporting it, and for this purpose the Shore Instrument & Mfg. Co., 551-557 West 22nd St., New York City, has devised a special fixture as indicated in Fig. 114. This comprises a bracket *A* held in an ordinary vise, to which is fastened an anvil plug *B*, as indicated. In order to hold the case tightly against the anvil plug, a spring *C*, fastened to the bracket *A*, is also fastened to a yoke *D* surrounding the case. A rod attached to this and to a foot treadle furnishes a means of drawing the yoke down to hold the case in contact with the plug. The anvil plug provides the weight or inertia to resist the impact of the drop-hammer of the scleroscope, but in order to be sure that there is proper contact of the case with the plug a rubber cushion *E* is provided between the pressure ring or yoke and the brass case.

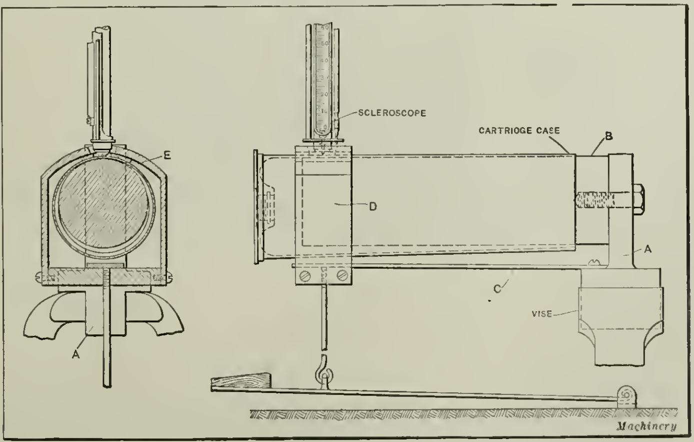

Fig. 114. Fixture for testing Hardness of Cartridge Cases with Shore Scleroscope

MACHINING SHRAPNEL CARTRIDGE CASES ON SPECIAL "BULLARD" MACHINE

The Bullard Machine Tool Co., Bridgeport, Conn., has designed and built a number of special machines for performing the machining work on the head and mouth ends of brass cartridge cases. This machine, as will be seen from Fig. 115, is of the hand turret machine type, designed to work on the case from both ends. In this machine the brass case is chucked in the center of an extremely large spindle, and worked on from the head end with four sets of turret tools and two sets of cross-slide tools, while the mouth end is bored and trimmed with tools held on a carriage located on the

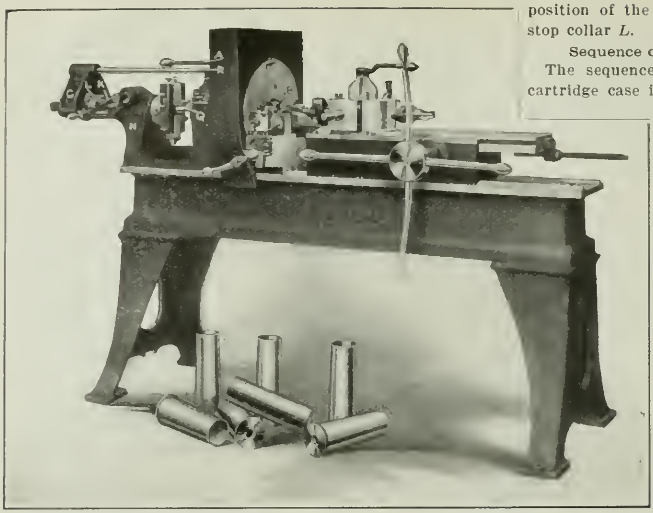

Fig. 115. Special Shrapnel Case Trimming, Facing and Chamfering Machine designed by the Bullard Machine Tool Co., Bridgeport, Conn.

back facing bar. The drive for the work chuck spindle is over a 16-inch pulley with a 3-inch belt. The pull of the belt is not taken directly on the spindle, but on a special pulley bearing 7¾ inches diameter and 5 inches wide. The spindle itself is supported in bearings 9 inches long and 5⅞ inches diameter. As previously mentioned, the spindle is hollow so that any type of shrapnel cartridge case up to 4¼ inches in diameter and from 10 to 18 inches in length can be machined.

From the construction of the machine in Fig. 115 it will be seen that the front end of the spindle carries a large three-jaw chuck of special design. These jaws catch the cartridge case just under the head and revolve it for machining. The case is supported internally by a tubular arbor *B* which also acts as a stop and is attached to the rod *Q* extending to the rear bracket *C* where it is backed up by a spring. The front end of this tubular support or stop is provided with a thrust ball bearing so that the case can be loaded in the chuck while the spindle is running. When the chuck operating lever *A* is manipulated to close the chuck jaws on the work, it first draws back the rod *Q* through the medium of the tie-rod *R* and bracket *C* to a positive stop, and then closes the jaws on the work. The cartridge case is put in and removed from the chuck with the turret indexed between stations to give the required space.

The back boring and trimming head is held on a hollow spindle through the center of which rod *Q* passes. This spindle is provided with rack teeth on its top surface which engage with a pinion located in extension bracket *N* and operated by handle *K*. The forward position of the boring and trimming head is governed by a stop collar *L*.

Sequence of Machining Operations on Cartridge Case

The sequence of machining operations performed on the cartridge case in this machine is shown diagrammatically in Fig. 116, and also in Figs. 117 to 121 inclusive. Referring to Figs. 116 and 117, the first operation consists in rough-drilling and counterboring the hole in the head of the case with combination tool *A*. The second operation (see Fig. 116) consists in facing, trimming and chamfering the head with tools *B*, *C* and *D* held on the front of the cross-slide. The third operation is to finish chamfering and facing the head of the case with tool *E* on the rear of the cross-slide. The fourth operation consists in under-cutting the primer seat with the tool *F* which works on a turret slide and is operated by lever *G* as shown in Fig. 118.

The following operations are now performed on the mouth or open end of the cartridge case as shown in Figs. 116 and 119, with the spindle running at the same speed —500 R. P. M.—as that used for the first series of operations. Two tools *H* and *I* are used. Tool *H* bores the mouth of the case for a distance of 1 inch, whereas tool *I* trims off the open end of the case and

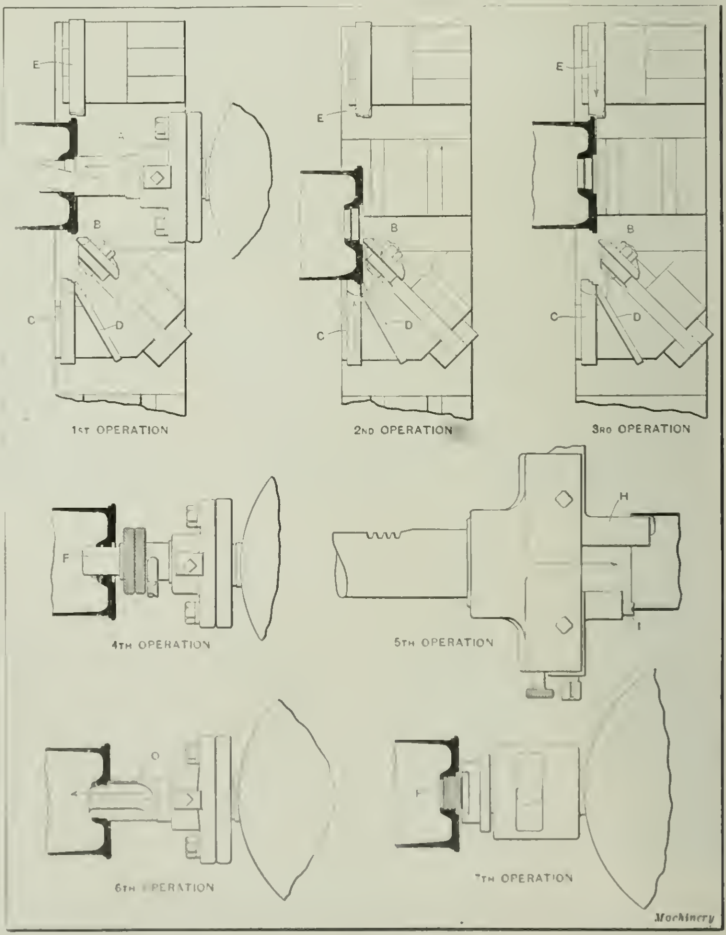

Fig. 116. Sequence of Operations performed on Cartridge Case in Machine shown in Fig. 115

rounds the edges. The mouth of the case at the rear end of the spindle is supported by a hardened bushing to prevent it springing away from the action of the boring tool. The boring and trimming tools are mounted in a special head *J*, Fig. 119, that is operated back and forth by a handle *K* through the medium of a rack and pinion. The forward movement of this head, as previously explained, is controlled by means of an adjustable collar *L* screwed onto spindle *M*. This collar contacts with the face of bracket *N*.

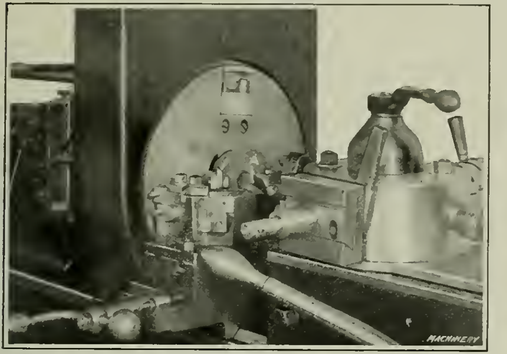

Fig. 117. Set-up showing First Operation on Cartridge Case Head

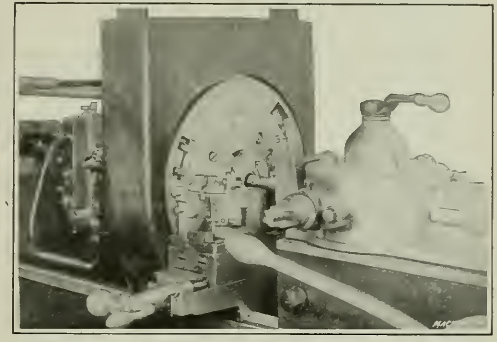

Fig. 118. Set-up showing Fourth Operation on Cartridge Case Head

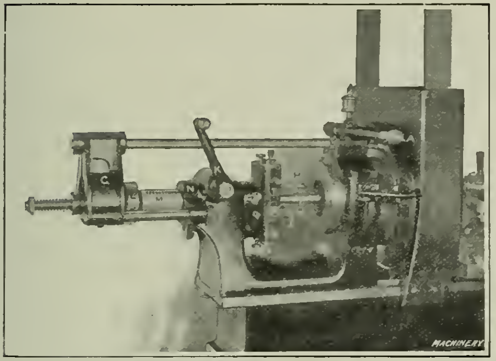

Fig. 119. Set-up showing Operations on Mouth End of Case

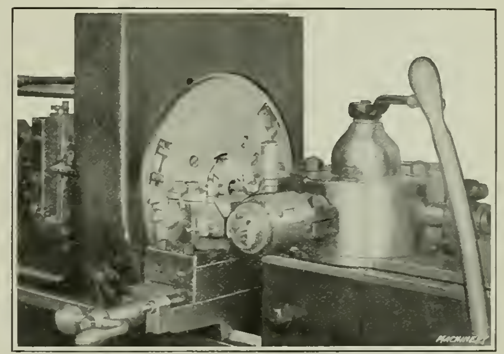

Fig. 120. Set-up showing Sixth Operation on Head End of Case

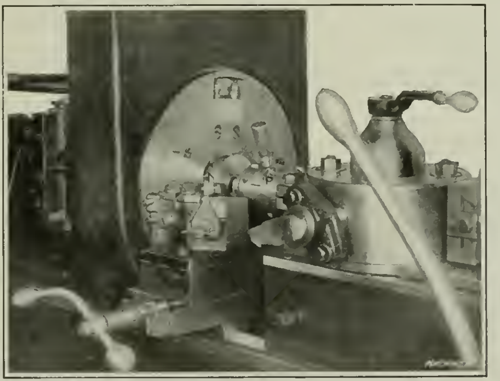

Fig. 121. Set-up showing Seventh Operation on Head End of Case

The work-spindle is now slowed down and the following operations, shown in Figs 116, 120 and 121, are performed on the head end of the case. The sixth operation is to finish-counterbore and ream the primer pocket with tool *O* held in an adjustable holder, whereas the seventh operation is threading the primer pocket with collapsing tap *P*. The chuck lever *A*, Fig. 115, is now manipulated, first releasing the grip of the chuck jaws on the case and second advancing rod *Q* to eject the case sufficiently to enable it to be easily removed from the chuck. The spindle is changed to the highest speed after the next case is put in. In changing the work, it is not necessary to stop the spindle.

MACHINING SHRAPNEL CARTRIDGE CASES ON POTTER & JOHNSTON AUTOMATICS

The cartridge case is made from sheet brass as previously stated. It is practically formed to shape in drawing and heading machines, but to secure the desired accuracy on the head and primer pocket these surfaces are machined. The method of holding the French 75-millimeter case on a No. 5A Potter & Johnston automatic chucking and turning machine for machining the head and primer pocket is shown in Fig. 122. Here it will be seen that the cartridge case butts up against a stop *B* and fits over the tapered plug *C* which steadies it. It is held in place by an ordinary draw-in collet *D*. This is operated by means of a lever *E*, fulcrumed to a bracket on the rear end of the machine and operating a sliding clutch collar. The chuck is operated through fingers which draw back the sliding sleeve to which it is attached. These fingers operate against a spring at the rear of the spindle which serve to open the collet.

The machining operations on the French shrapnel cartridge case are handled in the manner illustrated in Fig. 124. The first operation is to rough-drill the hole in the head. The turret is then indexed, bringing in a roughing reamer which reams the hole previously drilled, whereas the front cross-slide carries the tool *B* that faces the head and a circular tool *C* that rough-forms the external diameters of the head.

Upon the next indexing of the turret, the tool *D* counterbores the powder pocket and the circular forming tool *E* finish-forms and rough-chamfers the head. The last operation consists in finishing the primer pocket with a taper reamer *F*.

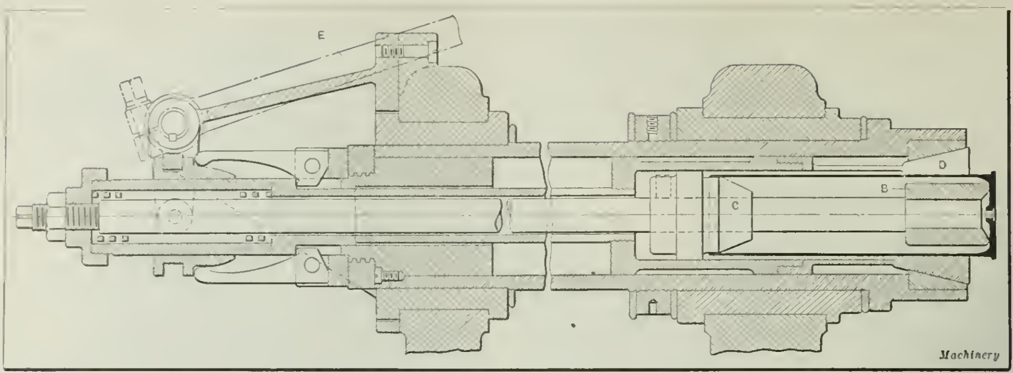

Fig. 122. Diagram showing Method of chucking a French 75-millimeter Cartridge Case on a Potter & Johnston Automatic Chucking Machine

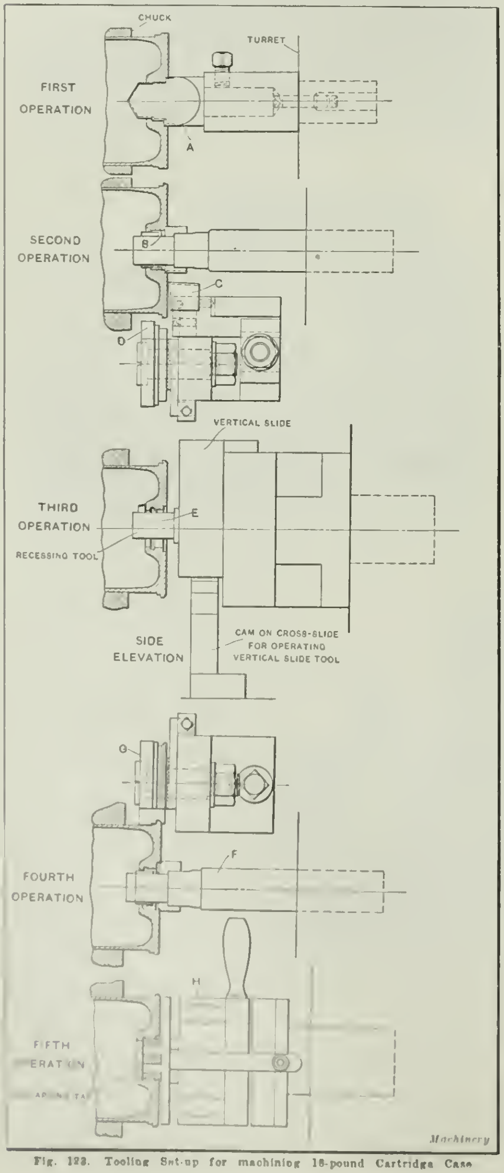

Fig. 123. Tooling Set-up for machining 18-pound Cartridge Case

Machining the British Shrapnel Cartridge Case

The brass cartridge case for the British shrapnel is more difficult to machine than the French case, as reference to Fig. 123 will clearly show. The machining operations are accomplished on a No. 5A Potter & Johnston automatic chucking and turning machine having a five-sided turret. The first operation is to drill the primer pocket hole with a three-step drill *A*. The turret is now indexed and the surfaces previously roughed out are finished with inserted-blade counterbore *B*. At the same time, the head of the case is faced with a relieving tool *C* held on the cross-slide and rough-formed with circular tool *D*.

The turret, in being indexed to the third position, brings vertical recessing tool *E* into operation. This carries two cutters, one of which recesses the primer pocket at the point where the thread is to terminate, whereas the other removes the burr and faces the inner boss. In the fourth operation, the smallest diameter of the primer pocket is reamed and the largest diameter of the hole chamfered by tools held in bar *F*. The rear cross-slide is advanced at the same time, carrying the circular tool *G* that finish-forms the head. The final operation—threading—is performed with the "Geometric" collapsing tap *H*.

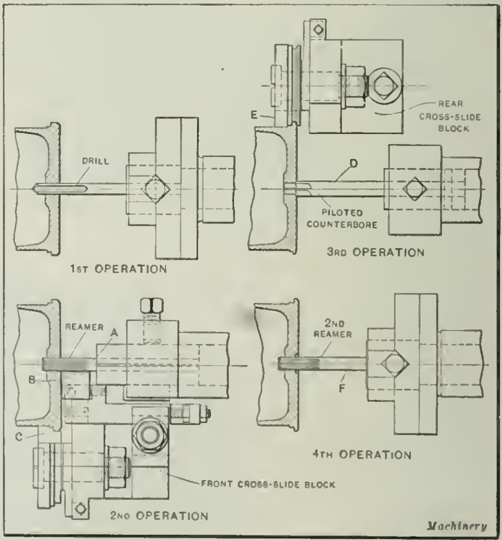

Fig. 124. Diagram illustrating Machining Operations on French Cartridge Case on Potter & Johnston Machine

In closing, it should be stated that the methods and machines employed in shrapnel manufacture call for the best mechanical skill obtainable, as is evident from the preceding review of current practice.

SALT BATHS FOR STEEL HARDENING

CARBONIZING AND DECARBONIZING EFFECTS OF MOLTEN SALTS WHEN USED FOR HEATING STEELS ABOVE THE TRANSFORMATION POINT

BY E. F. LAKE*

NUMEROUS kinds of metallic salts can be utilized for heating steels to the hardening and drawing temperatures. Their melting points are so diversified that combinations can be made which can be kept molten at any temperature from 400 degrees F. to the melting points of the steels, and their volatalization will be so slight that it can be ignored. With some salts, the carbon content of the surface of steel pieces can be raised when heated in them to temperatures above the transformation point of the steel. Others will have a neutral effect on the carbon content, and thus neither raise nor lower its percentage. While still others might have a decarbonizing effect, lowering the percentage of carbon in the exposed surfaces. Thus it is necessary to know which are the best salts to use and the best molecular mixtures to make from them if the desired results are to be obtained when hardening and tempering steels. These alkaline salts have so many good qualifications that their use is rapidly becoming more and more widespread in the modern shops that heat-treat their steel parts.

Advantages of Salt Baths for Hardening

This method of heating is much less severe on the steel than are other methods. When cold steel is immersed in a molten bath, the salt surrounding it will immediately solidify. This causes the steel to heat slowly until a temperature is reached that melts the salt away. Then the temperature rise will be more rapid until the temperature of the molten salt has been reached. Molten salt is transparent enough for steel to be seen when it is below the surface of the bath. Thus when the salt bath is maintained at the correct temperature for hardening, the steel should be removed to be quenched when it has turned to the exact color of the molten salt. This means that the steel and the salt are both of the same temperature.

This matching the color of the steel with the molten salt is the same principle as that on which optical pyrometers are built, and is very accurate. If one pyrometer was connected to the molten salt, and another to the steel immersed in this salt, it would be found that both pyrometers would give the same reading when the steel had reached the same color as that of the molten salt.

The salt bath prevents surface oxidization and the finished pieces retain the same bright steel color that they had before they were subjected to the heating process. There is a uniform temperature in all thin and thick sections of irregular or intricate shaped pieces when they are heated in the salt bath, and corners of all kinds have the same temperature as the body of the piece. Many other good reasons for using the salt bath could also be given. This does not mean, however, that all kinds of salts can be used without injury to the steel, and thus it is necessary to know what combinations of salts will give the desired results.

Decarbonizing Effect of Chloride of Potassium Bath

Numerous experiments and tests have shown that when steel is immersed in a molten bath composed only of chloride of potassium there is a decarbonizing effect upon the surfaces of high carbon steels when they are heated to the temperatures above the highest transformation point. Low carbon steels do not show any decarbonization when thus heated, and in medium carbon steels the decarbonization is so slight that it can be ignored. An equilibrium of carbonization between the steel and the bath seemed to occur when the steel contained something like 0.25 per cent carbon, *i. e.*, those steels with a higher carbon content would decarbonize on the surface while those with a lower carbon content would not. The decrease in the percentage of carbon at the surface seemed to be much more rapid than the depth of this decarbonization.

The length of time the steel is submitted to the heat of the bath is an important factor in the decarbonization. So also is the degrees to which the temperature is raised above the transformation point. When the temperature of the molten salt was maintained at 1500 degrees F and a 1.10 per cent carbon steel was subjected to this temperature for fifteen minutes the depth of the decarbonization was 0.005 inch. The percentage of carbon left at the outer surface was 0.85, as estimated by a microscopical examination. One hour's immersion in the salt bath at the same temperature made the depth of decarbonization 0.018 inch, while the percentage of carbon at the surface was reduced to 0.60; in two hours the depth was 0.030 inch and the surface carbon percentage 0.40; while four hours made the depth 0.051 inch and the carbon percentage 0.25. Raising the temperature to 1600 and 1700 degrees had a very marked effect on the increase in the depth of decarbonization. The percentage of carbon that was removed from this zone, however, did not show nearly as great an increase.

Since the microscope has been brought into use for examining steels, we have been able to measure this depth of decarbonization in thousandths of an inch and to judge the percentage of carbon closely. This has shown us that the surface of the higher carbon steels is decarbonized whenever their temperature is raised above the highest transformation point in almost any of the furnaces, forges, etc., that are now used. When these steels were heated in the air, in a carbon dioxide atmosphere, and in superheated steam the decarbonization was practically the same as that shown with the chloride of potassium bath.

Nearly all steel parts can be heated to their correct hardening temperature in less than fifteen minutes. Thus the decarbonized depth will be less than 0.005 inch and the reduction in the percentage of carbon in this zone will not be very great. On the ordinary run of work hardened with the salt bath this probably would not have enough effect to be of any importance. This is especially true of work that is ground after hardening, as the decarbonized outer surface would be ground away. As time greatly increases the decarbonization, the work should never be left to soak in the heat but should be removed as soon as it has reached the desired temperature. If left to soak for an hour the decarbonization might be so great as to destroy the usefulness of the piece being heat-treated.

Effect of Adding Ferro-Cyanide to Potassium Chloride Bath

In attempting to overcome this decarbonizing effect on steels it was found that 10 per cent ferro-cyanide added to the molten potassium chloride caused the superficial carbon to remain nearly constant, but the depth of decarbonization was increased for each period of time. With this composition, a eutectic steel showed a decarbonization to a depth of only 0.001 inch when it was subjected to the heat of the bath for fifteen minutes at a temperature of 1450 degrees F. The 0.85 per cent carbon in this eutectic steel was reduced to 0.70 per cent in the decarbonized zone. A steel containing 0.12 per cent carbon was subjected to these same conditions at the same time and the carbon content on the outer surface was raised to 0.35 per cent. This bath does not last long, however, as the ferro-cyanide soon begins to decompose. It then leaves a muddy deposit in the bottom of the pot. Thus a fresh salt mixture would have to be melted for each lot of steel parts heated, and this destroys its usefulness for commercial work.

Effect of Adding Cyanide of Potassium to Potassium Chloride Bath

By adding cyanide of potassium to the bath of chloride of potassium this muddy deposit was done away with, as there was no decomposition. The carbon, which was set free to enter the steel, seemed to be as great when cyanide of potassium was added as when the ferro-cyanide was used. At any rate, the percentage of carbon penetration was as great with

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TABLE I. EFFECT OF SALT COMPOUNDS ON HIGH CARBON STEEL WHEN THE TEMPERATURE IS MAINTAINED AT 1450 DEGREES F.

Per Cent of Cyanide of Potassium in Molten Chloride of Potassium	Time Steel was Immersed in Salt Bath in Hours	Decarbonized Depth in Thousandths Inch	Per Cent of Carbon at Surface of Steel originally containing 1.10 Per Cent
10	¼	.....	1.10
	1	0.002	1.05
	2	0.012	1.00
	4	0.021	0.90
20	¼	.....	1.10
	1	0.002	1.05
	2.	0.011	1.00
	4	0.019	0.95
50	¼	.....	1.10
	1	0.001	1.05
	2	0.010	0.95
	4	0.020	0.90
75	¼	.....	1.10
	1	0.001	1.05
	2	0.014	1.00
	4	0.020	0.95

Machinery

the one as with the other. When the commercial grades of cyanide and chloride are first melted together, a residue forms as a scum on top of the bath or in rock-like lumps that fall to the bottom. When the scum has once been skimmed off and the lumps removed, the bath remains clear, no matter how many times it may be allowed to get cold and be remelted. This constitutes a good method for cleaning a chloride salt bath before using or after it has become dirty. By stirring 3 pounds of cyanide into each 100 pounds of molten chloride, a chemical action takes place that forms this scum or the lumps of rock. Removing these, leaves the bath clear, and for all practical purposes the chloride salt has been made chemically pure.

Effect of Varying Proportions of Cyanide of Potassium

Experiments were conducted with the cyanide of potassium proportions at 10, 20, 50 and 75 per cent and the remainder chloride of potassium. The high carbon steel, heated for the tests in these salt mixtures, contained 1.10 per cent carbon; the low carbon steel had a carbon content of 0.22 per cent. The molten salt was held at a temperature of 1450 degrees F. while both of these grades of steel were simultaneously submerged in the bath for different periods of time, namely, one-quarter, one, two, and four hours. The specimens were examined with the microscope to estimate the carbon percentage and also to measure the depth of carbonization and decarbonization. The results of the examinations on the high carbon steel specimens are given in Table I, and those of the low carbon steels are given in Table II

TABLE II. EFFECT OF MOLTEN SALT COMPOUNDS ON LOW CARBON STEELS WHEN THE TEMPERATURE IS MAINTAINED AT 1450 DEGREES F.

Per Cent of Cyanide of Potassium in Molten Chloride of Potassium	Time Steel was Immersed in Salt Bath in Hours	Carbonized Depth in Thousandths Inch	Per Cent of Carbon at Surface of Steel originally containing 0.22 Per Cent
10	¼	0.006	0.35
	1	0.009	0.45
	2	0.013	0.55
	4	0.019	0.75
20	¼	0.007	0.40
	1	0.010	0.45
	2	0.015	0.60
	4	0.022	0.80
50	¼	0.005	0.30
	1	0.008	0.40
	2	0.014	0.60
	4	0.019	0.75
75	¼	0.004	0.30
	1	0.014	0.45
	2	0.016	0.65
	4	0.016	0.65

Machinery

It will be seen that there is very little practical difference in the results obtained with different percentages of cyanide. The 10 per cent mixture seemed to give about the same results as the one containing 75 per cent cyanide. This upholds the contentions of J. S. Brearley of England that but 10 per cent of the cyanide is available for the carbon that is free to enter the steel, and that the balance leaves the bath in the cyanogen gas that poisons the atmosphere and will poison individuals unless it is conveyed or blown to the upper region. In our experiments the chloride did not appear to retard the cyanide from doing its work, and the 10 per cent of cyanide was all that would affect the steel.

Effect of Varying Time and Temperature for Heating Steel

Time and temperature seemed to be the factors that increased the carbonization or decarbonization and the depth of penetration. On the low carbon steel there was a very decided addition to the percentage of carbon in two and four hours and to a depth of about 1/64 inch. One hour's immersion at 1450 degrees temperature, in the molten salt, practically doubled the carbon content of the steel; while fifteen minutes was long enough to show an increase. The effect obtained by raising the temperature to 1550, 1650, 1750 and 1850 degrees for one hour is shown in Table III. The increased temperatures show nearly the same rise in the percentage of carbon as does the increase in time at 1450 degrees. But the depth of penetration is nearly doubled. This is because each increase in temperature made the grain of the steels more and more coarse, and thus opened up the pores so the carbon could penetrate deeper. The results would be practically the same if the temperature of the steels were raised in heated air or any other medium.

TABLE III. EFFECT WHEN THE 0.22 PER CENT CARBON STEEL WAS IMMERSED FOR ONE HOUR AT DIFFERENT TEMPERATURES

Per Cent of Cyanide of Potassium—Balance Chloride of Potassium	Temperatures of Bath when Steel was Immersed, Degrees F.	Carbonized Depth in Thousandths Inch	Per Cent of Carbon at Outer Surface of Steel
10	1550	0.012	0.50
	1650	0.016	0.60
	1750	0.022	0.65
	1850	0.031	0.70
20	1550	0.014	0.55
	1650	0.018	0.60
	1750	0.022	0.65
	1850	0.030	0.70
50	1550	0.015	0.55
	1650	0.018	0.60
	1750	0.023	0.70
	1850	0.030	0.70
100	1550	0.014	0.55
	1650	0.019	0.65
	1750	0.024	0.70.
	1850	0.032	0.70

Machinery

In the heat-treatment of steel this latter experiment has no commercial application. Heating the carbon steels to such high temperatures would coarsen their grain so much that it would greatly weaken the metal. The highest temperatures would cause crystallization of the grain structure and thus make the steel very brittle. Aside from the bad effects on the metal, it is a waste of time, fuel and money to heat steels to more than 50 degrees F. above their highest transformation point for any annealing, hardening or tempering operations. It is for this kind of work that the salt bath is most proficient. For such work it is also a waste to hold the steel at these temperatures for an hour or more. It should be removed from the molten salts the minute it has reached the desired temperature. Several different kinds of metallic salts may give as good results as are required, if the time and temperature are kept as low as possible. When adding carbon to the outer surface, however, the time must be prolonged in order to get the percentage and penetration that is desired, and it is sometimes advantageous to raise the temperature 100 degrees or so above the highest transformation point of the steel.

In Table I it will be seen that there was no decarbonization when the 1.10 per cent carbon steel was subjected to the temperature of the bath for only fifteen minutes. This is a long enough time to heat almost any kind of a steel piece to the hardening temperature. Therefore this composition of salts gives better results in the hardening of high carbon steels than any kind of an oven furnace, and better than some kinds of salt baths. If the steel is left to soak in the heat for a long time there is a decided decarbonization, however, but there is no good reason for doing this in any heat-treating operation except carbonizing, and then a low carbon steel is used and the carbon content at the surface will be raised instead of lowered. Other salt mixtures may be used to prevent decarbonization when heating the medium and low carbon steels, without adding to the carbon at the surface.

The conclusions derived from these experiments might be summarized as follows:

1. Some salts have a decarbonizing effect on steels heated in them above the highest transformation point.

2. Some salts add carbon to steels which are heated in them above the transformation point.

3. The carbon will not flow in or out at temperatures below this transformation point.

4. In some salts there occurs a simultaneous decarbonization of the high carbon steels and carbonization of the low carbon steels at temperatures above the transformation point.

5. Every increase in temperature above the transformation point increases both the decarbonization and carbonization.

6. Prolonging the time that steel is subjected to such temperature also increases the decarbonization and carbonization.

7. The higher the carbon content of the steel the greater will be the decarbonization, and the lower the carbon content the greater will be the carbonization.

8. Decarbonization will be very slight if the temperature is kept close to the transformation point and the steel is not held at this temperature more than fifteen minutes.

9. Cyanide of potassium seems to be the best salt for adding carbon to the surfaces of low carbon steels and retarding decarbonization in high carbon steels.

10. Ten per cent of cyanide in solution with chloride of potassium seems to give as good results as higher percentages, or as the cyanide alone.

The Carl Nehls Alloy Co. of Detroit, who markets similar mixtures for heat-treating steels, should be given credit for supplying the salts with which to conduct these experiments and for aid in the work.

* * *

Stellite has been used as a cutting tool under varying conditions with good results. Messrs. Howe & Still, Keigley, England, builders of textile machinery, have proved to their satisfaction that stellite makes an excellent external cutting tool for work on Potter & Johnston automatics. Some of the experiments made by this company are given in the following: They found that under ordinary conditions, with a good brand of high-speed steel working on cast iron, the most satisfactory cutting speed varied between 40 and 50 feet per minute, but with a stellite tool a speed of 120 to 130 feet per minute could be maintained for thirty hours without resharpening. In one particular test—the turning of unannealed hard cast-iron pulleys with a 4½-inch face—the cut was 3/32 inch deep, the feed 1/64 inch per revolution and the cutting speed 130 feet per minute, at which speed the tool turned the full width of the pulley and still remained in reasonably good shape. The tool usually employed for this work was then tried under exactly the same conditions, but failed absolutely after turning only one-quarter inch across the face of the pulley. The stellite tool was then reinserted, without having been sharpened, and succeeded in again turning the full face of the pulley, making a total width of 9 inches with apparently no serious effect on the cutting edge. Turning mild steel, a cutting speed of 300 feet per minute was attained with a cut about 3/32 inch deep and a 1/32-inch feed. This taxed the lathe to the limit of its endurance. In fact, the belt slipped and had to be assisted by hand. Stellite, however, is comparatively easily broken, and must be so held as not to impose an excessive strain upon it.

MAKING AN INDEX PLATE

BY GUY H. GARDNER*

The article entitled "Making an Index Plate" which appeared in the November number of MACHINERY reminded me of an instance in which several methods of locating the holes in an index plate were tried out. A shop was beginning the manufacture of a line of machines on which an index plate was employed which had fifty-four holes equally spaced around a circle 7⅛ inches in diameter. It was essential for the index plates to possess a high degree of accuracy, the inspection requirements being that plugs should pass freely through all the holes in a pair of plates put together in any position.

In constructing the master plate that was to be used for making the regular index plates, the workman to whom the job was given intended to use the familiar button and micrometer method of locating the holes, but found it impracticable to fix the chordal distances in this way, as there would not be room enough between adjacent buttons to use a micrometer. Hence, a size block was made for this purpose and a micrometer was used to determine the radial distances. Although the work was done carefully by a skilled workman, it was found that slight inaccuracies existed in the index plates made from this master plate; and as a result, it was decided to make a new master plate. This time the micrometer was laid aside and the radial distances were determined by bringing the buttons, which were 0.375 inch in diameter, into contact with a 6.750-inch disk. The size block was used, as in the previous case, to secure the correct chordal distances. As errors were again found in the index plates, the superintendent decided to suspend further operations until he had had an opportunity of consulting a firm a few miles away, which had a high reputation for accurate toolmaking.

The method which they recommended for locating the holes dispensed with the use of both the micrometer and size block, the scheme being to make the buttons equal in diameter to the chordal distance between the centers of adjacent holes, and group them in contact with one another and with a central disk. In this way, the chordal distance is 7.125 inches $\times \frac{\text{sin 180 degrees}}{54}$ or $7.125 \times$ sin 3 degrees 20 minutes $=$ 0.4142475 inch. The required diameter of the central disk is $7.125 - 0.4142475$ inch $= 6.7107525$ inches. Although this method of doing the work effected a material saving in the cost of labor, by eliminating the tedious repetition of micrometer measurements, its greatest advantage, of course, lies in the extremely accurate division of the circle which is made possible. Obviously, it is as impossible to make the buttons exactly 0.4142475 inch in diameter, as it is to make a size block to a dimension expressed in seven decimals; but it is also impossible to divide the error in the size block equally between the fifty-four chordal distances, whereas any error in the size of the buttons does not vitiate the equal division of the circle, but simply causes a minute and negligible error in the diameter of the circle of holes.

In making the master index plate by this method, a slight looseness—estimated at 0.0005 inch—was noticeable in inserting the last button. The center disk was accordingly put in the lathe and touched lightly with a lap, after which the disk and buttons assembled satisfactorily. When the plate was finished, it was impossible to detect any error in the distance between diametrically opposite holes with a micrometer, although I am informed that a very accurate measuring machine showed it to be from 0.00004 to 0.00005 inch less than 7.125 inches diameter. Whatever the reader's opinion may be as to the reliability of this measurement, it seems safe to say that the master plate was "a good job," as the index plates made from it pass an unusually rigid inspection satisfactorily.

* * *

The smokestack of the Equitable Building, New York City, just completed, is said to be the largest stack in any building in the world. It is 11 feet in diameter and 596 feet high.

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* Address: New London, N. H.

ELECTRIC BUTT-WELDING PRACTICE—2

APPLICATION AND PRACTICE OF JOINING METALS BY ELECTRIC WELDING MACHINES

BY DOUGLAS T. HAMILTON*

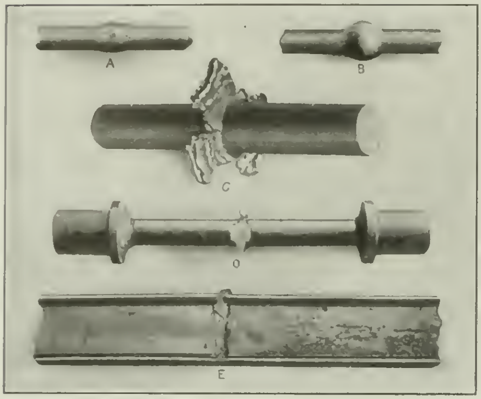

Fig. 6. Examples of Electrically Butt-welded Work showing Upset and Flash Welds (Toledo Electric Welding Co.)

In the previous installment of this article, several different methods of performing various types of butt-welding operations were illustrated and described. In the following is given a brief summary of these methods, showing their practical application to actual manufacturing practice. A variety of uses to which electric welding machines can be adapted, as well as tables of power consumption of electric welding machines, are also included.

Examples of Work done on Butt-welding Machines

Fig. 6 shows a group of work that has been welded on a butt-welding machine. The example shown at *A* is known as an upset weld; this does not take as much metal as a flash weld, but requires a considerably longer time to make. The method of making an upset weld is to reduce the amperage and take a longer time to heat the metal. This type of weld is used where it is not necessary to have the work highly finished and no flash need be removed. The example shown at *B* is known as an upset; the work is clamped between the jaws of the welding machine, the current turned on, and the jaws gradually brought together until the work has been upset to the required diameter. The work is then quickly removed and placed under a punch press or other machine and flattened out.

At *C* is shown a flash weld. A considerably greater amount of material is used in making a flash weld than an upset weld, and it is also done much quicker. A flash weld on some materials, such as brass, etc., is preferable because all the burnt metal is forced out into the flash and a much better weld is secured. It is also possible to bring the two members that are welded into much better alignment with a flash weld than with an upset weld. The examples shown at *D* and *E* are also flash welds, the one shown at *D* being two round sections, while the one at *E* is of I-beam cross-section.

Another common example of butt-welding is shown in Fig. 7. In the manufacture of large cap-screws it is found much more economical to make the cap-screw from two pieces and then weld them electrically than to turn the body part down from a large bar. In making cap-screws by the electric welding process, the first step is to make the stem, thread it and finish it complete, and then to turn down the hexagon head from another bar. There is a point in the making of this type of cap-screw that should not be overlooked. In electric welding, the two members that are to be joined must have the same cross-sectional area, so it is necessary to turn down the front part of the head to the same diameter as the body of the cap-screw and to have it of a length equal to that necessary to form the weld, generally about one-quarter to one-half the diameter of the cap-screw. The head of the bolt is then held in one pair of jaws of the electric welding machine, and the bolt in the other, and both are brought together and welded, the jaws, of course, being made to conform to the shape of the two parts.

An example of tee-welding is shown in Fig. 8. This can be accomplished on a butt-welding machine by a special arrangement of the jaws, as was described in a previous paragraph. When it is desired to weld a piece of iron to the middle portion of another bar of equal size or larger, it is necessary to preheat the middle portion of the bar to a bright red, then bring forward the other bar, the end of which is presented to the first one, and again turn on the current, when a weld can quickly be made. Special machines are built for handling this class of work, in which three pairs of clamping jaws are used instead of two.

Two different types of corner welds are shown at *A* and *B* in Fig. 9; the corner weld shown at *A* is an angular weld, and can be performed in a butt-welder without any special arrangement of the clamping jaws, as shown at *G* in Fig. 2 in the first installment of this article. The corner weld shown at *B* is a square weld and has to be handled in a manner similar to that described for making a tee-weld, except that three jaws are not necessary, as is shown at *F* in Fig. 2.

Jump-welding is another type of welding that can be handled on a butt-welding machine. When welding two rods in a jump-weld, one piece is held parallel with the opposing faces of the clamping jaws and the other at right angles to the first piece. The piece that is held as in butt-welding is sometimes pointed so that its cross-sectional area at the point of contact with the vertical piece will be reduced. Two examples of jump-welded tubing are shown at *C* and *D* in Fig. 9; *D* shows a jump-welded section which has been torn apart to illustrate how tenaciously the weld holds. Another example of butt-welding is shown in Fig. 10. This piece of work comprises a hollow irregular shaped tubing which is butt-welded at an angle. The manner of accomplishing this is shown in Fig. 2 in the March number at *G*.

Fig. 11 shows a collection of examples of butt-welded work. *A* shows a hollow steel knife handle welded to the knife blade, showing a sharp fin at the joint. The blade and the German silver prongs of the fork shown at *F* are formed on the end next to the handle practically to the same shape as the smallest end of the handle; that is, the end of the fork or knife is hollowed out into the shape of a tube so that it presents the same cross-sectional area as the lower end of the handle does. This is the preferable way to handle this work, but in some cases it is not necessary to do this. *B* shows a piece of high-carbon steel which has been butt-welded, and the nature of this weld is clearly indicated by the rugged fin, which shows that more current has been taken to perform the weld and it is accomplished in a shorter period of time. *C* shows a piece of softer steel with a smooth round

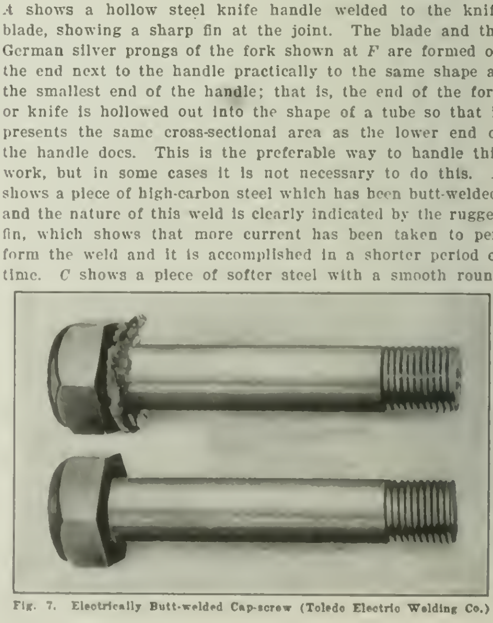

Fig. 7. Electrically Butt-welded Cap-screw (Toledo Electric Welding Co.)

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* Associate Editor of MACHINERY.

swelling made by the weld, which took less current but more time to make. This weld is more in the nature of an upset weld. *D* shows two sizes of steel rods welded and upset into a smooth round button or shoulder. *E* shows two steel cups which have been welded together to form a caster. The point of the weld here is indicated by very sharp fins. *G* shows two pieces of rectangular stock which have been cross-welded and mashed together. *H* shows two pieces of angle iron which have been welded at the corner. *I* shows two different sizes of pipe tee-welded.

Another group of miscellaneous examples of butt-welded work is shown in Fig. 12, where *A* is a leaf of an automobile spring with a weld in the center; *B*, the nose of pliers welded; *C*, a rod upset on one end; *D*, ends welded on a cotton mill steel flyer; *E*, a carriage step; *F*, a foot piece welded on a treadle step; *G*, an iron frame; *H*, a vertical oblique weld in flat steel; *I*, a cross-weld in two rods; *J*, an iron magnet ring; *K*, a pipe welded to a flange; *L*, a rod welded to a disk to form a gear blank; and *M*, one end welded to a crankshaft. The places where the welds are made are seen by the swelling or burrs at the joints.

Fig. 13 shows a common and very valuable use of the electric butt-welding machine. It is the joining of high-carbon or high-speed steel to low-carbon steel. To the right of this illustration at *A*, *B* and *C* are shown a diamond point turning tool, side facing tool and round-nose turning tool, all made from high-speed steel, which have been welded to ordinary soft carbon steel shanks. In this way the cost of the tool has been reduced, but its life has not been shortened in any way. To the left of the illustration is shown a counterbore before and after repairing. The counterbore shown at *D* has one tooth broken, which, of course, unfits it for use. The shank was then cut off and welded to a new piece of tool steel, as shown at *E*, making the counterbore ready for recutting and hardening. At *F* is shown a center which has been broken, and at *G* the center repaired. At *H* is a shank end welded to a drill and at *I* is a long shank welded to a short drill. The examples shown in Fig. 13 are such as commonly come up in the machine shop, and illustrate the application of the electric welding machine to general repair and tool work. Nearly all extension drills made at the present time have their shanks welded to high-speed steel cutting parts, the shanks being made of ordinary cold-rolled steel. In fact, a large number of drills of standard lengths are made up in this way. It makes a cheaper drill, and a better one, because a soft shank is much less likely to break than a hard one.

Other Uses of Electric Welding Machines

In addition to welding, a large number of other miscellaneous operations can be accomplished in a more or less limited way on electric welding machines. One use is the annealing of hardened steel plates and other articles so that they can be drilled or machined. The terminals of the welding machine are connected to each side of the article to be annealed. Enough current is then applied to heat the metal sufficiently to soften it. This process is also applied to the manufacture of springs where it is found necessary to take the temper out of the ends in order to flatten them. As a rule, special machines, however, are designed for handling this class of work. Electric hardening and tempering can also be accomplished on a welding machine. This is done by clamping the stock in the dies of a butt-welding machine, then turning on the current and bringing the metal to the proper temperature for hardening, whereupon it is quickly removed and cooled in the usual manner. As the metal is in plain sight of the operator, this is an ideal method of hardening many classes of work.

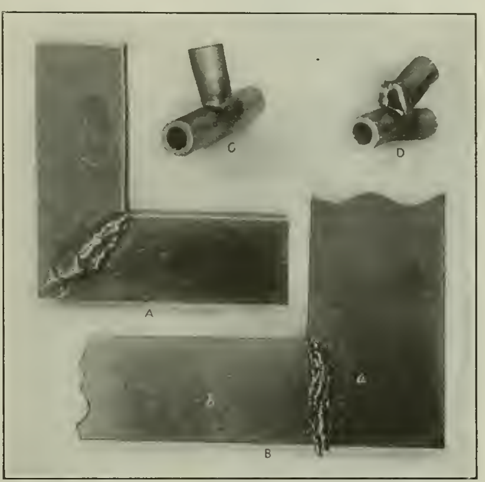


Fig. 9. Examples of Angular and Straight Corner Welds and Jump-welded Piping accomplished on Electric Butt-welding Machines (Toledo Electric Welding Co.)

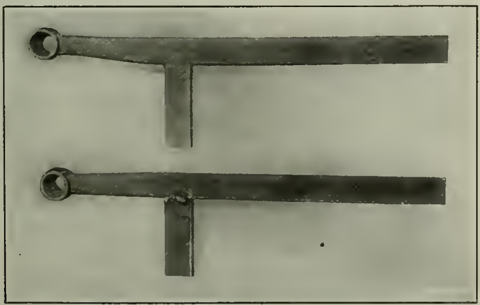


Fig. 8. Example of Tee-welding on Rectangular Work performed on Butt-welding Machine with Special Arrangement of Clamping Jaws (Toledo Electric Welding Co.)

Still another operation that is commonly handled on electric spot-welding machines is the riveting and heading of rivets, obviating the objectionable noise from pneumatic hammers and the heating of rivets in the forge fire. After the hole in the work has been punched and the rivet inserted, the electrodes of the spot-welding machine are pressed against the ends of the rivet, which are quickly heated. The electrodes are then brought together to shape the form on the head. Electric brazing can also be handled rapidly on the welding machine. When the work permits of its admission into the jaws of a welding machine, brazing becomes a comparatively simple operation. After the work is clamped in the jaws, the current is turned on. When the metal has heated sufficiently, the spelter and flux is applied and allowed to run into the joints. Having the work under absolute control and in full view offers many advantages for electric brazing. Other uses of electric welding machines will be more fully dealt with in subsequent articles.

Power and Time Required for Electric Butt-welding

For electric welding, single-phase or one phase of a multiphase system alternating current of from 100 to 500 volts, 40 to 60 cycles, is required. For other cycles, a special transformer must be used in the welder to adapt it to the higher or lower frequency. For voltages higher than 440, for example 550 or 600, handling becomes somewhat dangerous, so a special switch mounted on the wall at some distance from the machine has to be furnished. This prevents any possibility of the operator coming in contact with the current when operating the machine. Direct current is not advisable for operating the electric welder, because there is no way of reducing the voltage without interposing resistance, which uses up the power. For instance, a direct-current plating dynamo will give approximately 5 volts, which would be sufficient for certain kinds of welding, but lighter work calls for less current. By putting resistance in the line to take care of this decrease, the resistance uses up the power instead of allowing this power to do useful work. All electric welding machines are provided with transformers which reduce the voltage to from 3 to 5 volts.

The power and time required for electric welding varies with the cross-section of the stock and the material being welded. Copper and material offering a small amount of re-

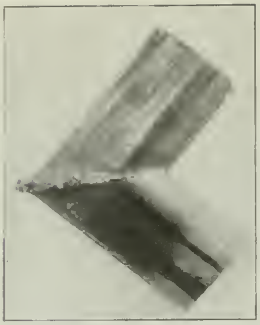


Fig. 10. Corner Weld on Irregular-shaped Tubing (Toledo Electric Welding Co.)

sistance to the passing of the electric current require a higher amperage to heat than other materials that offer more resistance to the flow of the current. Welds on copper, brass and high-carbon steel must be accomplished very rapidly if good work is to be secured, and hence the amperage used is higher than for low-carbon steel or wrought iron stock. The regulator, however, can be shifted over until the correct amount of current is supplied.

It is always desirable to have ample power to make the weld in the quickest possible time, as better results are usually obtained and both time and power saved. A ¾-inch round rod of wrought iron can be welded with 15 kilowatts in fifteen seconds or with 23 kilowatts in six seconds. Endless pieces, like rings, take more power as the diameter of the ring decreases; copper and brass take more power and less time than wrought iron or steel of like sections.

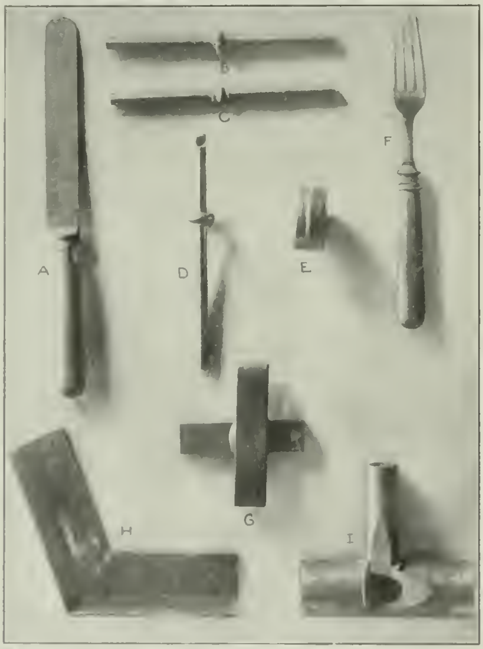


Fig. 11. Examples of Butt-welded Work (Thomson Electric Welding Co.)

TABLE I APPROXIMATE TIME AND CURRENT REQUIRED FOR BUTT WELDING (TOLEDO ELECTRIC WELDING CO.)

Diameter of Rod in Inches	Area of Rod in Square Inches	Approximate K.W. Required	H.P. at Dynamo	Time in Seconds to Make a Weld	Cost Per 1000 Welds at 1 Cent Per K.W.
¼	0.05	2	3	3	0.02
⅜	0.11	3.5	5	5	0.05
½	0.20	5	7.5	5	0.07
⅝	0.31	7.5	12	10	0.21
¾	0.44	12	17	15	0.50
⅞	0.60	15	22	18	0.75
1	0.79	18	25	20	1.00
1⅛	0.99	25	35	25	1.73
1¼	1.23	35	50	30	2.90
1½	1.77	50	70	40	5.55
1¾	2.41	65	85	45	8.12
2	3.14	75	100	50	10.42

Machinery

Table I shows the kilowatts and time required to make welds on round wrought iron rods or other sections, and it also gives the cost in cents per kilowatt for 1000 welds. The price of current in different places varies, but the current here is figured at one cent per kilowatt-hour to give a basis for calculating the cost. Multiplying the price as given in the last column of this table by the current rate charged by local electric light companies will give the cost of a current for 1000 welds.

Table II gives the power and time required for electric welding of wrought iron and steel, brass and copper. This table does not correspond with Table I, as the time given for welding is quite different. The power required for electric welding varies inversely as the time consumed in making the weld. The operator can do this work quickly and use more current for a shorter period, or he can heat the stock slowly and use less current for a longer time. The actual kilowatt-hour would be practically the same in either case. To do the work rapidly would, of course, require a larger generator or transformer capacity to furnish the desired current. The volumes of current used vary from 2000 to 50,000 amperes. In Table II, 18.75 kilowatts is found necessary to weld a one-inch area stock in forty seconds. Now if the time is shortened to twenty seconds, it would require a 35-kilowatt generator capacity to do the same work. The area of the

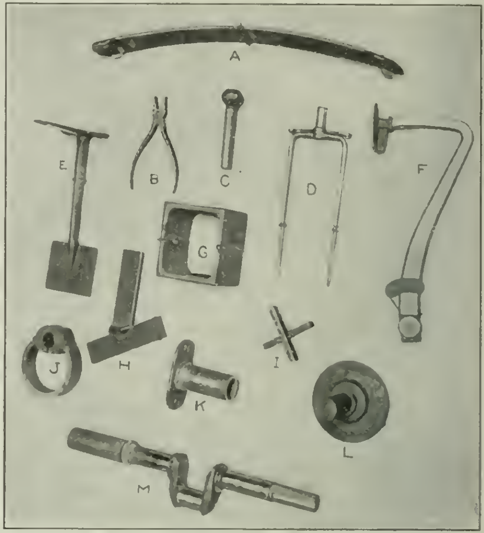


Fig. 12. Examples of Butt-welded Work adapted particularly to the Automobile Industry (Thomson Electric Welding Co.)

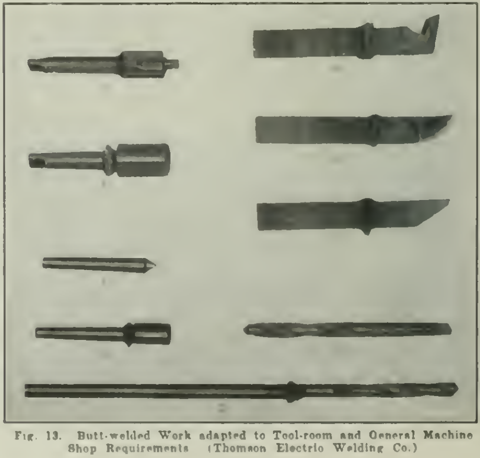


Fig. 13. Butt-welded Work adapted to Tool-room and General Machine Shop Requirements (Thomson Electric Welding Co.)

TABLE II. TIME AND POWER REQUIRED FOR BUTT-WELDING VARIOUS MATERIALS (TOLEDO ELECTRIC WELDING CO.)

Area of Bar in Square Inches	Equivalent Diameter Round Bar	Equivalent Side of Square Bar	Approximate K. W. Required	H. P. at Dynamo	Time in Sec. to make a Weld
WROUGHT IRON OR STEEL BARS OR RODS					
0.25	9/16	1/2	6.0	8.0	20
0.50	1 3/16	23/32	10.0	13.5	28
0.75	1	7/8	13.0	17 5	35
1.00	1 1/8	1	18 75	25.0	40
1.50	1 3/8	1 15/64	29 5	39.5	44
2 00	1 5/8	1 27/64	33.0	44.0	57
2 50	1 3/4	1 19/32	38.0	50.0	63
3 00	1 15/16	1 3/4	43.5	58.5	70
4 00	2 1/4	2	56 3	76.0	80
5 00	2 1/2	2 15/64	61.7	83.0	90
6.00	2 3/4	2 29/64	69.0	92.5	98
BRASS BARS OR RODS					
0.125	13/32	23/64	6.0	8.0	10
0 250	9/16	1/2	12 0	15.7	14
0.375	11/16	39/64	12.6	17.0	17
0.500	13/16	23/32	15.0	20.0	20
0.750	1	7/8	25.0	33.5	22
1.000	1 1/8	1	29.5	39.5	28
1.250	1 1/4	1 1/8	37.0	50.0	32
1.500	1 3/8	1 15/64	43.0	52.7	35
2.000	1 5/8	1 27/64	53.0	71.0	40
2.500	1 3/4	1 19/32	60.0	80.0	45
3.000	1 15/16	1 3/4	66.0	88.5	49
COPPER BARS OR RODS					
0.0625	9/32	1/4	5.0	7.0	5
0.125	13/32	23/64	8.5	11 5	7
0.1875	15/32	27/64	12.0	16.0	9
0.250	9/16	1/2	18.0	24 0	10
0 375	11/16	39/64	28.5	38.0	11
0.500	13/16	23/32	32.0	43.0	14
0.625	29/32	25/32	37.0	50.0	16
0.750	1	7/8	43.0	52.0	18
1 000	1 1/8	1	55.5	75.0	20
1.250	1 1/4	1 1/8	61.0	82.0	23
1.500	1 3/8	1 15/64	68.0	91.0	25

Machinery

bar has been converted into the equivalent diameter for round and the equivalent side of the square bar, for convenience in use. It will also be noted here that the current required for the various materials differs considerably. Wrought iron or steel requires about 6 kilowatts for a bar of 9/16-inch diameter round stock. The same diameter of brass rods requires 12 kilowatts, and of copper 18 kilowatts, showing that the copper bars require a greater quantity of current or amperage than any of the other materials listed in the foregoing table.

* * *

It is not generally known, we believe, that blueprints, wrapping paper or any sheet of ordinary paper that has become badly wrinkled through folding or crushing may be made smooth and flat by ironing with a hot flatiron. Care must be taken, of course, not to have the iron so hot that it will scorch the paper. When ironed, badly wrinkled prints will be as smooth and flat as when new.

DEEP DRAWING IN COMBINATION DIES

Rectangular parts are commonly drawn either in combination dies or the double-action type, the former being employed ordinarily for drawing shallow parts and the latter for deeper drawing operations. The principal reason why ordinary combination dies cannot draw as deeply as double-action dies is that the pressure between the drawing die and the pressure pad gradually increases as the part is drawn, owing to the increased compression of the drawing rubber or spring-pressure attachment which is common on dies of this type. The result is that the stress upon the metal being drawn increases rapidly as the drawing die descends, because the stress due to the drawing operation is unduly increased by the excessive pressure on the outer part of the blank. In other words, if the pressure on the blank is sufficient at the beginning of the drawing operation, it rapidly rises as the pressure pad or "drawing rubber" is compressed. On the other hand, when the pressure on the blank is practically uniform, as in the case of a double-action die, a somewhat greater depth may be obtained in one draw, assuming that the same material is used in each case and that other conditions are equal.

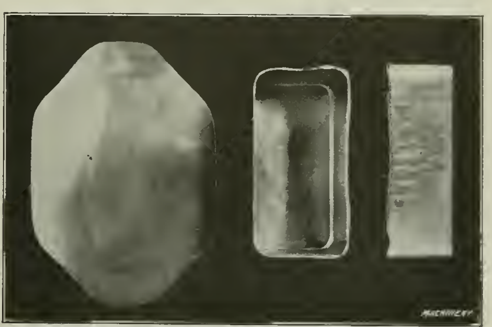


Fig. 1. Blank and Aluminum Rectangular Case drawn in a Combination Die

In order to prevent an increase in pressure between the die and blank-holder, some combination dies are equipped with a compensating attachment. This attachment has a cross-bar under the table which carries the rubber pressure pad. This bar extends outward at each side, and vertical pins are attached to the ends, passing up through the press table. When the ram of the press descends, it begins to force these compensating pins downward as soon as the required blank-holder pressure is obtained. As the pins move downward, they also lower the cross bar and rubber pressure pad and, consequently, the latter is not further compressed. In other words, when there is sufficient pressure on the blank, the compensating pins are engaged by the slide, and as the drawing operation continues the blank-holder pressure remains practically constant, because the drawing rubber is carried down at the same rate

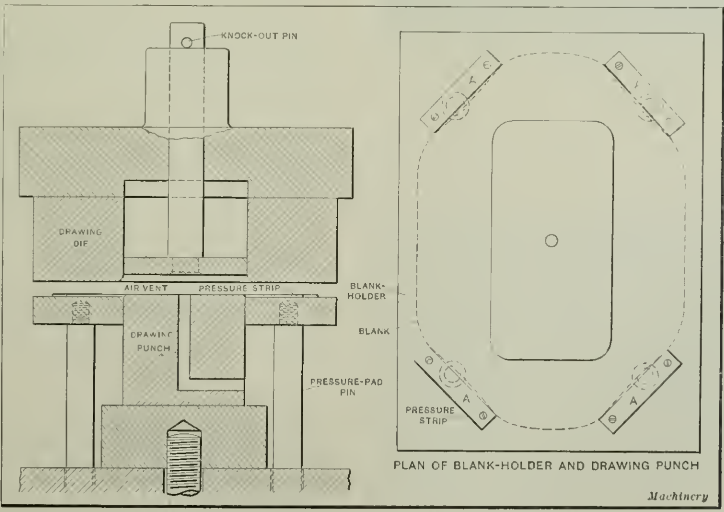


Fig. 2. Drawing Punch and Die used for Operation illustrated in Fig. 1

as the press slide. The screws on the slide which engage the compensating pins are adjustable so that the pressure pad can be compressed the required amount before the compensating attachment comes into action. While this attachment has been used in many cases where it was desired to obtain an exceptionally deep draw in a combination die, the results have not been altogether satisfactory, because it has been found difficult to produce a uniform pressure on the blank; moreover, the compensating attachment is rather cumbersome and complicates the construction.

To avoid the use of such an attachment, the Nelson Tool Co., Inc., 781-783 East 142d St., New York City, has designed and built a combination die which is very simple but ingenious, and, so far as we know, represents a new development in drawing die construction. The work done in this die is illustrated in Fig. 1, which shows the flat blank and also the rectangular case which is drawn in one operation. The stock is aluminum, 0.050 inch thick, and the case is 4¼ inches wide, 8 9/16 inches long, and is drawn to a depth of 2 13/16 inches. In order to draw to this depth in one operation in a combination die and avoid the excessive increase in blank-holder pressure, four steel pressure strips *A* were attached to the blank-holder near the corners of the blank, as indicated in Fig. 2, which shows a detailed view of the die. These strips are the same thickness as the stock and they are engaged by the die during the drawing operation. The result is that while the blank is confined between the die and blank holder, it is not subjected to an appreciable increase in pressure as the die descends, because the steel strips hold the die in a fixed position relative to the blank-holder. By this simple method, the increase in pressure resulting from the compression of the drawing rubber is not transmitted to the blank; the latter is merely confined between the flat surfaces of the die and blank-holder which are positively held a fixed distance apart. As the plan view to the right in Fig. 2 shows, the four pressure strips are so located on the blank-holder as to form a "nest" for the blank.

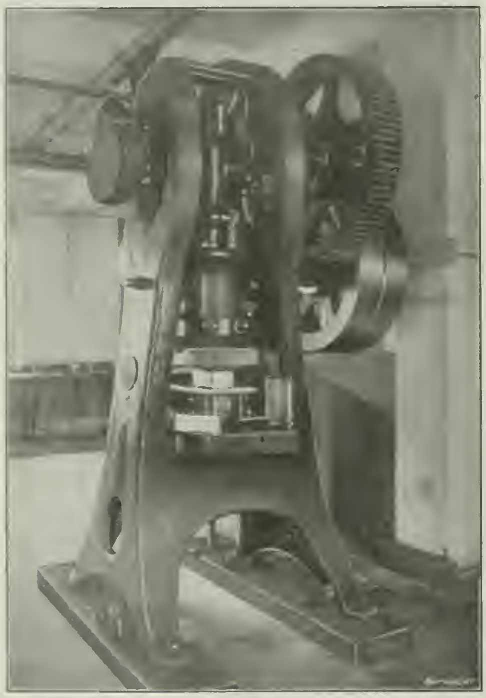


Fig. 3. Press equipped with Combination Die for Operation illustrated in Fig. 1

The use of these pressure strips or distance pieces between the die and blank-holder not only simplifies the construction of the die but, in this particular instance, enables the required depth of 2 13/16 inches to be drawn in one operation. At first, experiments were made with pressure strips 0.012 inch thicker than the aluminum stock. While the results were fairly satisfactory, there was slight wrinkling. When strips of the same thickness as the stock were used, however, the aluminum cases were drawn without difficulty, and they are a fine example of rectangular drawing. The radius of the corners of the case is 13/16 inch, whereas the radius at the bottom, on the inside, is 3/32 inch, which, of course, corresponds to the radius of the drawing punch. The drawing edge of the die has a radius of ¼ inch, or five times the stock thickness. Located within the drawing die, as Fig. 2 indicates, there is a knockout which is operated by a cross-bar in the usual manner, at the upper end of the stroke. The drawing punch is provided with an air vent hole in the center to prevent the formation of a partial vacuum under the case when the latter is being stripped from the punch. The blanks are cut out in a separate blanking die. F. D. J.

* * *

EARLY ENGINEERING HANDBOOKS

One of the earliest, if not the very first, engineering handbooks published in the United States was the well-known work of Haswell, the first edition of which appeared in 1843, and which in 1863 had reached its fifteenth edition, and contained 316 pages. In the preface to this book, Mr. Haswell stated that "to the young engineer it is necessary to cultivate a knowledge of physical law, without which eminence in his profession can never be securely obtained."

Another early American engineering handbook was published in New York in 1848 and was entitled "The Mechanical Principia," containing, according to the title page, "all the various calculations on water and steam power and on the different machinery used in manufacturing, with tables showing the cost of manufacturing different styles of cotton goods." The author of this book was Charles Elbredge Leonard. The book was published by Leavitt, Trow & Co., 191 Broadway, and contained 197 pages. The following extract from the preface may be of interest: "The present work pretends to no other merit than that of being a laborious collection of the most useful calculations for the mechanic and manufacturer. All the various calculations on motive power have been condensed and arranged in as comprehensive a mode as possible, which are such as to enable the mechanic to obtain the solution of any problem simply by reference to the tables; hence, it will be seen that those mechanics who possess very little mechanical knowledge will be able to obtain the solution of the most intricate problem in mechanical science. All must readily admit that it requires no small amount of labor to perfect the present work, and that its design proposes a plan of arranging calculations which cannot fail to be very useful to the mechanic and manufacturer."

In 1871, J. C. Trautwine published his well-known civil engineers' pocketbook, which, exclusive of the index, contained 684 pages. Since that time a great number of engineering handbooks have appeared.

Among early English engineering handbooks may be mentioned the "Engineers and Contractors' Pocketbook," a volume of 382 pages, published in 1847 in London. One of the earliest French engineering handbooks was "Nouveau Manuel Complet de L'Ingénieur Civil," which was published in Paris in 1845, in two parts of about 500 pages each. Judging from the number of pages it might be thought that this was a very complete work, but as a matter of fact the size of the page was very small. The earliest German engineering handbook of any importance was "Der Ingenieur," published by Julius Weisbach, in Braunschweig, in 1848, a second edition of which was published in 1850 and which contained 607 pages.

* * *

In view of the disorganization or cutting off of the sources of supply of electrical machinery and appliances imported into South Africa, the Bureau of Foreign and Domestic Commerce, Washington, D. C., has prepared a series of tables for the benefit of American manufacturers, giving all available details concerning various electric lighting and power plants, copies of which may be had from the Bureau upon request

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

MODEL REYNOLDS GIRDER FRAME CORLISS ENGINE

In the February number of MACHINERY is a historical note on the Reynolds girder frame Corliss engine with an illustration of a working model now belonging to the College of Engineering, University of Wisconsin.

It will only be doing justice to make some corrections. I built this engine myself, reducing the proportions from shop blueprints of a 24-inch by 48-inch girder design; hence, it is a 2-inch by 4-inch engine, and not 1-inch by 4-inch as given in the article. I whittled out the patterns at home, mostly evenings, and did the machine work on a Barnes foot power lathe and with some small tools. When Mr. Allis and Mr. Reynolds became aware of this model engine they wished to use it in connection with a miniature flour roller mill which they intended to exhibit at the New Orleans Exposition. I parted with it for a liberal consideration and put the finishing touches on it in the company's tool-room of which I was foreman.

The 2-inch by 4-inch Model Reynolds Girder Frame Corliss Engine and its Maker

After the engine was returned from New Orleans it was exhibited at the World's Fair at Chicago, after which it drifted into the hands of Louis Allis who presented it to the University of Wisconsin. The accompanying illustration of the engine and myself was taken to show its comparative size. I was then thirty-nine years old and am now past sixty-seven, and I am still busy in the same works—now called the Allis-Chalmers Mfg. Co.

Milwaukee, Wis. GUSTAV J. LUCK

TOOL CHECKING SYSTEMS

There are two methods in general use for checking tools given out to the employes from the tool-room. Several conditions must be considered to determine which of the two methods is the better for any one shop. In a small shop, the single check system meets all the requirements. A man goes to the tool-room and exchanges a metal check bearing his number for a tool. Usually the check is placed in the space from which the tool is removed by the tool-room attendant. If the tool required by the workman has been previously given out to someone else, the check in the compartment enables the attendant to find it in the shop, and if the first user can spare it at that time, it can be immediately handed over to the second man. By limiting the number of checks given to each employe, it is possible to prevent anyone from taking out of the tool-room more than a fair number of tools. When a man leaves the employ of the firm, he must return the number of checks originally given to him. If he claims to have lost a check, it takes only a few minutes to look over the spaces for the tools in the tool-room and determine that the check is not in the tool-room and that some tool that should have been returned is not in the workman's possession.

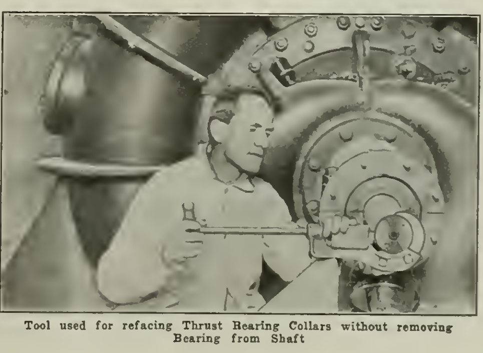
The second type of checking system for tool-rooms uses double checks. In addition to the checks held by the workman, there is a check provided for every tool in the tool-room, and on these checks the number of the compartment or name or symbol of the tool is stamped. There is also in the tool-room a board with the numbers of all the employes and with a hook for each number. Each employe has checks, as in the first system, bearing his number. When a man requires a tool, he gives one of his checks for it. The tool-room attendant takes the tool out of its compartment and delivers it to the man. He takes the compartment check and places it on the board against the man's number and places the man's personal check on the compartment hook. If there is a later call for the same tool, the attendant can tell who has it. If any man leaves the employ of the company, an immediate reference to the tool-room board will show how many tools and what tools he has. This plan is more applicable to large shops and is quite necessary where there are numerous changes among the employes, as in railroad repair shops, etc. It requires careful and better paid men in the tool-room, because there are more chances for errors and the consequences are more serious. If an inventory of tools is maintained and records are kept showing breakages and failures, it is a simple matter to determine whether the loss of tools is large enough to warrant the increase in labor cost necessary in the second system, or whether the first system meets all reasonable requirements.

Boston, Mass. C. W. THAYER

TOOL FOR REFACING THRUST BEARING COLLARS

The accompanying illustration shows a tool used for refacing the collars on the thrust bearings of the centrifugal pumps referred to in the article entitled "Cream Separator Used as an Oil Filter," which was published in the December number of MACHINERY. An old pipe cutter was utilized in making this tool, and the cutting tool employed was just wide enough to "clean up" the worn faces of the thrust bearings. The method of using the tool was to run the hydraulic turbines which were direct-connected to the pumps, at the desired speed; and to feed the cutting tool in by hand until it had reached the bottom of the groove in the thrust bearing. By applying oil to lubricate the tool, a very smooth finish was obtained.

Palisades, Colo. A. J. HUMPHREY



Tool used for refacing Thrust Bearing Collars without removing Bearing from Shaft

QUICK-OPERATING DRILL JIG

The design of quick-operating drill jigs is a difficult matter, particularly when the shape of the work is such that it must be located in more than one direction and clamped at several points. If the necessary clamps could be positively operated by a single lever, the greatest possible speed would be obtained, but this ideal condition is hard to produce owing to the fact that the holding position of each clamp is likely to vary with the size of the work, thus making any combined positive movement of the clamps ineffectual. The clamps may be released by a single lever, but when holding the work their position is fixed by the work itself, and this condition, coupled with variations in the size of the work, makes the operation of the clamps by a single lever a difficult matter.

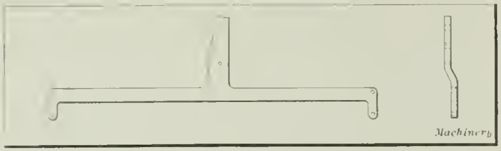


Fig. 1. Work to be drilled

If it were always possible to reverse this condition, making each clamp independent of the others in its closing movement and thus compensating for varying sizes of work, a single lever might be arranged to release all the clamps at once. This desirable result has been accomplished in the jig shown in the accompanying illustration by employing spring pressure to close the locating and holding mechanisms. The position of the work is fixed in two directions, and the work is clamped at two points by a single movement of the operating lever to the right, while moving this lever to the left releases the work from the clamping and locating devices. The work lies on three hardened steel blocks *A*, and is located behind pins *B* mounted in these blocks and to the left of the pin *C* in the base of the jig.

The block *D* forms a seat for the cover-plate and the latch which holds the cover-plate down is pivoted in this block. The latch is held down by a spring plunger. The bellcrank lever *E*, which carries the fourth locating pin, is pivoted to the base of the fixture and provided with a lug which enters an opening through the base and receives the pressure of the spring plunger *F*. The brackets *G* are attached to the base of the fixture and the cover-plate is hinged to these brackets. The brackets are also bored out to receive two spring plungers. The operating lever is fastened to a hub *H* and a link *I* is pivoted on this hub, the opposite end of the link being attached to the hub *J*. The screws which hold the operating lever to the hub *H*, and the link *I* to the hub *J*, are extended to form pins which engage the levers *K*.

The jig is shown closed with all parts in the positions they would occupy when holding a piece of work. To raise the cover-plate, the latch is pressed back, when the thrust of a spring plunger raises it sufficiently to prevent the latch re-engaging the cover-plate. The cover-plate is raised to the limit of its movement which is a few degrees beyond the perpendicular. The operating lever is then swung to the left until it strikes a limit pin. This movement of the lever turns the hubs *H* and *J*, bringing the pins against the tail ends of the levers *K* and compressing the springs behind the plungers carried in the brackets *G*. The result is that the ends of the levers *K* which engage the work are swung back, thus releasing their grip.

The final movement of the left-hand lever *K* brings the adjustable stop-screw *L* carried by this lever against a lug projecting above the lever *E*, thus compressing the spring *F* and releasing the work from the pressure of the pin carried by the lever *E*. The screw *L* limits the movement of the lever *E* to the minimum amount necessary to release the work, and the stop-screw may be adjusted to accomplish this after the jig has been locked open. After removing the work from the jig, a fresh piece is placed in position and the operating lever thrown to the right. This causes the different holding members to go through their sequence of movements in the opposite order to that described for releasing the work from the jig. The result is that the work is clamped in place in a minimum amount of time.

Bridgeport, Conn. F. W. Barrows

A TUBE FORMING DIE

The accompanying illustration shows a short tube and the die which makes it in a single operation. The tube is 3/8 inch long by 0.337 inch inside diameter, and is pressed into a 7/16-inch hole. It seemed likely that we should use about 300,000 of these tubes a year, and when I was given the job of making a punch and die for manufacturing them, I was told to pay particular attention to reducing the cost of pro-

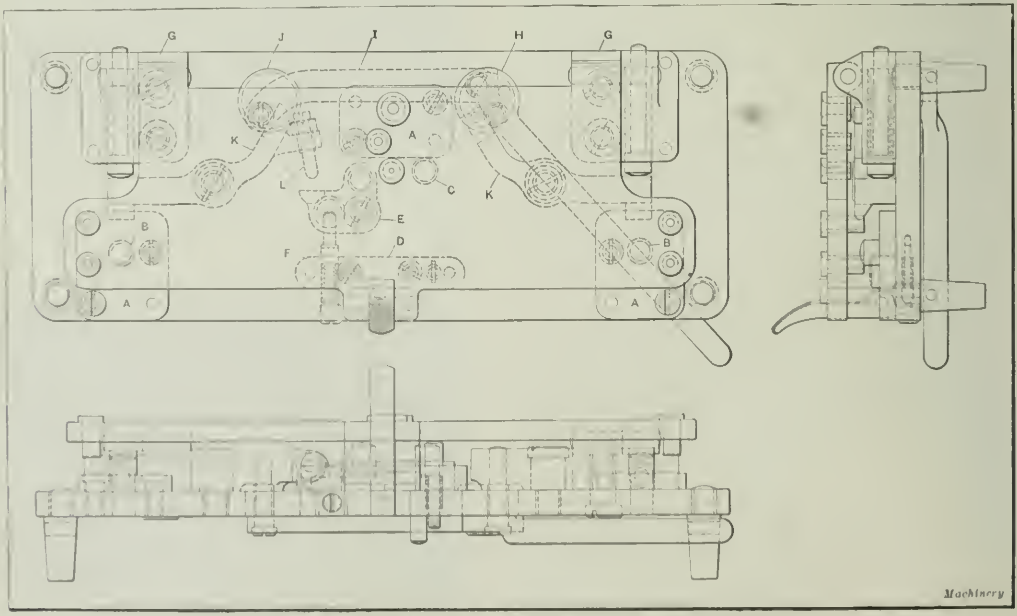


Fig. 2. Quick-acting Jig designed for drilling Work of the Form shown in Fig. 1

duction as far as possible. As a small variation in the length of the tube did not matter, I decided to use strip steel 0.050 inch in thickness by ⅜ inch in width. The die which forms the subject of this article was finally developed and has been found to give very satisfactory results; as I have never seen a tool like it, I thought it probable that readers of MACHINERY would be interested in the following description.

The die-block *A* was made of machine steel and planed to fit the sliding jaws *B*, *C* and *D*. The two steel blocks *E* and *F* were next planed and bolted onto the die-block *A*, and by making the block *F* in two pieces, provision was made for easily renewing the cut-off blade when it is worn out. The machine steel pieces *G*, *H* and *I* are casehardened, ground and fastened to the die-block *A* to provide bearings for the sliding jaws; and the tool steel blocks *J*, *K* and *L* are for backing up the plungers which cause the jaws *B*, *C* and *D* to close in on the stock. The cast-iron punch-holder *M* is drilled and reamed so that the mandrel *N*, about which the tube is formed, fits accurately in the punch-holder. Three other holes are drilled and reamed to receive the plungers that actuate the sliding jaws *B*, *C* and *D*. It will be noticed that the mandrel *N* has a pilot which is made long enough so that it enters the die-block *A* before the sliding jaw *B* starts forward to cut off the stock and perform the first operation on the tube blank. The plunger *O* is made slightly longer than the other plungers so that the sliding jaw *B* moves in, cuts off the blank and performs the first forming operation before the jaws *C* and *D* move.

The stock is fed in to the die by means of a spring roller which draws it through a suitable sized slot, a detail of this feed roller mechanism being shown at *R*. It will be seen that this feed mechanism consists of two slots cut in the block *F* to receive the ends of the feed rollers. A hole is drilled at each end of the slots and springs are placed in these holes with hardened steel balls between the springs and the rollers. With this arrangement the necessary tension can be placed on the stock without retarding its movement. A hole is drilled in the front ends of the jaws *C* and *D* into which springs of sufficient tension are inserted to provide for forcing the jaws apart when the ram of the punch press rises. The jaw *B* is drilled and tapped to receive two shoulder screws which pass through the backing-up piece *J* and carry springs that return the jaw when the ram of the press rises.

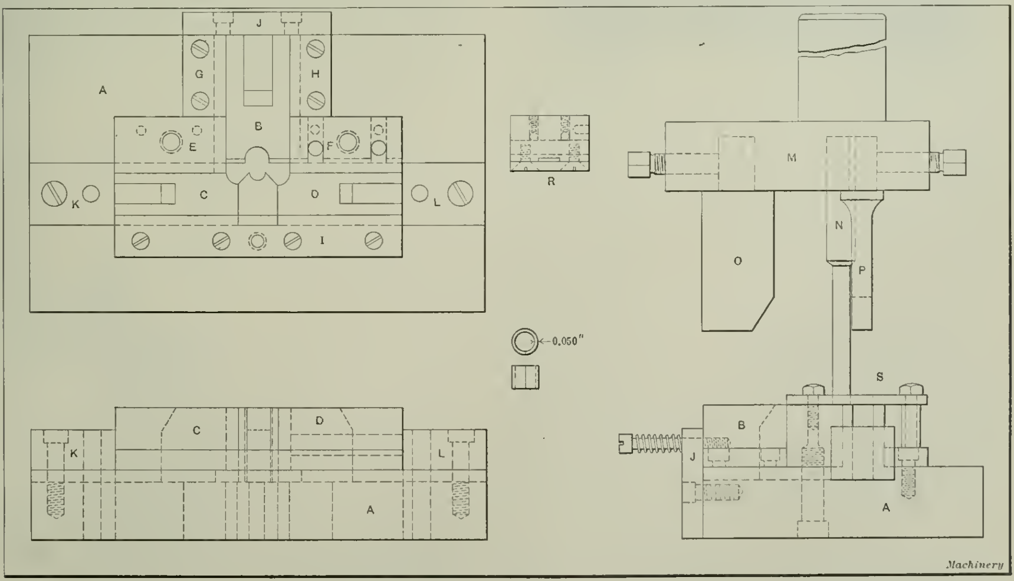
The following describes the way in which the die operates: As the ram of the press descends, the pilot on the mandrel *N* enters the die-block *A* to provide the necessary support for the mandrel. As the ram continues to go down, the plunger *O* engages the sliding jaw *B* and forces it forward, thus cutting off the blank from the ribbon stock and bending it around the mandrel *N*. The jaw *B* is then held stationary while the plungers engage the sliding jaws *C* and *D*, forcing them in and causing them to complete forming the tube around the mandrel. When the ram starts to rise, the jaws *B*, *C* and *D* are forced out by the springs and the tube is stripped from the mandrel by the stripper *S*, the tube falling through the opening in the die-block into a pan placed under the press to receive it. With this die, a press running at 75 or 80 revolutions per minute, and using ribbon stock, can be kept in operation continually. The finished tubes do not interfere with the action of the die in any way, and a very satisfactory rate of production is secured.

Chicago, Ill. A. H. WILSON

PREVENTING BROKEN FEED PINIONS

In MACHINERY for June, 1914, I noticed an article about preventing the breaking of feed pinions by F. Hillix. As instructor in charge of the elementary machine shop at the Lewis Institute, Chicago, I have had the same problem to deal with; and I think we have found a better way of preventing this breakage, and at the same time overcoming a very serious objection to Mr. Hillix's method. It goes without saying that the best way to prevent accidents is to teach a man to be careful. Now how can we teach a student to be careful about throwing in both feeds at once if we make him dependent upon padlocks? Here at the Lewis Institute we have had no greater proportion of such accidents than Mr. Hillix has, and we have no padlocks on our lathes.

In our shop we have a variety of makes of lathes and it has been my experience that lathes having a friction feed of the cone type are the greatest trouble makers in this particular. The reason for this is that the friction disk will work into contact with the friction cone gear while the lathe is being used for thread cutting. It must be remembered that in thread cutting the rack acts as the driver of the feed train, and this reverses the value of the train causing the friction disk to rotate at high speed. Should the friction disk work over and contact be made with the cone gear, something would happen. The first thing that tends to happen is an acceleration of the rest of the feed train. This seems to be too much of a strain and something usually gives way. Among the things I have seen happen are broken feed pinions and



Die made for forming Small Tubes in a Single Operation racks, broken cone gears, broken idlers and change gears, and a broken idler bracket.

The method we use to prevent this trouble was devised by Prof. C. E. DePuy, our superintendent of shops. It consists in introducing a flat spring between the friction disk and the cone gear. This spring holds the friction members apart when the nut is loosened. The spring is made from a circular piece of brass a little smaller in diameter than the friction disk. A hole is made in the center, large enough to clear the stud which pulls the friction disk into contact, and it is cut to form three or four arms which are bent outward to give the proper tension. I am well aware that this method does not prevent the student from throwing in both feeds at once, but I have had very little trouble from that source, as I make it a special point to warn the students of this danger when instructing them about the use of the machine.

La Grange, Ill. Clyde L. Adams

BLUEPRINTS FROM TYPEWRITTEN COPY

It is sometimes required to make a typewritten copy from which a number of blueprints may be made, but if one attempts to make such blueprints from an ordinary typewritten sheet, the result is usually unsatisfactory because the purple or blue ink commonly used on typewriter ribbons offers very little resistance to the passage of light. The result is that the blueprint has a weak and "washed-out" appearance. If, however, the stenographer takes two pieces of black carbon paper and places them face to face with a piece of thin white paper between, and then proceeds to write the copy in the ordinary way, it will be found that the letters, which are black and written on both sides of the sheet, are practically impervious to the passage of light. From a copy prepared in this manner, good clean-cut blueprints can be made.

Harry Foster

THE EFFECT OF A LEAKY PROPELLER HUB

Fig. 1 shows the effects of a leaky propeller hub. To many, the term "leaky propeller" may seem a misnomer, but a propeller hub may be made water-tight to insure safety to the propeller shaft. The steel propeller shaft must be entirely isolated from the salt water by bushing it with bronze and boring out the hub of the propeller large enough to force onto the bronze sleeve, as shown in Fig. 2, leaving about 0.0005 inch per inch of diameter for a force fit on the straight part of the bore. When the propeller is forced on as tight as it will go, a keeper ring should be fitted snugly over the nut and secured solidly to the hub. Having the keys properly fitted and the nut secured, the cap should be fitted carefully to the hub and a ½-inch pipe tap hole drilled in the cap, through which tallow is forced under pressure, filling up every cavity. The same operation should be performed in the cavity of the hub, as shown in Fig. 2. After this is done, plug up the hole, and you will have a water-tight propeller hub. It will be seen in the illustration of the old shaft, Fig. 1, that the diameter of the shaft is reduced nearly 50 per cent from the action of the salt water on the steel shaft. Fig. 3 shows the old propeller removed from this shaft, having been in use for a few years on a hull that was copper sheathed.

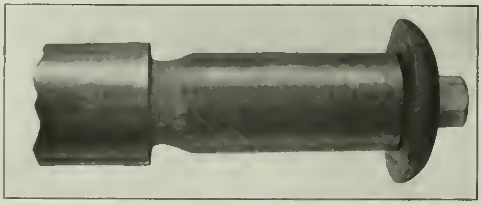


Fig. 1. Damage done to Shaft by having a Leaky Propeller Hub

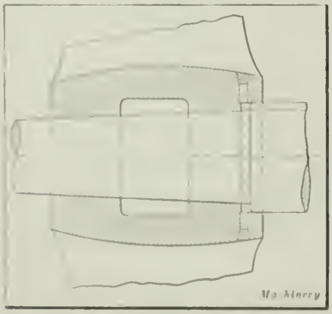


Fig. 2. Method of bushing Propeller Hub to make it Water-tight

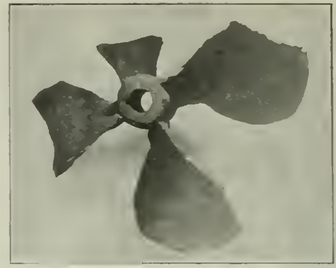


Fig. 3. Old Propeller removed from Shaft shown in Fig. 1

Winter Hill, Mass. N. I. Moshea

GEOMETRICAL CONSTRUCTIONS

To Draw an Arc of Specified Chord Length and Height.—Suppose it is required to describe a circular arc having a specified length of chord and a specified perpendicular height. If it is required to draw such an arc through three points, where space will not allow a beam compass of sufficient length to be used, the arc may be easily drawn by using the following method. In the accompanying illustration *AC* is the length of the chord, and *BD* the perpendicular height of the arc which it is required to draw through the three points *A*, *B* and *C*. The method of procedure is as follows: Cut a piece of board *EFGH* the length of which is equal to *AC* and the width equal to *BD*. Next cut away the corner *JGH* so that the length *JG* is exactly equal to *DC*. Place a pin in the drawing paper at *B* and another at *C* and lay the board in the position shown by the dotted lines. Holding the pencil in contact with the edge of the board close to the pin *C*, and holding the board in contact with the two pins *B* and *C*, push the board in the direction of the arrow, and the pencil will describe one-half of the required arc. The other half may be generated in the same way by placing the pin at *A*.

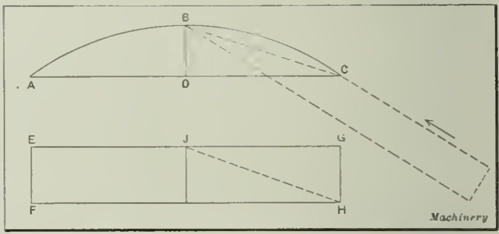


Fig. 1. Method of drawing a Circular Arc of Specified Chord Length and Height

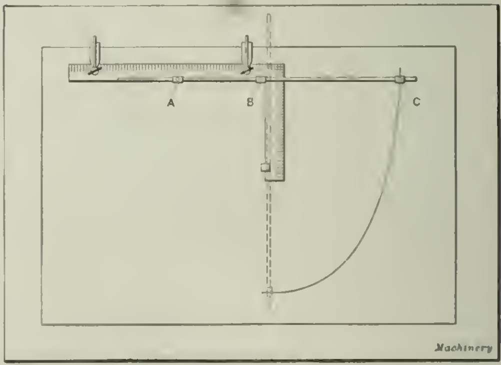


Fig. 2. Method of drawing an Ellipse with Specified Major and Minor Axes

To Draw an Ellipse of Specified Major and Minor Axes.—This problem can be easily solved by the use of a carpenter's steel square and a beam compass. Clamp the square down on the drawing paper with its inside edges lying on the axes of the desired curve and set the beam compass so that the pencil or pen point is located at *C*. The two auxiliary points on the compass are so set that the distance *BC* is equal to the minor axis and the distance *AC* equal to the major axis of the ellipse. The points *A* and *B* should be blunt and smooth so that they may be drawn along against the edges of the square without catching on the drawing paper. The point *B* is drawn along the short leg of the square and the point *A* is kept in contact with the long leg. With the two points *A* and *B* moved along the inner edges of the square in this way, the pencil point *C* will describe the required ellipse.

Hamilton, Ontario, Canada. K. D. McFarlane

STIFF WIRE-CUTTING PLIERS

Needing wire-cutting pliers of the sort in which the wire is inserted in notches, I tested four in one store and eleven in another, and found none that could be opened easily wide enough to admit the wire. It took both hands, or one hand and a knee, to force the pliers open. I found the same trouble with the American and German pliers in Germany.

New York City. Robert Grimshaw

STAYBOLT BORING TOOL

The tool described in this article was designed by the writer for the purpose of rapidly boring out old staybolts from locomotive boilers. The need for a tool of this kind was due to the fact that we were replacing the old-style bolts by the improved flexible type with which most locomotive shop men are familiar. The boring tool is driven by an air motor and the size of the holes bored is 1⅝ inch in diameter. Men who have had experience boring out staybolts with a twist drill used in connection with a ratchet and "old man," will readily understand the value of a tool of the form illustrated. In this connection it might be mentioned that the attempt was made to bore the holes with an ordinary twist drill driven by an air motor, but the result was unsatisfactory.

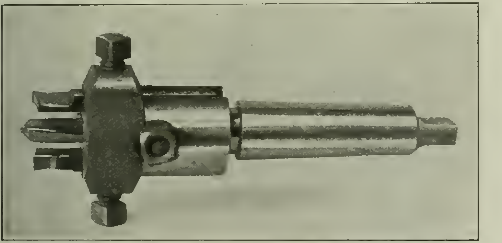


Fig. 1. Special Boring Tool designed for removing Staybolts

The cutters were made of "Novo" steel, which was annealed to provide for turning them to the required size, after which they were alternately backed off on the inside and outside to afford the required clearance. This backing off was performed by throwing the lathe jig in which they were held to be turned 1/16 inch out of center in a plane at right angles to the faces of the tools, first in one direction and then in the other. Made in this way, the life of the cutters was quite satisfactory. One of the side cutters is 5/32 inch wider than the other, and referring to the cross-sectional view of the boiler plates, it will be seen that the smaller cutter works 1/16 inch in advance of its fellow. The purpose of this is to overcome the tendency of the chips to crowd at the point of the tool and fracture it. This boring tool gave very satisfactory results, producing clean-cut holes of exactly the required size; and its cutting capacity may be judged from the appearance of the chips shown in Fig. 2, one of which was 38 inches long.

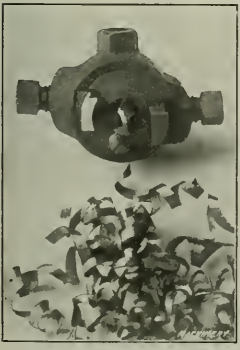


Fig. 2. End View of Boring Tool shown in Fig. 1

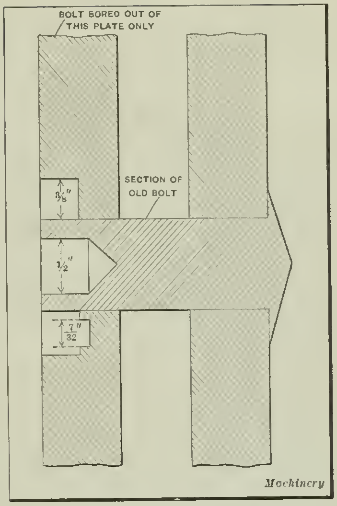
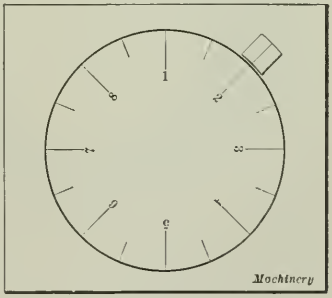


Fig. 3. Section through Boiler Plates, showing Relative Positions of Tools in Operation

Fort William, Ontario, Canada. William Hall

A THREAD INDICATOR KINK

Using a lathe equipped with the usual form of thread indicator, I cut multiple threads by a method which I do not believe is generally known. Suppose a screw with a double thread of ½ inch lead and ¼ inch pitch is to be cut. Evidently the first step is to determine the proper gears to engage for cutting the thread. Now, referring to the illustration of the thread indicator dial, it will be seen that this has sixteen graduations, eight of which are numbered. In the case which we have under consideration, the pitch of the thread to be cut is an even number, *i.e.*, two threads per inch. There are thirty-two teeth on the worm-wheel of the thread indicator, and we will assume that there are four threads per inch on the lead-screw of the lathe. In any case, the number of teeth on the worm-wheel of the thread indicator must be a multiple of the number of threads per inch on the lead-screw; hence, having an even number of threads to cut in the case under consideration, the half-nuts may be closed on any line of the indicator dial, after which the first cut for one thread can be taken. The tool is now withdrawn, the half-nut opened and the carriage returned to the starting point. Then to make the setting for cutting the second thread, close the half-nuts *between* any two lines on the dial and proceed in the usual way.



Dial of Thread Indicator

If it is required to cut a double thread with an odd number of threads per inch, the half-nuts are closed on any one of the numbered lines on the indicator dial and the first cut is taken. The tool is then withdrawn, the half-nuts are opened and the carriage returned, after which the setting for cutting the second thread is on any unnumbered line of the dial. The first thread of a quadruple thread of an odd number is cut with the half-nuts closed when the pointer is on any numbered line. The second thread is then cut by setting on any unnumbered line. The third thread is cut with the pointer on one side of a numbered line, and the fourth thread with the pointer on the opposite side of any numbered line. By this method, it is obvious that only one adjustment of the tool is necessary to take a cut in each thread, and the threads will be accurately spaced.

Burlington, N. J. **Arthur A. Baumgartner**

FRACTION CALCULATOR

When one has become accustomed to its use, a fraction calculator is about as indispensable as a slide-rule and every draftsman, engineer and mechanic should possess one. There are several types of fraction calculators on the market, but these need more or less careful attention while adding or subtracting with them, thus making the operation slower than it need be. A simple form of fraction calculator that I made for myself and that gives me more satisfaction than those sold by different instrument makers, is illustrated and described herewith for the benefit of those who would like to make one like it.

Two brass disks 3 inches in diameter and 1/16 inch thick have a hole in the center to fit a small button headed wood screw, which may be of any convenient size. The bottom disk also has a hole drilled in it with a No. 43 drill, this hole being 1⅜ inch from the center hole; and there are also two countersunk holes for small, flat-headed wood screws. By means of these wood screws, the bottom disk is secured to a piece of board 4½ inches square and ½ inch thick. The top disk has sixty-four holes drilled in it with the No. 43 drill, these holes being equally spaced on a circle 2¾ inches in diameter, or at a distance of 1⅜ inch from the center hole. An arrow is marked with black ink from the center hole to any one of the sixty-four holes. This disk is then laid on top of the bottom disk and a small button headed wood screw is driven into the board through the two disks, this screw serving as a stud around which the top disk is allowed to turn freely.

The next step is to take a piece of cardboard 4½ inches square by ⅛ inch thick, with a hole 3 1/16 inches diameter cut in the center of it, and glue it on top of the board in order to bring the face of the scale, which is drawn on a piece of drawing paper and glued to the cardboard, level with the face of the top disk. It will be seen that this scale is graduated in sixty-fourths and that there are two concentric scales that run in opposite directions. The scales may be marked in black ink, or in order to avoid confusion, the ½, ¼ and ⅛ graduations are marked in black in the usual way, while the 1/16, 1/32 and 1/64 graduations have their denominator left off entirely, only the numerators being shown and these printed in different colors. For instance, the sixteenths may be written in green, the thirty-seconds in orange and the sixty-fourths in red ink. The heavy black marks opposite 0, ½, ¼ and ⅛ graduations will aid in locating the sought fractions.

Fig. 1 shows the fraction calculator completely assembled; Fig. 2 shows a cross-sectional view; and Fig. 3 shows the calculator with the top disk removed to show the location of the "stop-hole" in the bottom disk with respect to the zero on the scales. It has already been mentioned that the fractions on the two scales run in opposite directions. To operate this fraction calculator, a pencil is inserted in the hole in the disk to which the arrow points and the disk is then turned with the pencil in place until it stops on account of the pencil point dropping into the hole in the bottom disk. This brings the arrow to the zero point. The outside scale is used for adding, and the inside scale for subtracting and for obtaining the result of the addition or subtraction of several fractions.

To make the method of operation clear, let us take a specific example. Suppose we wish to add 41/64, 9/16 and 25/32. After the arrow has been brought to the zero point, insert the pencil in the hole in the top disk opposite 41/64 on the outer scale and turn the disk to the left until it stops; then insert the pencil in the hole opposite 9/16 on the outer scale and again turn the disk to the left until it stops; repeat this operation for the 25/32 graduation. The arrow will now point

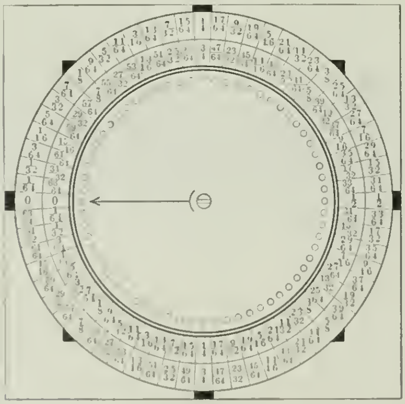


Fig 1

Fig 2.

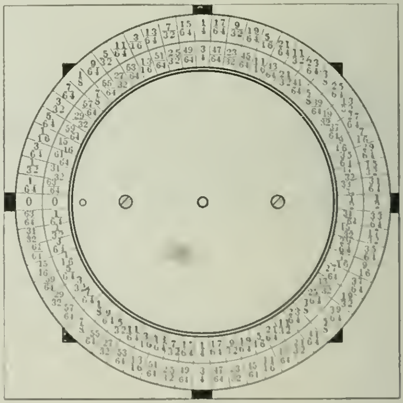


Fig 3.

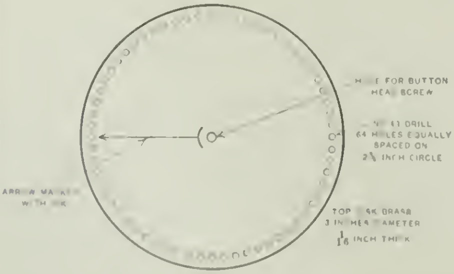


Fig 4

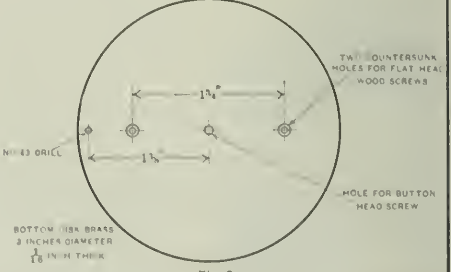


Fig 5

Machinery

Figs. 1 to 5. Design of and Method of operating an Improved Fraction Calculator to the sum of these three fractions, which is read on the inside scale and is in this case 63/64. It will be observed that the arrow has passed the zero mark once, which means that one whole number must be added to the indication of the calculator, thus making the required answer 1 63/64.

When using the calculator to subtract fractions, the fractions are taken on the inside scale and the disk is turned to the right. The answer is always found on the inside scale. It must be remembered that in subtracting, the first fraction is always positive and must be taken on the outside scale. For example, suppose it is required to subtract 15/32 from 53/64. Bring the arrow to the zero point and then take 53/64 on the outside scale and turn the disk to the left until it stops, after which take 15/32 on the inside scale and turn the disk to the right until it stops. The arrow will then point to the answer, which in this case is 23/64. Any number of fractions may be added or subtracted in this way and by observing the number of times the arrow passes the zero, the whole numbers may be incorporated in the result. When the arrow passes the zero when the disk is turned to the right, it will be evident that the whole number must be subtracted from the result instead of added to it.

The disk may be turned to the stop in either direction, the shortest distance being chosen; but when adding or subtracting a number of fractions, it is more difficult to ascertain the whole numbers completed. It is therefore safer to turn the disk in the direction mentioned. In order to prevent the scale from getting soiled, it may be given a coat of shellac or covered with a sheet of thin transparent celluloid with a hole the size of the brass disk in the center. A cardboard cover will also be found useful to protect the calculator when not in use.

Kewanee, Ill. Franz Szabo

AUTOMATIC SHUT-OFF ON B. & S. AUTOMATIC SCREW MACHINE

One of the convenient and, at times, most important features of the Brown & Sharpe automatic screw machine is the provision for automatically shutting off the machine when the bar of stock is exhausted. The same mechanism also rings a bell to notify the operator. As every operator knows, the device is not made use of as often as it should be. In visiting various automatic screw machine departments the writer found that only a small percentage of operators really understood the adjustment of the automatic shut-off, and as nothing has ever appeared in print, either in hand-books or in the technical publications, the writer desires to offer a description of the mechanism and also some suggestions in regard to its adjustment.

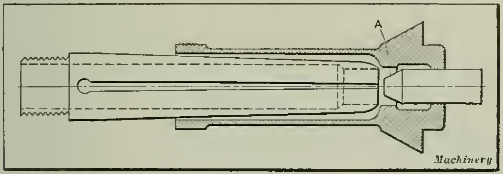


Fig. 1. Diagram showing Danger of grinding too Large a Bevel on the Crop End of the Stock

In many instances, when the bar of stock is exhausted and the crop end escapes from the feed-finger, if the machine is not shut off the end of the feed-finger inside the spring collet will press on the end of the wire which (when small) will be bent. The result is that when the box-tools, threading die, or other tools approach, they will not engage properly with the work, and as a result will be broken. As one tool has not prepared the work to be operated on by the following tool as it should, in a few minutes the entire tool setting is displaced, including the cross-slide circular tools which will probably turn down or break when they are fed into the bent stock.

In the case of larger bar stock, ranging from ¼ to 1 inch in diameter, the crop end may not provide enough surface to be clamped tightly in the collet and for this reason will cause damage. In this connection the writer will call attention to the fact that most operators grind a large bevel on both ends of the bar before inserting it in the machine. The front end is beveled so it will readily enter the feed-finger and collet, and the other end so that there will be no corners or burrs to prevent the crop end from being ejected (by hand) from the collet. Fig. 1 shows why the rear end of a bar of stock should not have a bevel larger than sufficient to dress off the corner. As seen at *A*, the large bevel does not prevent the feed-finger from feeding and pushing the crop end, but it does reduce the surface for clamping in the spring collet.

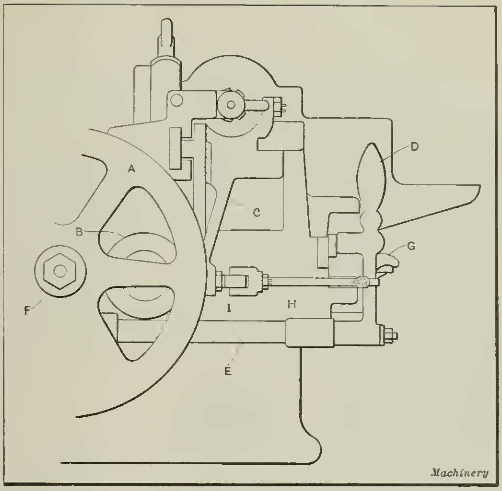


Fig. 2. End View showing Arrangement of Drive and Feed Mechanism

Fig. 2 shows an end elevation of the No. 00 and No. 0 machines, and although the feeding mechanism of the No. 2 machine is slightly different, the following description will answer for all. The pulley for driving the machine is shown at *A*, the cam-shaft for operating the feeding of the stock at *B*, and the lever that operates the feed-tube at *C*. The starting and stopping lever is shown at *D;* this lever oscillates the shaft *E* which operates a clutch on the driving shaft *F*. Fig. 3 is a plan view of the automatic shutting-off lever, but the bell *G* is shown as a side view. When the machine is out of stock, the feeding lever *C* throws back (in the direction of the arrow) a little further than usual, because the feed-finger, being empty, is not held back by the friction of sliding over the stock. Having gone back far enough, the pin *I* catches on the corner of the hardened steel block *J* (notice the compression spring *O*) so that when the lever *C* returns, it operates the arm *H* that pivots on pin *K*, and the adjustable screw *L* then pushes over the starting lever *D*, thus shutting off the machine. When lever *C* again moves forward the arm *H* is released and quickly returned to its former position by the spring *M*, thus causing the clapper *N* to ring the bell. From the above description it will be seen that a little care on the part of the operator in adjusting the screw *P* and lock-nut *Q*, and also the set-screw *L*, will save a great amount of time in readjusting and repairing of tools. E. Whitney

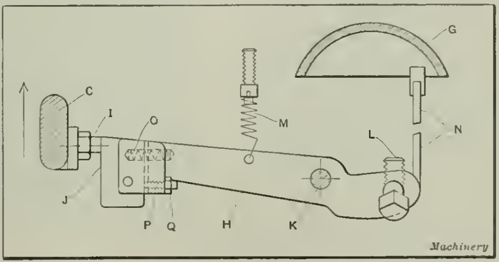


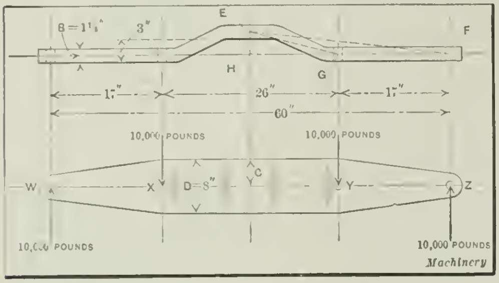
Fig. 3. Plan View showing how Automatic Shut-off Mechanism operates

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

DETERMINING THE STRESSES IN AN OFFSET BEAM

A. H. P.—Will you please suggest a method by which the stresses in the section between X and Y of the offset beam shown in the accompanying illustration may be calculated? A thickness of the beam of 1¼ inch has been arbitrarily assumed; and an offset at the center of 3 inches. What would be the maximum fiber stress between X and Y, assuming the width of the beam to be 8 inches; or what method would you suggest to determine the width, assuming a stress of 16,000 pounds per square inch to be allowable?



Offset Beam in which Stresses are to be determined

Answered by William L. Cathcart

The correspondent does not state the nature of the loads—whether live or static—or the exact character of the supports of the beam. If the latter is rigidly attached to pins at W and Z, its supports will be restrained with a corresponding effect on the deflection and stress. If, on the contrary, the sockets at W and Z are a loose fit, so that the beam will be free to deflect there, it may be treated as a simple beam, *i.e.*, one which is freely supported. In the following, a simple beam, with static loads, will be assumed. We have, then, a simple beam, 1¼ inch thick and 60 inches long, supported at W and Z, and carrying two loads of 10,000 pounds, each one at a distance of seventeen inches from each support. Between the points of application, X and Y, of these loads, the beam is offset for a distance of three inches. Since the loads are equal and equally distant from the nearest support, the reaction at each support is 10,000 pounds. As the lines of action of the loads and reactions all lie in the same central plane passing through WZ, there is no turning moment to twist the beam. Hence, the latter may be treated for each section considered, as a simple beam, if due regard be given to the distances of the loads and reactions from that section. The maximum stress will occur at the middle section E of the beam. The bending moment M at that section is equal to the moment of either reaction about that section, minus the moment about the section of the load nearest to the reaction considered. Draw the lines EF and EG. Then, in the right-angle triangle EFH, the side $EH = 3$ inches and $HF = 30$ inches.

$$EF = \sqrt{30^2 + 3^2} = 30.2 \text{ inches.}$$

$$EG = \sqrt{13^2 + 3^2} = 13.4 \text{ inches.}$$

The moment of the reaction at F about the middle section at E is then found to be:

$$10{,}000 \times 30.2 = 302{,}000 \text{ pound-inches.}$$

The corresponding moment of the load at Y is:

$$10{,}000 \times 13.4 = 134{,}000 \text{ pound-inches.}$$

The bending moment at section E is then calculated as follows:

$$M = 302{,}000 - 134{,}000 = 168{,}000 \text{ pound-inches.}$$

The fundamental formula for the bending moment is:

$$M = \frac{SI}{C} \qquad (1)$$

where S = safe unit stress;
I = rectangular moment of inertia;
C = distance of remote fibers from the neutral axis.

For a rectangular section, as in the case of the beam under consideration:

$$I = \frac{BD^3}{12}$$

where B = width of beam = 1¼ inch;
D = depth of beam = 8 inches.

$$I = \frac{1.25 \times 8^3}{12} = 53.3.$$

Finally, the neutral axis of the cross-section at E evidently passes through the middle of that cross-section and hence

$$C = \frac{8}{2} = 4 \text{ inches.}$$

Substituting in Formula (1) gives:

$$M = 168{,}000 = \frac{S \times 53.3}{4}.$$

$$S = 12{,}603 \text{ pounds per square inch.}$$

This is the maximum stress at the middle section E of the beam. When the allowable stress is given, Formula (1) becomes:

$$S = \frac{MC}{I} \qquad (2)$$

Thus, for an allowable stress of 16,000 pounds per square inch at section E, we have, with M as before:

$$S = 16{,}000$$

$$C = \frac{D}{2}$$

$$I = \frac{1.25D^3}{12}.$$

Substituting in Formula (2) we have:

$$16{,}000 = \frac{168{,}000 \times \dfrac{D}{2}}{\dfrac{1.25D^3}{12}}$$

$$D = 7.1 \text{ inches} = \text{depth of beam at section } E.$$

The depth at any other section between X and Y can be determined similarly by finding the value of the bending moment M for the section considered, from the altered values for the distances corresponding with EF and EG. The weight of the beam has not been considered in these calculations, since it is small as compared with the loads. If this weight were taken into account, the magnitude of the stress S in the first case would be a little greater than 12,603 pounds, and, in the second case, the depth D would be a trifle more than 7.1 inches. The discrepancy in either case is immaterial. This method of solution may possibly be open to some slight criticism, owing to the angle between the vertical planes passing through the lines EF and EG, in which lines the two moments act. The method is, however, sufficiently accurate for all practical purposes in this case, as the angle is small.

* * *

ACCIDENTS CAUSED BY REVOLVING SHAFTING

Attention has frequently been called to the dangers of revolving shafting. The dangers from set-screws and other projections are fairly well understood, but it seems difficult to convince some people, says the *Travelers' Standard*, that at points remote from belts and pulleys there are any hazards associated with smooth shafting which has no projections of any kind upon it. Nevertheless, serious and even fatal accidents are of frequent occurrence, due to the clothing or hair of persons coming in contact with the shafting and being wound up upon it. To guard against such accidents, shafting seven feet or less from the floor should preferably be completely boxed in or if this is not feasible a loose sleeve should be placed upon it so that the sleeve can remain stationary while the shafting revolves inside of it.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

TOLEDO BUTT AND SPOT WELDERS

The machine shown in Fig. 1 is a special butt welder by means of which extreme accuracy can be obtained. This is due to the exceptionally heavy clamping mechanism which holds the work; and to the fact that the work is clamped in place before the welding dies are brought into contact with it, thus avoiding the possibility of misplacing the work before it is secured. The machine shown in Fig. 2 is a special spot welding machine adapted for welding heavy work.

In the manufacture of spinning machines the Saco Lowell Shops, Biddeford, Maine, find it necessary to turn shafting of the form shown in Fig. 3; and these shafts cannot be turned and ground with the required degree of accuracy in pieces over 2 feet in length. The shafts vary from ¾ to 1¼ inch in diameter, and after the short pieces have been turned and ground they are assembled in lengths of 30 or 40 feet. This was formerly done by drilling and tapping the ends of the sections and then inserting threaded pins to hold them together; but this method was found unsatisfactory as it was extremely difficult to make up a 40-foot shaft and have it fulfill all requirements in regard to strength and alignment.

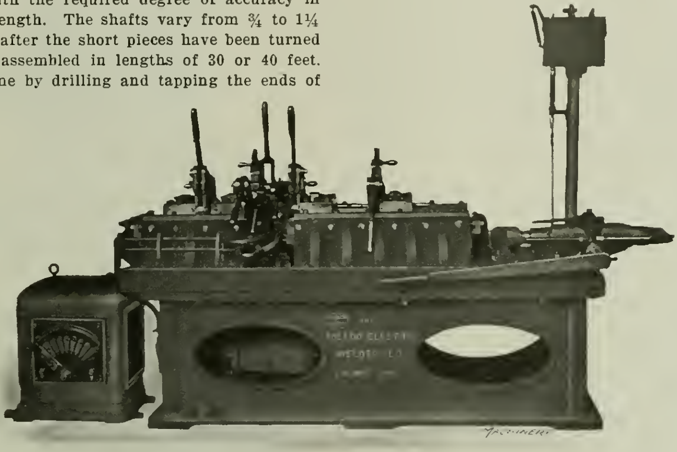


Fig. 1. Toledo Butt Welding Machine for welding together Sections of Shaft shown in Fig. 3

It was finally decided to try connecting the sections of which these shafts are composed by electric welding, and the Toledo Electric Welder Co., Langland and Knowlton Sts., Cincinnati, Ohio, was commissioned to built an electric welding machine for this purpose. The specifications called for the production of shafts 40 feet in length, in which the error in alignment or concentricity could not exceed 0.004 inch. The machine shown in Fig. 1 was finally developed for this purpose, and on the first test, rods were made that more than fulfilled the specifications in regard to accuracy.

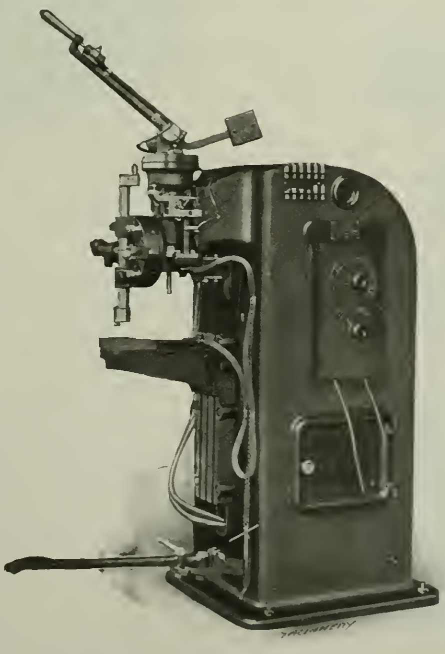


Fig. 2. Toledo Spot Welding Machine

The extreme degree of precision obtained with this machine is largely due to the fact that the clamping mechanism is so heavy that there is no perceptible spring in any part of the machine after the work is clamped in place and the pressure is applied to force the ends of the work together. Two sets of steel clamping dies are provided on each slide to clamp the work at two points, so that absolute alignment is secured. The clamps are adjustable for the whole length of the slides, and the slides operate in V-ways provided with adjustable tapered gibs. Four "floating" copper dies conduct the electric current to the work, and they are arranged in such a way that no strain is developed upon the work which might tend to throw it out of alignment. This result is obtained by bringing the dies up to the work after it has been clamped in position. The electric current is turned on by a switch, and in about fifteen seconds the ends of the work are heated to the welding temperature. When this result has been obtained, a "pumping" motion on the lever-handle, which will be seen at the front of the machine, operates a five-ton hydraulic ram that forces the ends of the semi-molten work against each other and produces a perfect weld. The copper dies are then withdrawn from the work and the clamps are released, after which the machine is ready to make the next weld. The clamping of the work and the actual welding is completed in from fifty to sixty seconds, and the work is concentric to within from 0.002 to 0.003 inch in its entire length. The small amount of flash left on the stock where the weld was made is turned down on a lathe.

The principal dimensions of the machine are as follows: capacity for welding stock from ⅞ to 1¼ inch in diameter; pressure with which ends of work are forced together, 5 tons; maximum power required by the machine, 40 kilowatts; height from floor to center of dies, 35½ inches; floor space occupied by machine, 29 by 80 inches; and weight, approximately 7500 pounds.

Fig. 2 shows a special spot welding machine which is another recent product of the Toledo Electric Welder Co. This machine was built for heavy work, and as the parts to be welded are too heavy to be handled conveniently, means are provided for making the welds without changing the position of the work. Three different dies are used on the machine without changing the work after it has once been set up. The upper part of the machine is arranged with the die points mounted on a swiveling head. A weld is made with one die, after which the next die is swung around to engage the work in a different position, and after the

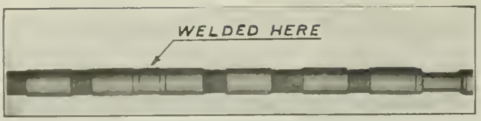


Fig. 3. Section of Work to be welded

weld has been made with this die the third die is employed to make a weld in still another position. All three welds are made within a radius of 4 inches. The work is then removed and the next pieces set up ready to be welded. This machine was designed for welding stock 5/16 by 5/16 inch in size, and takes the place of riveting which was formerly employed. The actual time consumed in making the three welds required on each piece of work is 12 seconds—including the shifting of the dies.

LANGELIER SHRAPNEL MACHINES

These are special drilling machines for shrapnel work. The machine shown in Fig. 1 is used for drilling aluminum shrapnel stems. Fig. 2 illustrates a machine employed for drilling four vent holes through a brass nut simultaneously. The machine shown in Fig. 3 is employed for drilling a 3/16-inch and a 3/8-inch tap hole simultaneously.

The machines illustrated in Figs. 1, 2 and 3 have recently been built by the Langelier Mfg. Co., Providence, R. I., for drilling the shrapnel parts shown in Fig. 4.

Automatic Vertical Drilling Machine

The vertical drilling machine illustrated in Fig. 1 is provided with automatic feed and is employed for drilling the 0.150-inch hole in the upper face of aluminum shrapnel stems *A*, Fig. 4, the rate of production being twelve pieces per minute. Another machine of similar type, which is equipped with suitable fixtures, drills the angular hole in the side of the stem. The machine shown in Fig. 1 is continuous and semi-automatic in operation. It is equipped with eight spindle units equally disposed around and contained in a single casting, which is rotated from left to right around the main vertical shaft to bring each spindle unit successively in front of the operator for the removal of finished parts and the setting up of fresh blanks in their place. Each spindle unit is provided with its own drill spindle and driving mechanism, in addition to a work-holding table fixture and table slide. The spindles are driven by a "Fabroil" gear meshing with cut steel, heat-treated pinions on the spindles. The tables on which the work is supported are fed up to the drills by a stationary cam around the base of the machine. The upward feed of the table continues until the hole has been drilled to the required depth, when the table quickly recedes from the drills and pauses in its lowest position to give the operator just sufficient time to take the finished piece out of the fixture and insert a fresh blank. The machine is equipped with an automatic oil pump; the floor space occupied is 41 by 28 inches, and the weight of the machine is 2250 pounds.

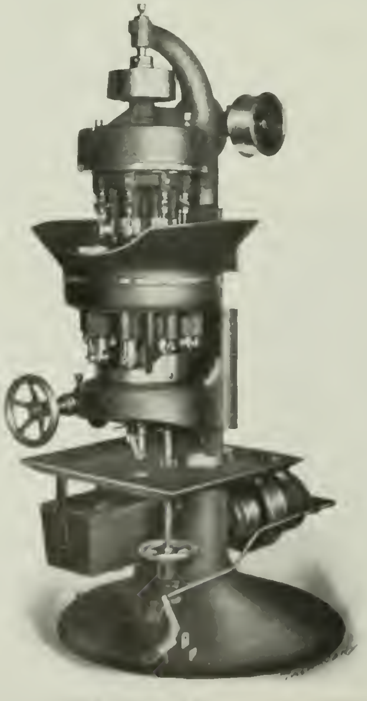


Fig. 1. Langelier Vertical Machine for drilling Aluminum Shrapnel Stems

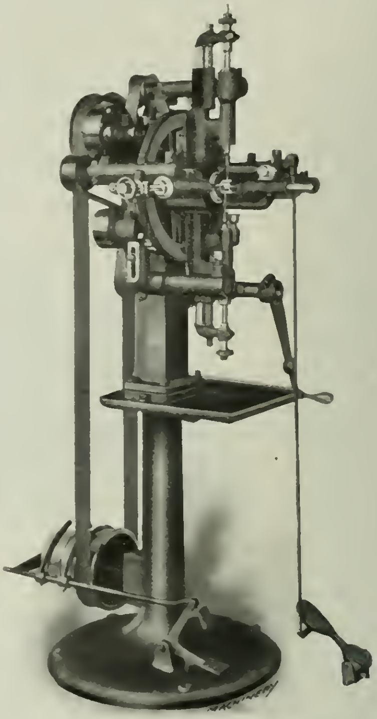


Fig. 2. Langelier Four-spindle Machine for drilling Vent Holes in a Brass Nut

Four-spindle Drilling Machine

The machine illustrated in Fig. 2 is employed for drilling the four 0.110-inch vent holes through the small neck of the brass nut *B*, Fig. 4. These holes are drilled simultaneously from the four sides, the output being about ten nuts per minute. This machine is constructed on the same general principle as the Langelier four-spindle drilling machine which was described in MACHINERY for April, 1913. The work is held on a supporting arbor, the outer end of which is recessed to receive a tongue on the nut, and is locked firmly in position by a plunger which has its outer end formed to correspond with the profile of the work. This plunger is operated by means of a foot treadle. To feed the four spindles and their drills into the work, the operator raises the hand lever at the right-hand side of the machine through a quarter turn, which rotates the feed cam that feeds the four spindles in toward the work. After the drilling operation has been completed, the spindles and the clamping plunger recede automatically.

Six-head Vertical Drilling Machine

The machine shown in Fig. 3 is used for drilling the 3/16- and 3/4-inch tap drill holes in the part shown at *C*, Fig. 4, at a single operation. The rate of production is about ten bushings per minute. The machine consists essentially of a vertical turret carrying six multiple drill heads, each of which is equipped with two spindles, a work-holding table fixture, and vertical table feed-slide, all operating in unison and revolving continuously from left to right around the vertical stationary post. In this way each of the drilled shrapnel bushings is brought to the front or loading and unloading position, where the drilled bushing is removed from the fixture and replaced by a fresh blank. The drill heads are driven by a large central gear keyed to the vertical driving shaft, which meshes with the "Fabroil" gears on the spindles. The feed is accomplished by the upward movement of the tables, which is secured through the contact of a roller on each table with a stationary feed cam. The tables may be adjusted vertically to compensate for wear of the drills.

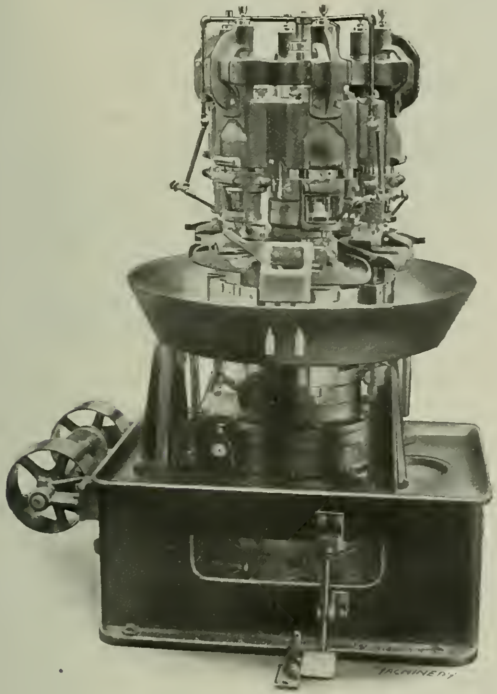
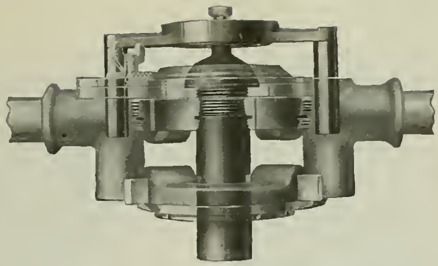


Fig. 3. Langelier Machine for drilling 3/8- and 3/16-inch Tap Drill Holes simultaneously

BORDEN CROSS-BAR DIE-STOCK

The accompanying illustration shows the "Beaver" cross-bar die-stock which has recently been added to the line of products manufactured by the Borden Co., Warren, Ohio. This tool has capacity for threading pipe from ½ to 1¼ inch in diameter. The most distinctive feature consists of a bar extending across the top of the tool which carries a plug that rests on the end of the pipe to be threaded, and controls the opening of the finishing die.


"Beaver" Cross-bar Die-stock made by the Borden Co.

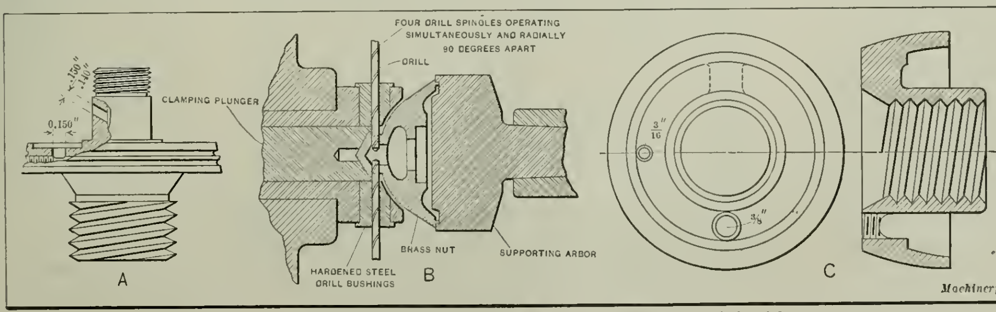
The dies are made in two sections. The lower die section does the rough work of starting the thread on the pipe and is provided with teeth especially formed for handling this work satisfactorily. While starting the cut, the die remains stationary, but after the upper die section begins to cut, the lower die gradually opens until it no longer touches the pipe. The upper die section consists of a narrow receding die which opens as the thread is cut to produce the required taper. The second die section follows the partial thread cut by the first section, which reduces the labor required for turning the die-stock and insures a correct pitch for the thread.

The principle on which this die-stock operates is as follows: In starting, the swivel plug extends down between the dies to the bottom of the upper die section. The threading operation is conducted in the usual way, and when the work of the lower stationary die is completed the end of the pipe comes into contact with the swivel plug, raising it as the second set of dies starts to cut. The raising of the plug lifts the side posts, turns the die cam, and gradually opens the dies to provide for cutting the thread on the required taper. When the threading operation is completed, the dies are released so that no backing off is necessary.

To re-set the dies for cutting another thread, the cross-bar is simply pushed down to the bottom of its movement, which brings the dies into position ready for starting the next operation. The body of the tool is made in practically one piece with wide openings to allow the chips to clear freely; and this also provides plenty of space for oiling. A universal guide centers all sizes of pipe from ¼ to 1¼ inch. This die-stock is regularly furnished with double-end reversible dies for threading all sizes of pipe from ½ to 1¼ inch in diameter; and extra dies may be obtained for threading ¼- and ⅜-inch pipe. All sizes of dies are provided to cut either right- or left-hand threads.

BROWN & SHARPE PLAIN GRINDING MACHINE

In the February, 1914, number of MACHINERY announcement was made of the development of a No. 11 plain grinding machine by the Brown & Sharpe Mfg. Co., Providence, R. I. The design of this machine has recently been improved by


FOUR DRILL SPINDLES OPERATING SIMULTANEOUSLY AND RADIALLY 90 DEGREES APART
DRILL
.150"
.140"
CLAMPING PLUNGER
0.150"
A
HARDENED STEEL DRILL BUSHINGS
BRASS NUT
SUPPORTING ARBOR
B
3/16"
3/8"
C
Machinery
Fig. 4. Shrapnel Parts drilled by Langelier Machines illustrated in Figs. 1, 2 and 3

making certain changes in the drive, and independent automatic cross-feed has also been provided. The capacity is the same as formerly, i. e., for work up to 32 inches in length by 6 inches in diameter.

The machine is driven by a single pulley carried at the end of a main driving shaft which runs in two taper roller bearings bolted to the frame of the machine at the rear. This pulley runs at 900 revolutions per minute and is driven by a 3-inch belt from a simple countershaft equipped with one tight and loose pulley, and one driving pulley. A large pulley located near the center of this main driving shaft drives the wheel spindle by means of a 3-inch belt which runs over two idler pulleys. Changes of wheel speed are obtained by means of split pulleys of various sizes that can be quickly interchanged. The idler pulleys run on taper roller bearings which are supported in a heavy swinging bracket so constructed that it follows the traverse movement of the wheel stand and maintains the desired tension upon the driving belt regardless of the position of the grinding wheel. In this way accurate feeding of the wheel is insured under all conditions. The slack in the belt, due to the difference in the diameter of the pulleys which are employed for different wheel speeds, is taken care of by the upper idler pulley which is provided with independent adjustment, making it possible for the operator to obtain any desired belt tension. The arrangement of this drive will be readily understood by referring to Fig. 2.

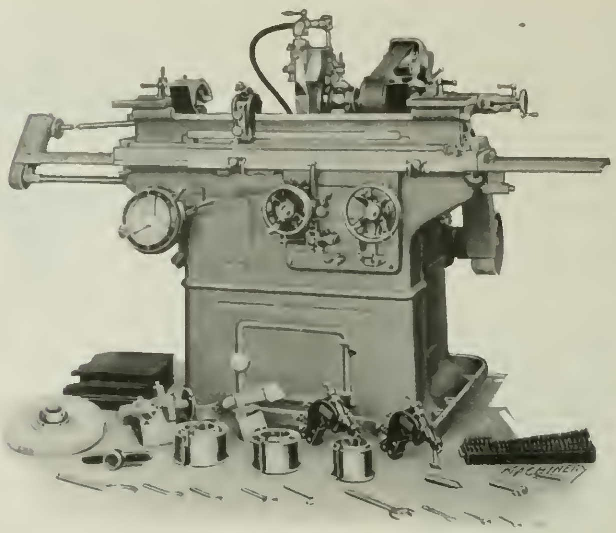


Fig. 1. Improved Brown & Sharpe No. 11 Plain Grinding Machine

In this improved No. 11 B. & S. plain grinding machine, the table traverse movement is driven by the sprocket *A*, Fig. 2; this sprocket is located on the speed case and drives the sprocket *B* on the table traverse reversing mechanism which is self-contained in a case in the bed of the machine. The headstock is also driven from the speed case by a sprocket *C* which transmits the power to the intermediate sprocket *D* that acts as an idler, and from which the drive is transmitted to the splined sprocket *E*. A splined shaft, supported in bronze bearings under each end of the work-table, slides in the splined sprocket *E* and drives the headstock through a chain and sprockets, a telescopic shaft and universal joints. The splined and telescopic shafts are clearly shown at the end of the table in Fig. 1. The work driving plate is mounted upon a sprocket running on tapered roller bearings around a fixed spindle which firmly holds the dead center in such a manner as to become practically an integral part of the head.

All chain drives throughout this machine are of the silent type, eliminating slippage but providing the desired flexibility and giving a smooth, steady drive; and easy means of adjustment are provided in all cases. The tapered roller bearings used are of an adjustable type and are lubricated by means of grease cups. The machine is equipped with the simple and efficient work speed and feed change mechanism which has already been described. The control is by means of three levers grouped around a dial mounted at the left-hand end of the machine within easy reach of the operator, as shown in Fig. 1. The lever marked "head" controls the speed of the headstock or rotation of the work. The lever marked "table" changes the rate of table traverse. The third lever serves to instantly start or stop both the work and table simultaneously without stopping the rotation of the grinding wheel. The dial is graduated in revolutions per minute of the work-head, and in inches per minute traverse of the table. The convenience of this type of work speed and feed change mechanism, and the way in which it is controlled will be appreciated by any grinding machine operator.

Another feature which has been added to this machine is the independent automatic cross-feed, which enables the wheel to be fed automatically into the work without traversing the table. This feature is especially useful when the work to be ground is not as wide as the grinding wheel, as by feeding the wheel straight in, a marked increase in the rate of production is secured. This independent automatic cross-feed is driven by the table traverse mechanism and operates the ratchet arrangement of the regular automatic cross-feed. As a result, the full number of changes of feed that can be made with the regular cross-feed mechanism are available. These may be increased or decreased by changing the speed of the table traverse with the table traverse feed mechanism, thus providing practically a universal selection of feeds from the coarsest to the finest that are required in practice. The provision of this wide range of independent cross-feeds has added greatly to the efficiency of the machine in grinding narrow surfaces. A positive safety lock is provided to prevent throwing in the table traverse when the cross-feed is in operation

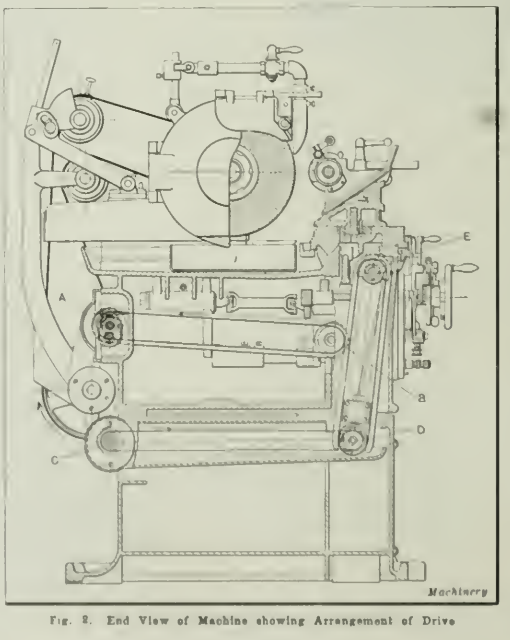


Fig. 2. End View of Machine showing Arrangement of Drive

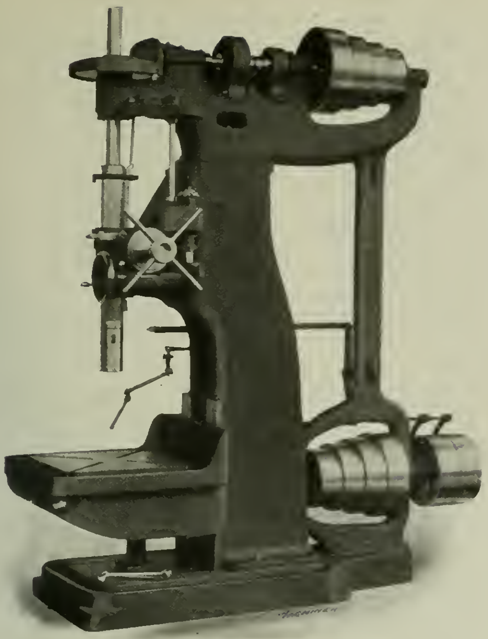


Fig. 1. Cincinnati-Bickford "Hercules" Drilling Machine

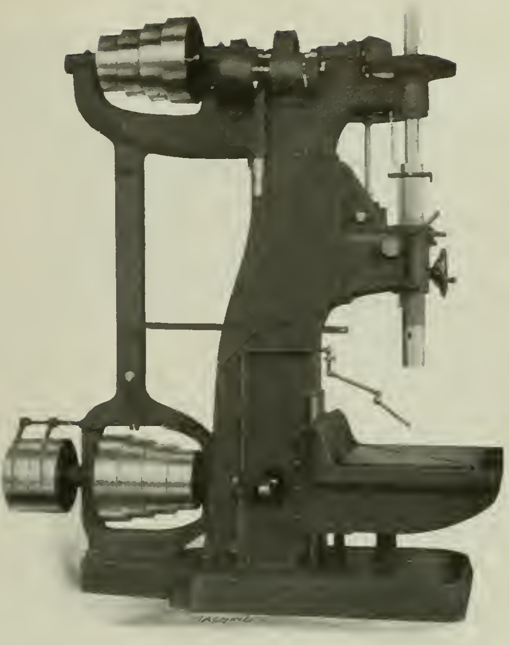


Fig. 2. Opposite Side of Cincinnati-Bickford Drill shown in Fig. 1

CINCINNATI-BICKFORD "HERCULES" DRILL

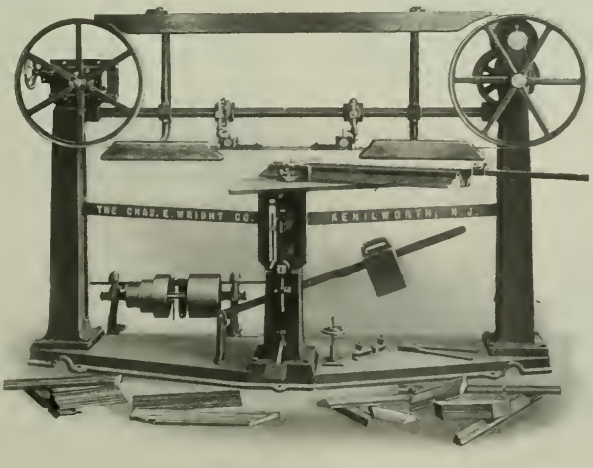
The Cincinnati Bickford Tool Co., Oakley, Cincinnati, Ohio, has recently added to its line of drilling machines the "Hercules" upright drill which is illustrated in Figs. 1 and 2. Reference to these illustrations will show that the column of the machine is of box construction; and it will also be evident that the entire construction of the machine is unusually massive. The standard machine of this design is equipped with four-step cone pulleys which provide eight spindle speeds, four of which are direct and four through the back gears. The bevel driving pinion on the cross-shaft is of high-carbon steel, while the bevel gear on the drill spindle is made of a special metal mixture containing a liberal quantity of steel so that the gear is strong and durable. The spindle is made from a high-carbon steel forging; it is 2 9/16 inches in diameter in the spindle sleeve and 2 7/16 inches in diameter above the sleeve. The spindle is bored No. 5 Morse taper and has a maximum vertical travel of 18 inches.

The largest step on the cone pulleys is 16 inches and the smallest 10.9 inches in diameter; and these pulleys carry a 4-inch belt, which gives ample power. The tight and loose pulleys are 14 inches in diameter; they carry a 4½-inch belt and run at 545 revolutions per minute. The table is of massive construction and supported from the base by means of a screw support in addition to being clamped to the column. It is provided with grooves or channels of liberal proportions to take care of the lubricant which is delivered to the drill. The vertical travel of the table is 12 inches, and the maximum height of the table from the floor is 30 inches. The maximum distance between the spindle and the table is 31 inches.

This drilling machine will drill to the center of a 30-inch circle. Spindle speeds of 50, 65, 83, 108, 139, 180, 232 and 300 revolutions per minute are available, and six changes of feed are provided ranging from 0.007 to 0.049 inch per revolution. The total height of the machine is 8 feet 9 inches and its weight 5100 pounds.

WRIGHT HORIZONTAL BAND SAW

The 30-inch horizontal band saw illustrated herewith is a recent product of the Charles E. Wright Co., Kenilworth, N. J. This machine is particularly adapted for cutting all kinds of metal-covered fireproof molding, small angle irons, tube stock, and similar classes of work. It will be seen that the blade runs over two pulleys which are mounted on horizontal shafts placed far enough apart to enable the blade to be given a quarter turn so that it cuts in a vertical plane. The blade is held in position and guided through the work by two non-friction guides fitted with extension jaws. These jaws are made of phosphor-bronze and provided with automatic lubricators which keep the blade perfectly cool at



Wright Thirty-inch Horizontal Metal-cutting Band Saw all times. The guides are adjustable toward and away from the work.

The work-table feeds to the saw by the action of gravity on a weight, the position of which may be adjusted on the lever to vary the rate of feed according to the size or weight of the work which is being cut by the machine. The position of the table can be quickly adjusted to bring the work into position ready to start the cut by means of a foot treadle. The table may be tilted to a given angle on either the right or left of the center, in order to avoid the saw coming in direct contact with a flat surface; and the vise in which the work is held can be set to any required angle for making miter cuts, or the work can be cut off square.

The machine is driven from the driving shaft by either tight or loose pulleys for constant speed drive, or a cone pulley for variable speed. The driving shaft is back-geared in the ratio of 4 to 1. If so desired, either a direct or alternating current motor may be attached directly to the driving shaft. The floor space occupied is 9 feet by 5 feet 6 inches, and the weight of the machine 1500 pounds.

BLANCHARD MAGNETIC CHUCK

The most noteworthy features of this chuck are the fact that the body is machined from a single forging, all of the poles being connected by a web of metal so that water cannot find its way through the face of the chuck to the windings; and that the space between each of the main poles is subdivided by three intermediate poles. The intermediate poles assist in carrying the magnetic flux when the chuck is used for holding thin work, and add to its holding power.

The Blanchard Machine Co., 64 State St., Cambridge, Mass., is now manufacturing the circular magnetic chuck which forms the subject of this article. This chuck is of the "fine-divided" type, and the poles are all formed on a single steel forging, as shown in the cross-sectional view, Fig. 2, which makes the working face of the chuck absolutely water-tight and very rigid. Only four coils are used, but each coil energizes four ring poles which are so closely spaced that a piece of work the size of a nickel will touch two poles, no matter where it is placed on the working face of the chuck. The sixteen ring poles of the chuck are all concentric. The cross-sectional view shown in Fig. 2 is taken on a radial line from the center of the chuck, and all such sections would be identical. It will be seen that the construction amounts to a series of four ironclad magnets nested one inside of the other, the shell of one magnet serving as the core of the next magnet on the outside.

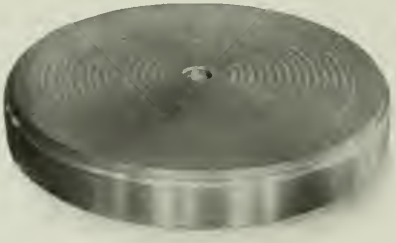
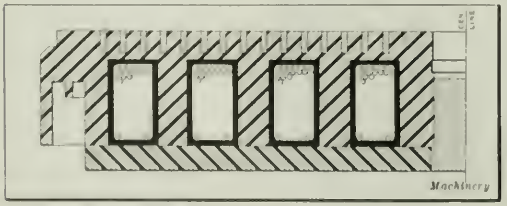


Fig. 1. Blanchard "Fine-divided" Type of Magnetic Chuck

It will be evident from Fig. 2 that the forging which forms the body of the chuck is in the form of a disk which has four large concentric grooves machined in one side to receive the coils, while the opposite face of the forging has fifteen small grooves machined in it to receive the brass which divides the face of the chuck up into the sixteen ring poles. These grooves in the face of the chuck are 3/16 inch wide by 3/4 inch deep and are filled with strip brass which is driven tightly into place. A safety flange is provided at the circumference of the chuck to prevent water from reaching the joint between the chuck body and the bottom plate.



2. Cross-sectional View taken on any Radial Line from the Center

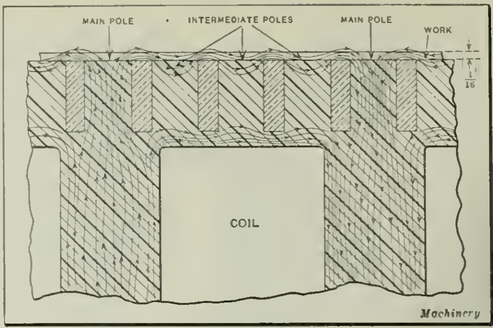


Fig. 3. Diagram showing Path of Magnetic Flux when holding Thin Work

At first sight it might seem that much of the magnetism would be wasted by short-circuit through the connecting web of steel that extends across the entire face of the chuck; but the cross-section of the rest of the magnetic circuit is so large in comparison with this web and the magnetizing power of the concentrically arranged coils is so great that the loss of magnetism through this web is relatively slight. This magnetism is voluntarily sacrificed to secure the water-tight feature obtained through having the chuck body in a single piece. The intermediate poles provided between each of the main poles may be termed "stepping poles" for the magnetic flux. Pieces of work that are too small to reach from one main pole to the next will reach to an intermediate pole which is in contact with other pieces of work reaching to the next intermediate pole, and so on until the next main pole is reached. In other words, the intermediate poles help to transfer the flux through the work from one main pole to the next, and as the path of the flux is always in a vertical direction when passing to or from the work, the latter is held down in contact with the chuck face at each intermediate pole as well as at the main poles. The magnetic flux could pass without the help of intermediate poles if the small pieces of work were butted together, but if such were the case only those pieces on the main poles would be held down; and the rest of the pieces of work would merely attract each other horizontally.

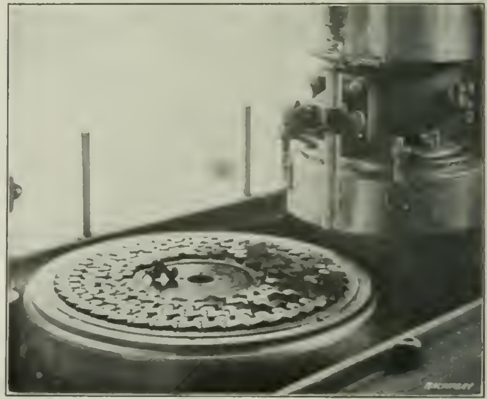


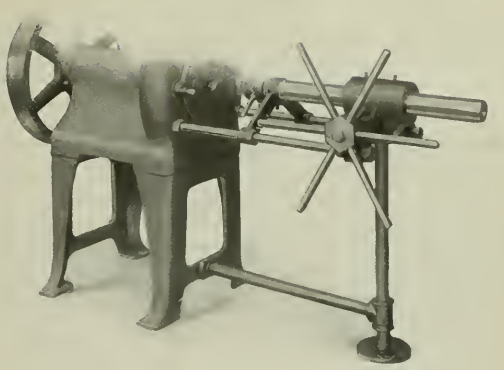
Fig. 4. Blanchard Chuck holding Rifle Hammers—note the Retaining Rings on Inside and Outside of Work

An example is shown in the case of the thin piece of work held on the chuck in Fig. 3. This is only 1/16 inch thick and the total distance between the poles is 2 1/16 inches; but this distance is divided into four spaces 3/16 inch wide filled with brass, and three intermediate poles 7/16 inch in width. Instead of having to travel a distance of 2 1/16 inches in a strip of steel 1/16 inch thick, the magnetic flux has to travel only ¾ inch, *i.e.*, the sum of the intermediate spaces filled with brass; and for the rest of the way the intermediate poles offer a greatly increased area of path for the flux. This results in lowering the resistance of the path and thus increasing the magnetic flux and holding power of the chuck; and in holding down the work at the edges of each intermediate pole, *i.e.*, at six places between the edges of the two main poles. In holding heavy pieces of work, it is probable that the intermediate poles play little or no part, as there is sufficient area in the path to allow the magnetic flux to pass easily from one pole to the next.

The coils are wound on forms, heavily taped and then impregnated with an insulating compound. The grooves in the body of the chuck are carefully lined with insulating material and a sufficient quantity of the melted insulating compound is poured into each groove just before dropping the coil into place to completely fill the space between the bottom and sides of the coil. After the connections have been made, more compound is poured in to fill any space which still remains in each of the grooves. The bottom plate of the chuck is then secured in place. The coils are connected in two groups of equal resistance and the terminals are mounted on a block of molded "Bakelite." By simply shifting a "jumper" on this terminal block the chuck may be connected with either 110 or 220 volts. Connection from these terminals to the contact rings is effected by spring plungers which make the necessary connections when the chuck is in place, or allow of its removal without disconnecting any wires. The complete chuck is solid with no air spaces which afford a chance for the condensation of moisture to cause trouble with the wiring.

The distribution of magnetic flux in a chuck is dependent upon the resistance offered by the different paths. In the Blanchard chuck the cross-sectional area of magnetic circuit is much greater than that of any small work that can be placed on the face of the chuck. For example, pieces of flat steel ½ inch thick covering the entire face of the chuck offer a path for the magnetism which is only little more than half as great in area as the circuit in the chuck itself. As a result, the holding power of the chuck does not decrease perceptibly with an increase in the number of pieces held. It is claimed that the holding power is sufficient to enable rough castings or forgings to be ground without the use of stops of any kind for preventing the work from sliding, when the chuck is used on the Blanchard vertical surface grinder, taking twenty horsepower to drive the wheel. However, it is always best to use stops as a safeguard in case the current should fail during the grinding operation. The best practice for small work, where a number of pieces are held at one time, is to use light rings of sheet steel laid inside and outside the work. An example of this kind is illustrated in Fig. 4, where the chuck is employed for holding rifle hammers which are to be ground on the sides. These rings are not secured to the chuck in any way, but merely serve to tie the group of pieces of work together. The rings are removed when it is required to clean the face of the chuck. In cases where irregular shapes necessitate the use of a fixture for holding the work, this can often be designed to hold the work magnetically. The chuck is made in two sizes, one of which is 26 inches and the other 30 inches in diameter.

FEED MECHANISM FOR "STANDARD" SWAGING MACHINE



No. 3 "Standard" Swaging Machine equipped with Feed Attachment

The accompanying illustration shows the No. 3 rotary swaging machine built by the Standard Machinery Co., Auburn, R. I., which is equipped with a new feeding-in attachment. The purpose of this attachment is to feed in long bars or tubes which are to be swaged. The large wheel shown at the right-hand end gives the traverse motion to the spindle of the attachment, while the smaller wheel at the end of the spindle operates a collet which holds the work. The bar is pushed through the spindle from the rear and clamped tightly in the collet with its end extending out ready to be swaged. The work is then fed into the machine by turning the large wheel.

It will be seen that the attachment is bolted to the front of the machine and supported by a pipe stand; and that the bracket attached to the front portion of the spindle carries two bushings which are a sliding fit on the guide rods that maintain the proper alignment of the spindle. This attachment is shown on a No. 3 machine, but the Standard Machinery Co. intends building the same attachment for use on other sizes of swaging machines of its manufacture.

F. E. WELLS LUBRICANT PUMP

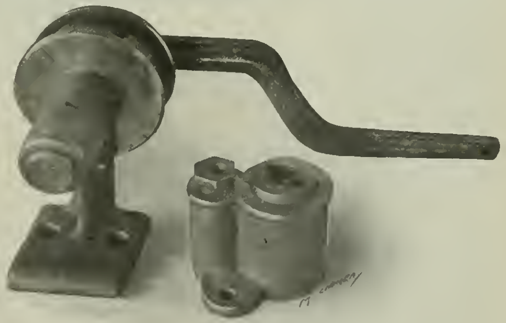


Fig. 1. F. E. Wells Lubricant Pump and Belt-driven Crank which drives it

F. E. Wells & Son Co., Greenfield, Mass., has recently placed a small lubricant pump on the market, which is adapted for use on screw machines, drill presses, and other machine tools. This pump is of the type which is submerged in the lubricant in operation, so it is always primed and requires no attention other than provision of a sufficient volume of lubricant to cover the pump. Referring to Fig. 1, the crank for reciprocating the pump plunger is shown at the extreme left. In the cross-sectional view, Fig. 2, the plunger is shown at *A*, and the crank is connected to the plunger by means of the pin *B*. The plunger casting is cored out to allow the required freedom of motion for the crank; and the under side of the plunger is also cored out to receive the valve disk *C*, which is allowed about 1/16 inch of play. This disk strikes the flange around the opening in the plunger on the downward stroke and drops down against the pin *D* when it is free to do so.

When the plunger is forced down, the disk *C* is pressed

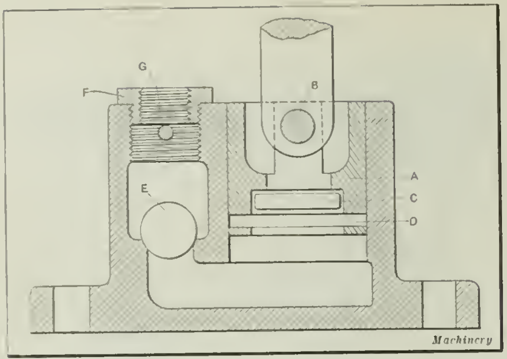


Fig. 2. Cross-sectional View of F. E. Wells Lubricant Pump

against the opening or "intake" in the plunger, thus closing the opening. The lubricant beneath the plunger is then forced through the outlet opening in the pump. This opening is kept closed by a $\frac{5}{8}$-inch ball *E* at all times except when the plunger is making its downward stroke; but during this stroke of the plunger, the ball is raised up and the lubricant passes through the outlet *F*, where connection is made with the pipe which delivers the lubricant to the tool. A small pin *G* in the outlet prevents the ball from clogging the opening. The plunger has a stroke of $\frac{3}{4}$ inch and is $1\frac{1}{2}$ inch in diameter, so that 1.35 cubic inch of lubricant is delivered for each stroke of the pump. As soon as the plunger starts to return, the ball *E* drops back into its seat and prevents the oil from running back into the cylinder. Similarly, the disk *C* drops down onto the pin *D*, and permits a new supply of oil to enter the pump cylinder.

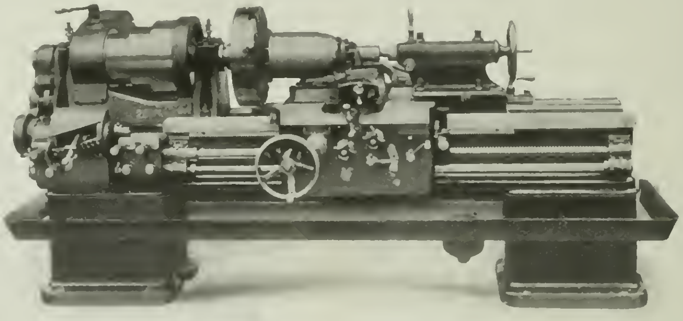


Fig. 1. American Projectile Turning Lathe

AMERICAN PROJECTILE LATHE

To meet the present demand for a lathe for use in the turning of projectiles, the American Tool Works Co., Cincinnati, Ohio, has developed the 20-inch lathe which is illustrated in Fig. 1. This machine is heavily constructed to enable it to stand up under the severe duty required of lathes employed in the manufacture of projectiles. The bed is unusually heavy and is ribbed transversely with double-walled box girths at intervals of two feet. The compound rest is of the most modern type employed on the lathes of this company's manufacture, and has a large square bearing surface for the swivel, which eliminates overhang. The top slide is made exceptionally large. A heavy-service double-screw tool-holder is supplied with the compound rest, which experience has shown to be well suited for the requirements of heavy work. The apron is of box construction, providing outer supports for all studs; all gears in the apron are made of steel and the rack pinion is of hardened tool steel. The feed mechanism is of the standard American quick-change gear type and provides forty-eight changes of feed

For use in projectile turning, these lathes are furnished with either a double back-geared head or a patented eight-speed geared head. The double back geared head is of the American quick change friction type, and, used in combination with a two-speed countershaft, provides nine forward and nine reverse speeds; or eighteen forward speeds if reverse speeds are unnecessary. With the eight-speed geared head, either belt or motor drive may be employed. The head is oil-tight so that the entire mechanism of the head can run in oil. This head provides eight spindle speeds in the forward direction, and with a double friction countershaft eight reverse speeds are also available; or sixteen forward speeds may be obtained provided it is not necessary to use the reverse speeds.

Probably the most interesting feature is the profiling attachment for shaping the conical ends of projectiles, with which the lathe is equipped; and a detail view of the attachment is shown in Fig. 2. With this attachment the action of the tool is controlled by a pair of templets *A* which form a groove in which a roller operates, this roller being connected to the yoke extension of the tool-rest at the rear end of the bottom slide. On machines for light or medium work, this mechanism is carried on the rear of the carriage, connection being made with the bed through an adjustable dog clamped to the rear vee. This provides adjustment longitudinally along the bed. On larger sized machines where very heavy cuts are to be taken, the attachment is of slightly different design, being mounted on planed strips on the rear of the bed. Provision is also made for moving this type of attachment along the bed when required. Both types of attachments are similar in operation and the same templets may be used for either attachment. The roller traverses along the slot between the templets and accurately reproduces their curve on the work, two tension springs on the carriage attachment, and a counterweight on the bed type of attachment, being employed to hold the roller in close contact with the front side of the templet. The templets used with the attachment are made especially to correspond with the particular form of projectiles which are to be turned.

DETRICK & HARVEY FLANGE FACING MACHINE

The machine shown in the accompanying illustration is a recent product of the Detrick & Harvey Machine Co., Baltimore, Md. It is intended for facing the flange ends of large pipes, and consists of three essential parts, *viz.*, a headstock which carries a rotating facing head, a vise for holding the pipe to be faced, and a bed for supporting the working parts of the machine. The head is similar to an engine lathe headstock, being equipped with a cone pulley and back gears for driving the spindle. Mounted on the front end of the

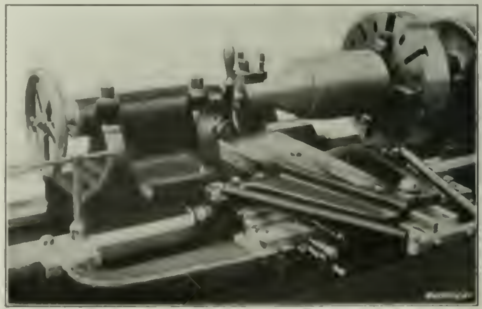
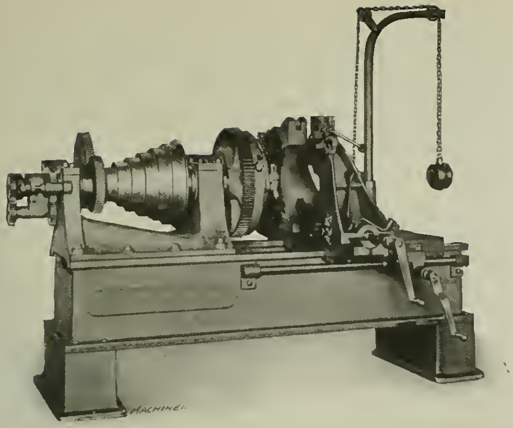


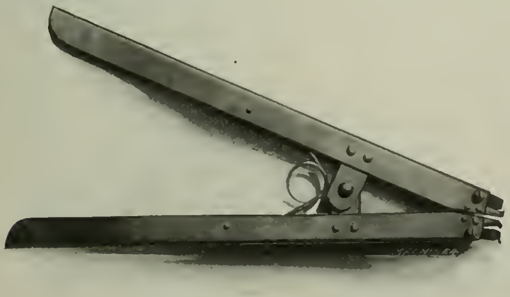
Fig. 2. Close View of Profiling Attachment used on Lathe shown in Fig. 1



Detrick & Harvey Pipe Flange Facing Machine

spindle there is a large faceplate that is provided with a slide-way and tool-slide, the latter having automatic feed from the periphery of the faceplate to the center. This feed motion is obtained by means of a shaft which extends through the hollow spindle. The shaft is driven from the rear end of the spindle by differential gearing, and drives the feed-screw that operates the tool-slide. A clutch is provided for disengaging the feed.

The device for holding the pipe is mounted on a carriage on the bed of the machine, and has adjustment to and from the facing head by means of a crank handle and screw. A pair of vise jaws similar to those of a lathe steadyrest, but made in halves and operated by right- and left-hand screws, facilitate rapid chucking and removal of the work. The vise jaws are fitted with four auxiliary radial jaws which have adjustment for holding work of various diameters. A swing locking bolt is provided at the top for clamping the vise. This machine may be equipped with a small crane for use in supporting the outer end of the pipe. The machine is built in two sizes which have capacities for work up to 24 inches and 38 inches in diameter, respectively. There are five or six changes of speed, which affords sufficient variation to cover the entire range of work for which the machines are adapted.



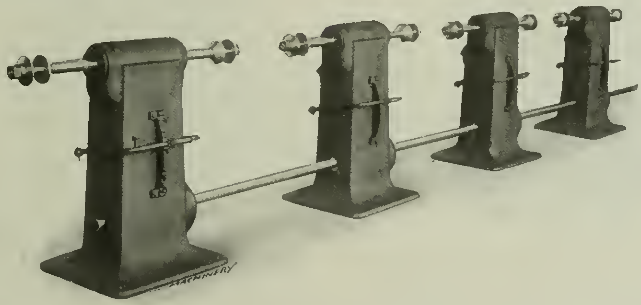
Wilhelm Piston Ring Remover

WILHELM PISTON RING REMOVER

The Wilhelm-Smith Machine Co., 926 Bingaman St., Reading, Pa., is now manufacturing the piston ring remover illustrated below. This tool is made from pressed steel with U-shaped handles. The small jaws that engage the piston ring are milled from the solid metal, and the tool is adapted for removing practically all sizes of rings. For handling those piston rings which are cut diagonally, small guards are provided on the jaws to keep them from sliding down the incline. As some piston rings have the inclined cut running in one direction and some in the other, the guards are removable so that they can be attached on either side of the jaws according to the rings which are being handled. Although particularly adapted for removing piston rings which are cut diagonally, this tool can be used with equally good results on any other form of piston rings.

GARDNER POLISHING LATHES

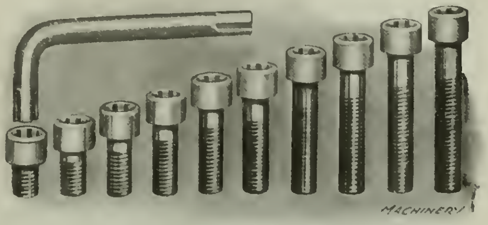
The accompanying illustration shows four under-belt driven ball bearing polishing lathes built by the Gardner Machine Co., Beloit, Wis. This arrangement is an adaptation of the under-belt type of machines built by this company, for use in places where there is not sufficient head room beneath the floor to permit of the use of the regular countershafts. A number of machines can be connected to the lineshaft which passes through the base of each machine near the floor. This shaft runs in ball bearings and carries a driving pulley within the base of each machine which is connected to the spindle pulley by means of a slack belt. By pushing down a lever at the front of the machine an idler pulley, which is mounted on ball bearings, is forced against the belt, thereby taking up the slack. To stop the machine, it is simply necessary to raise the lever. A metal cover on top of the machine completely encloses the spindle pulley and belt; and it is the general practice to cover the lineshaft which drives this type of installation.



Gardner Polishing Lathes with Under-belt Drive

BRISTOL FILLISTER-HEAD SCREWS WITH SOCKET HEADS

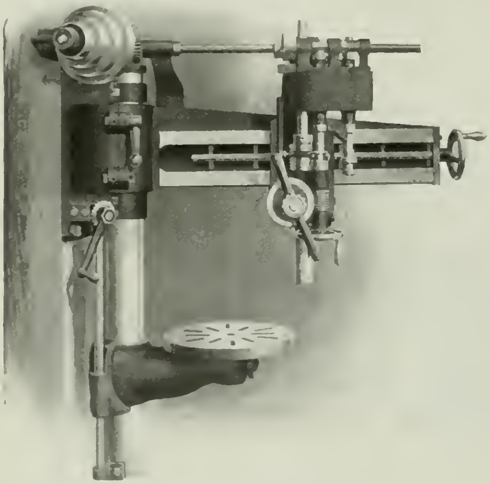
The fillister-head screws with socket heads, which are shown in the accompanying illustration, have recently been placed on the market by the Bristol Co., Waterbury, Conn. Reference to the illustration will make it evident that these fillister-head screws have heads which are provided with sockets instead of having the usual form of slot to receive



Bristol Fillister-head Screws with Safety Socket Heads a screwdriver. With the wrench employed to turn the screws, a very tight grip can be obtained; and the socket has the same dovetail feature as the safety set-screws of this company's manufacture. The screws are made with U. S. standard threads, but they can be furnished to order with V-threads or any special form of thread which may be required. They are made in sizes ranging from ¾ inch to 6 inches in length; and with diameters ranging from ¼ to ¾ inch.

CANEDY-OTTO RADIAL DRILL

In the July, 1914, number of MACHINERY, the No. 50 post type radial drill built by the Canedy-Otto Mfg. Co., Chicago Heights, Ill., was illustrated and described. Since the appearance of the description referred to, a machine of quite similar design, which is known as the Canedy-Otto No. 51 post type radial drill, has been developed. The design of this machine is similar to that of the No. 50 except that it is provided with power feed and a quick return lever which serves as a pilot wheel to move the spindle. Four changes of feed are available, any of which may be instantly obtained. The No. 51 machine is built in two sizes, one of which has a 2½-foot arm and the other a 3½-foot arm.



Canedy-Otto No. 51 Post Radial Drill with Power Feed

"DETROIT SPECIAL" TWIST DRILL

The Detroit Twist Drill Co., 600-612 Fort St., Detroit, Mich., has added to its line a high-speed steel twist drill which is styled the "Detroit Special." The steel from which this drill is made contains a high percentage of tungsten and vanadium which impart the properties of toughness and hardness after being subjected to a careful process of heat-treatment. The distinctive feature of this drill is the departure from common practice, which has been made in the angle of twist of the flutes. One of the Detroit drills is illustrated in Fig. 1; and Fig. 2 shows a Detroit drill and a twist drill fluted according to common practice. In the latter illustration, *A-A* represents the center lines of the drills while *B-B* and *C-C* are tangent to the flutes at the points of the drills and at points near the shanks, respectively. It will be seen that this angle has been increased 7 degrees, making it 32 degrees at the point of the "Detroit Special" drill, and decreasing to 27 degrees at a point near the shank.

The advantages which are claimed for this drill resulting from the change in angle are a more acute cutting edge, and as a result, a reduction in the amount of power required to drive the drill. The greatest gain resulting from increasing the angle of twist is said to consist of the improved cutting condition at the center of the drill close to the web. Here the angle corresponding to the rake of a lathe or planer tool is only a fraction of that at the outside of the drill. This angle is indicated by *EDA* in Fig. 2; and the angle at the center of the drill corresponds to the angle *BDA* at the outside. At the point of the Detroit drill, it will be seen that this angle decreases from 32 degrees at the outside to 4½ degrees near the web, while in the drill of common design, it decreases from 25 degrees to 3½ degrees. The more acute angle of the cutting edge near the web is said to add greatly to the efficiency of the drill.

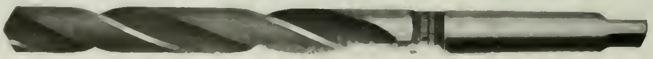


Fig. 1. "Detroit Special" Twist Drill

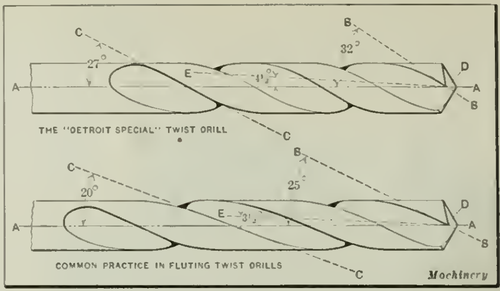
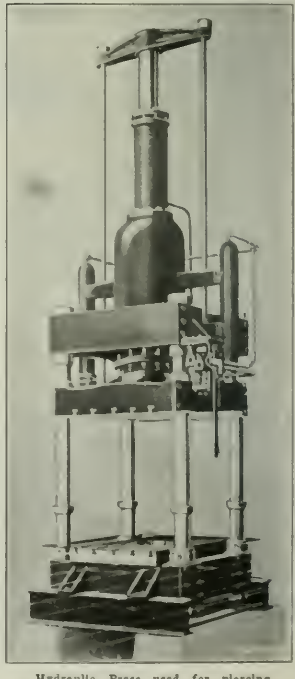

C
27°
E
4½°
B
32°
D
A
A
B
C
THE "DETROIT SPECIAL" TWIST DRILL
C
20°
E
3½°
B
25°
D
A
A
B
C
COMMON PRACTICE IN FLUTING TWIST DRILLS
Machinery

Fig. 2. Comparison of Fluting of "Detroit Special" Drill and a Drill fluted according to Common Practice

HYDRAULIC SHRAPNEL BILLET PIERCING PRESS

The hydraulic press which is illustrated and described herewith has recently been developed by the Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio, for piercing the billets used in the manufacture of shrapnel shells. It will be seen that this press is of the four-rod inverted cylinder type. The movable platen is guided in its travel by four bearings which work on the strain rods, and these guides limit both the upward and downward movement of the platen by coming into contact with collars forged on the strain rods. The arrangement will be clearly understood from the illustration, which shows the platen at the extreme of its upward movement.

The ram in the main cylinder is 28 inches in diameter and the maximum pressure capacity is 1000 tons. On each side of this cylinder is a cylinder in which a 4-inch ram works, these 4-inch rams being provided for the purpose of quickly moving the platen down to the work; and this quick movement of the platen allows the main cylinder to be filled with water from a surge tank. When the platen reaches the work, the



Hydraulic Press used for piercing Shrapnel Shell Billets pressure is instantly applied by a movement of the operating valve lever which admits the water to the main cylinder from the pressure line. On top of the main cylinder there is another cylinder in which an 8-inch ram works, the purpose of this cylinder and ram being to return the platen after the pressing operation has been completed. Sufficient pressure is also obtained from this return ram to strip the shell from the plunger.

The die used for the billet piercing operation is of cylindrical form with the bottom closed. The plunger carried by the movable platen is forced down into the die containing the billet, and causes the steel to flow upward into the space between the plunger and the wall of the die. In order to withstand the severe strain to which it is exposed, this press is of steel construction throughout. The strain rods are of forged and heat-treated steel; the heads and collars are forged on the rods; and all castings are of open-hearth steel. The press has a space under the ram of 84 inches and a pressing surface of 34 by 36 inches in size. The movement of the platen is 36 inches.

The Hydraulic Press Mfg. Co. is also building another press of similar design for use in drawing the rough shells produced by the piercing operation conducted on the machine shown in the illustration. This press has just one-half the pressure capacity of the billet piercing press, *i.e.*, 500 tons; but the maximum pressure requirement in operating either of the presses is one-half their maximum capacity. The drawing press has a ram 20 inches in diameter; the pressing surface is 30 by 36 inches in size and the maximum movement of the platen is 48 inches. As in the case of the billet piercing press, a return cylinder is placed above and two small cylinders at the sides of the main cylinder, the small cylinders being employed to move the pressure platen rapidly down to the work. The method of operating the drawing press is also similar to that employed in the billet piercing operation.

BICKFORD DRILL FLUTING MACHINE

The Bickford Machine Co., Greenfield, Mass., is now manufacturing a machine for fluting twist drills in sizes up to 1/4 inch in diameter. This machine is fully automatic in operation for both the forward and return movements of the carriage, and the indexing of the work ready to mill the second flute after the first flute in the drill has been milled. The angle is constant between the cutter spindle and the line of travel of the carriage; and the machine is equipped with a mechanism for providing the increase of lead of the flutes of the drill and the corresponding change in angle of the cutting lips.

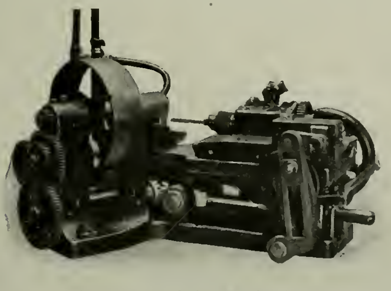


Fig. 1. Bickford Drill Fluting Machine for Drills up to 1/4 inch in Diameter

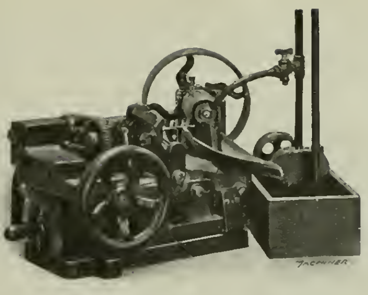
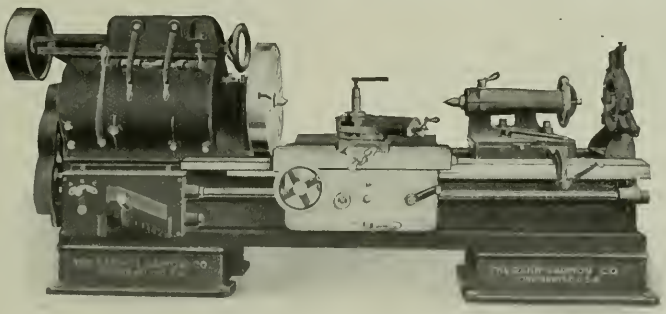


Fig. 2. Opposite Side of Bickford Drill Fluting Machine shown in Fig. 1

In addition to the power feed, a handwheel is provided for use in setting up the machine. A single turn of this wheel causes the machine to go through the complete operation of machining one flute in the drill. These machines are intended to be set up in a row on a bench with a long trough to receive the oil from each machine and carry it back to the supply tank where the pump is located. Each machine is provided with a pipe to carry the oil to the cutter and a guard which prevents the oil from being thrown onto the floor. In addition to serving its purpose as a lubricant, the oil carries away the chips to a strainer where they are separated from the oil. These machines are intended to use high-speed cutters, and have a capacity of thirty 1/4-inch drills per hour.

RAHN-LARMON THIRTY-INCH GEARED HEAD LATHE

The 30-inch geared head lathe, which is illustrated and described herewith, is a recent product of the Rahn-Larmon Co., Cincinnati, Ohio. The geared head of this machine provides nine spindle speeds, ranging from 4 to 300 revolutions per minute, the changes being obtained by means of a sliding clutch gear. The design is such that no two speeds can be engaged simultaneously. The headstock is heavily constructed with bronze spindle bearings and all gears are of steel. The gears are direct-connected to the spindle, making a powerful construction. All gears are entirely covered, but are easily accessible for oiling. These lathes are made to swing 28, 30, and 32 inches; and a quick-change gear box can be furnished, as shown in the accompanying illustration.



Rahn-Larmon Thirty-inch Geared-head Lathe equipped with Quick-change Gear Box

* * *

CORRECTION

The references in the descriptive article on J. H. Williams & Co.'s tool-holders in March MACHINERY contain some statements about other tool-holders which it is contrary to MACHINERY's editorial policy to make, and which should not have been published. Our rule is to describe tools and appliances illustrated in these columns without expressing any opinion in regard to the merits or demerits of competing articles, and the statements referred to are a regrettable departure from that rule.

NEW MACHINERY AND TOOLS NOTES

Flexible Hacksaw Blade: E. C. Atkins & Co., Indianapolis, Ind. A flexible hacksaw blade which may be twisted into a coil 1 inch in diameter without breaking. It is claimed that after such treatment the blade can be straightened out and used with satisfactory results.

Horizontal Forcing Press: Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. A horizontal hydraulic press capable of exerting pressures up to 35 tons. The table is 18 inches wide by 62 inches long; and the ram is 6 inches in diameter with a stroke of 15 inches.

Numbering Machine: American Numbering Machine Co., 224 Shepard Ave., Brooklyn, N. Y. This machine is adapted for stamping numbers on such products as keys, locks, revolvers, metal tags, etc. The machine can also be used on wood, leather or fiber or any other hard material.

Disk Grinder: Modern Pattern & Machine Co., Detroit, Mich. A double wheel patternmaker's grinder in which the work-tables may be set at any required angle, and compound angles are readily obtainable. The tables are adjusted by handwheels and provided with gages for use in making the required angular setting.

Storage Battery Crane Truck: Atlas Car & Mfg. Co., Cleveland, Ohio. This crane truck is adapted for carrying heavy parts in industrial plants. The truck is equipped with rubber tired wheels, and the wheel base is short so that the truck may be easily turned in confined spaces. The crane has a radius of 4 feet and a lifting capacity of 2000 pounds.

Rivet Spinning Machine: Fred J. Swaine Mfg. Co., St. Louis, Mo. A machine particularly adapted for spinning down the rivets on stove drums, bodies and other parts. No vertical movement of the spindle is provided, the work being fed up to the spindle by means of a foot treadle which raises the work-table. In this way both the operator's hands are free at all times.

Portable Cylinder Grinding Machine: Boxill & Bruel, 112 E. 4th St., Cincinnati, Ohio. This machine is intended to true up the inside of gas engine cylinders—particularly to remedy damage done by the piston and piston rings in wearing one half of the cylinder more than the other half. This portable machine provides for doing work formerly done on the lathe or boring mill.

Screw Driving Machine: Reynolds Pattern & Machine Co., Moline, Ill. This is a large machine adapted for driving screws that are located in straight lines. It is equipped with two spindles. The screws are thrown into hoppers at the top of the machine from which they enter magazines that arrange the screws in the required position and deliver them to the spindles of the machine.

Polishing Machine: John C. Blevney, 209 Parkhurst St., Newark, N. J. A two-belt rotary polishing machine adapted for automatically finishing hardware specialties and other small parts. The general principle of the machine is the same as that of the Blevney tube polishing machine except that in the present machine two belts are employed, one for roughing and the other for finishing.

Hardness Testing Machine: Pittsburg Instrument & Machine Co., Pittsburg, Pa. A hydraulic machine for testing the hardness of steel by the Brinell method. Until the outbreak of the European war made deliveries uncertain, machines for this purpose were largely imported. The present machine has been developed to meet the demand for an American made equipment for this purpose.

Open-side Planer: Cleveland Planer Works, 3150-3152 Superior Ave., Cleveland, Ohio. A 26-inch machine of the open-side type. The drive is of the spur and bevel gear type, power being provided from a countershaft secured to the top of the machine. Motor drive can be applied if desired. The machine has a cutting speed of 30 to 50 feet per minute and a return speed ratio of 3 to 1.

Drilling Stand: Standard Electric Tool Co., Cincinnati, Ohio. This drilling stand is used in connection with the high-power portable electric screw feed drills of this company's manufacture. The stand is made in two sizes adapted for supporting drills with capacities from ½ to ¾ inch, and from ⅞ to 1¼ inch, respectively. The weight of the smaller stand is 50 pounds and of the larger stand 75 pounds.

Metal Cutting Band Saw: E. B. Bronson & Co., Blue Island, Ill. This machine is equipped with a carriage which runs on ball bearings; and gravity feed is employed. The idle side of the blade runs back through the cut immediately behind the working side of the blade, thus enabling the machine to be employed for cutting pieces of any length. The capacity is for sections up to 16 by 16 inches in size.

Drawing Press: Consolidated Press & Tool Co., Hastings, Mich. In this machine the functions of an independent double-acting press are combined with the operations of a single-acting press by means of two plungers and a revolving dial carrier which automatically transfers the work from one plunger to the other. The entire mechanism is carried by a single frame, and machines of this type are built in seven sizes.

Cold-rolling Mill: United Engineering & Foundry Co., Pittsburg, Pa. A cold-rolling mill for the production of cold-rolled steel, copper, brass, aluminum, zinc, etc. Two of these mills were built, one with 12-inch and the other with 20-inch rolls. A point of interest in connection with these machines is that they have been developed to meet the demand for a class of equipment which has, until recently, been filled by German machinery manufacturers.

Quintuple Punching and Shearing Machine: Joseph T. Ryerson & Son, Chicago, Ill. This machine is designed to perform punching, shearing and notching operations without requiring any change of adjustments. It is claimed that it will handle work for which five separate machines are commonly employed—hence the name "quintuple" punching and shearing machine. It is designed for operations performed on plates, bars, angles, tees, I-beams and channels.

Duplex Cold Saw: Earle Gear & Machine Co., Stenton and Wyoming Aves., Philadelphia, Pa. The term "duplex" has been applied to this saw because the blade is driven by two sprockets, the teeth of which enter holes in the saw blade. This machine is intended to cut those classes of work which are too large to be handled on the "simplex" cold saw of this company's manufacture. The work is held stationary and the saw traversed up to it. Control of the feed is obtained through a gear-box of the selective automobile transmission type, six rates of feed being available which range from ¼ to 1½ inch per minute.

Drill Grinding Machine: F. E. Wells & Son Co., Greenfield, Mass. A line of drill grinding machines which are built in three types. The head and grinding fixture of all types are the same, but in one machine the head is mounted on a plain column and driven from an independent overhead countershaft. In another type, the countershaft is attached to the column of the machine and belted direct to the lineshaft; while in the third machine, the drive is provided by an individual motor, the belt being carried up inside the column. The spindle is equipped with a 6-inch cup-wheel at one end and a 6-inch wheel at the opposite end.

Three Projectile Making Machines: Niles-Bement-Pond Co., 111 Broadway, New York City. The first of these machines consists of a projectile boring lathe which is of exceptionally rigid construction and provided with ample power for heavy work. This machine is used for rough- and finish-boring operations on projectiles from 6 to 14 inches in diameter. The second machine referred to is a hydraulic press built in sizes with capacities varying from 50 to 1000 tons. This press is of the four-post inverted cylinder type with the cylinder in the upper platen; the piston is attached to the middle platen and the lower platen is stationary. The third machine is a lathe particularly adapted for turning projectiles up to 10 inches in diameter. This machine is adapted for rough- and finish-turning and is built in 20- and 24-inch sizes.

* * *

LABOR CONDITIONS ABROAD

Advices from Great Britain and Germany indicate that the heavy drain of men for the armies is seriously affecting labor conditions in the metal working industries in both countries. From England a correspondent writes us: "It is no exaggeration to say that machine tools are practically unobtainable under five or six months' delivery, and nearly every manufacturer whose plant is adaptable to shell turning is engaged in the manufacture of shells for the government. The great necessity at present with our manufacturers is men and materials, and in fact the labor question has become a most serious item, some of the larger firms who are engaged on government work having made special representation to the government to have men sent back from the front to work in the shops, and this request has been granted where government work has been delayed owing to the shortage of labor."

A German correspondent writes: "It is almost impossible to obtain either trained or untrained workmen, and in many trades, including machine shops, women work at milling machines and lathes, because of the lack of men. There is no unemployment. There are, of course, unemployed, but whoever is unemployed in Germany today is so because he does not want to work."

* * *

Germany has supplied Spain with most of the electrical machinery and appliances used in that country. On account of the present war, there is a shortage of electrical supplies in Spain and a market is opened in that country that has been for many years practically closed to American manufacturers of electrical machinery and devices.

A DANGER IN WAR ORDERS

The great volume of machine tool orders placed in this country by foreign dealers has obscured the danger to our manufacturers of a wholesale cancellation of such orders if the war ends suddenly. All retain a vivid recollection of their experience in 1907, when orders amounting to hundreds of thousands of dollars were cancelled without any notice or recourse, except a law suit, which no manufacturer wishes to undertake with his dealers; and the present situation is more complicated than in 1907 on account of the delays in shipping, which now run into months, and may mean the tying up for extended periods of large amounts of money in machine tools and other material, and resulting misunderstanding between buyer and seller.

One or two manufacturers ask for one-third cash with the order and the balance against inland bills of lading, the buyer retaining the right to cancel his order if the machines are not shipped on the date agreed, and the seller being subject to a small penalty. Other manufacturers ask for a confirmed bank credit in New York, available for payment of invoices on receipt of inland bills of lading. These terms seem rigorous, but are of course intended to apply only while present abnormal conditions exist. Some action by our manufacturers is necessary for their own protection, and it seems advisable that a general policy be agreed on so that the risk may be passed on to the "ultimate consumer," rather than to be saddled on either the manufacturer or the dealer. Many of the machine tools required for the production of war material are of such sizes that they are almost unsalable except for that purpose. Of one such size an extensive lathe builder said he had previously sold only three in more than a year. The writer remembers to have seen in the stock of a Cincinnati manufacturer some odd size lathes which had been held for seven years. Whether they are there now or not we don't know—but hope not.

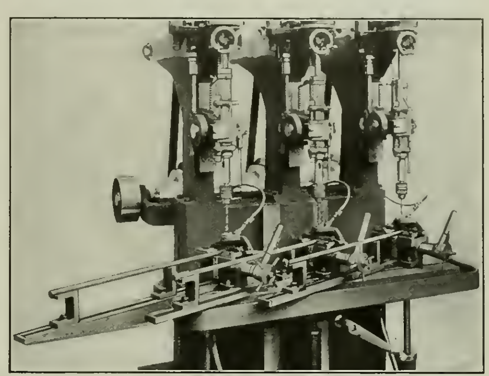
Machine tool builders are obliged to place orders for material from four to six months ahead, and such orders cannot be cancelled as is the case with orders from their dealers; so that if the war came to a sudden end, the wholesale cancellation of orders and the obligation to pay for material ordered might involve some manufacturers in serious financial difficulty. Certainly it would leave them with an unsalable stock and vanished profits.

The sales of American machine tools have run into figures that are almost incredible. One lathe manufacturer, who enjoys a reputation for conservatism, figured up that orders for about 5200 lathes had been placed in Cincinnati alone during the months of December, January, February and March. A number of machine tool builders are sold up to August, and some as far as October. One large Eastern concern has enough orders on its books to run for nearly a year. The speeding-up of an organization to produce such a volume of business at a profit, and to turn out good work, necessitates a gradual extension which requires time as well as money, and involves many other factors that cost money. The sudden stoppage of an enterprise under such momentum represents more loss than simply that of the unfinished stock on hand and the obligations for material required for four to six months' work.

A well informed French machine tool dealer was asked recently if the cessation of the war would result in throwing a large number of machine tools on the foreign market, and he expressed the opinion that it would not. A large proportion of the machines now being sold for war purposes have been bought for government arsenals, and will of course be retained by them, especially in France where such plants have for years greatly needed up-to-date equipment. Other machine tools have been sold to manufacturers of automobiles and various material for war purposes; but as Europe will be stripped of automobiles at the close of the war, such plants will readily find plenty of business. This encouraging view of future European conditions seems a reasonable one, and augurs a continuation of our export trade after the close of the war, especially in machines which have not been used for the production of war material, because many of the plants will require tools that are not now being bought, to balance their equipment.

DRILLING COTTER PIN HOLES

An outfit for drilling cotter pin holes is shown in the accompanying illustration. It consists of the "Avey" No. 2½ automatic drilling machine equipped with quick-acting jigs for holding the rods or bolts in which the holes are to be drilled. The machine is of the regular type built by the Cincinnati Pulley Machinery Co., Cincinnati, Ohio, which was illustrated and described in MACHINERY for December, 1914. It is provided with automatic, semi-automatic or hand feed, any of which may be used according to the nature of the work which is being handled on the machine. In drilling cotter pin holes with the equipment which forms the subject of this article, the automatic feed is employed. The spindle feeds down to the required depth; it is then automatically returned to the top of the stroke, when it is once more automatically reversed to perform the next drilling operation, this cycle being repeated indefinitely. The position of the stop collar on the spindle sleeve can be adjusted to regulate the point at which reversal takes place at the top of the stroke. This is very convenient in adapting the machine for different classes of drilling, as the distance which the spindle is required to feed down before the drill engages the work enables the time between the successive drilling operations to be regulated so that the operator has just enough time to keep all of the fixtures on the machine loaded and all spindles working to their full capacity.


"Avey" No. 2½ Automatic Drill equipped for drilling Cotter Pin Holes

The jigs used for drilling cotter pins on this machine have a capacity for rods or bolts from ½ to 2 inches in diameter and from 1 to 30 inches in length. Reference to the illustration will show that the supports for the work are adjustable on the bases of the fixtures, and when the cotter pin holes in bolts are required to be at a specified distance from the under side of the head, the supports serve the additional purpose of gages for locating the work. When it is required to have the holes located at a specified distance from the opposite end of the bolt to the head, the work is located in the jigs by means of screws that are provided for this purpose.

The handles shown in an inclined position are used for actuating the vise jaws which hold the work while it is being drilled. These handles are connected to double-threaded screws by means of ratchets so that the operating position of the handles is always above the horizontal. The pin wheels on the end of the screws are used for setting the jaws to accommodate work of various diameters; and the supports which hold the drill bushings are also provided with vertical adjustment for work of different sizes, so that the bottoms of the bushings are always close to the work. The problems of lubrication and the disposal of drill chips have been worked out in a very satisfactory manner by having the lubricant supplied to each drill through the fixture and delivered directly to the point of the drill, where it serves the double purpose of lubricating the tool and washing away the drill chips, without giving any trouble through the splashing of oil onto the floor. The average rate of production on ⅝-inch bolts with 5/32-inch cotter pin holes drilled through them is 450 per hour.

SWEEP-MILLING AND SHAVING OPERATIONS ON PISTOL FRAMES

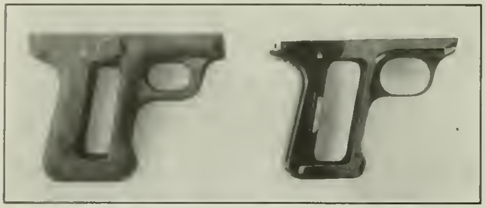


Fig. 1. Rough Drop-forging and Finished Frame for Savage Automatic Pistol

The rough drop-forging for the frame of a Savage automatic pistol is shown to the left in Fig. 1, and a completed frame, to the right. This rough forging weighs two pounds two ounces, whereas the weight of the finished frame is only seven ounces, and the total number of operations on this part is sixty-five. As many of the surfaces must be machined accurately with relation to each other, it is necessary to provide some means of locating the frame in the different fixtures. The simple and yet ingenious way in which this frame is machined at the factory of the Savage Arms Co., Utica, N. Y., so as to provide fixed locating points for all important operations, is worthy of note, and the same general principle can doubtless be applied in locating other classes of work.

The plain side of the rough drop-forging and the top edge are milled first, and then the side illustrated to the left in Fig. 1—which, as will be seen, is provided with two circular bosses. Heavy-duty vertical drilling machines equipped with face mills are used for this work. The machine for sweep-milling the plain side has a large face cutter with radial teeth extending in to the center, and two frames are machined simultaneously by simply feeding the cutter downward against the work. The forgings are not clamped to the table but are prevented from revolving with the cutter by pins in the base of the fixture, which pass up through the handle and trigger openings.

After the plain sides are milled, the frames A and A_1 are placed on another vertical drilling machine in the position indicated by the plan view, Fig. 3. As will be seen, the two forgings are located so that the bosses C are nearly opposite and in the center of the machine table, and the work is clamped between two jaws by a screw operated by handle B. The face cutter used for this operation has an opening in the center to clear the two central bosses C, and also an annular groove to clear the outer bosses D. The milling operation is done very rapidly, as it is simply necessary to feed the revolving cutter down against the work, thus sweep-milling the sides of both frames at once. When the cutter is lowered to the working position, it enters between four close-fitting lugs E which have circular faces that conform to the curvature of the cutter head. These lugs support the cutter-head and spindle against lateral thrust and make it possible to do the rough-milling rapidly. A rough unfinished ridge is left opposite each boss D (as indicated by the shaded areas) and there is also an unfinished surface surrounding each central boss C. These unfinished ridges are removed by a combined hollow mill and face cutter, which is afterward used to finish the bosses to the required diameter.

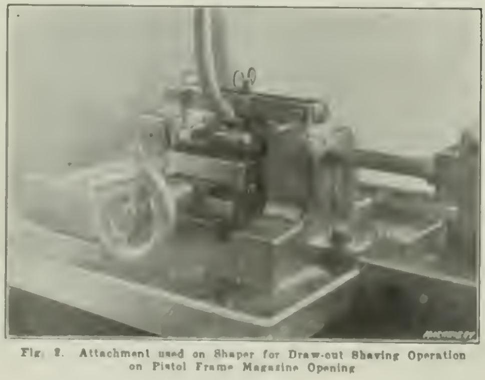


Fig. 2. Attachment used on Shaper for Draw-out Shaving Operation on Pistol Frame Magazine Opening

When the sides of the frame have been milled, the various profiling, drilling, and milling operations are performed, and for practically every operation the two bosses on the side of the frame enter close-fitting holes in the jigs or fixtures and thus locate the work. By locating the frames exclusively from these two points, errors which would otherwise accumulate are prevented, and a high standard of accuracy is maintained between the various surfaces. When the bosses are no longer needed, they are milled or sawed off in a hand milling machine. As they are not in exactly the same plane on the finished frame, the latter is attached to a sliding fixture which, after one boss has been removed, is shifted in against a stop, thus locating the work for cutting off the remaining boss. The provision of fixed locating points, such as are formed by these bosses, is particularly important for work of this class, because of its irregular shape, the number of different operations required, and the necessity of producing accurate interchangeable parts.

In machining these pistol frames, the profiler is largely used. A number of the more interesting profiling operations were described in the November number of MACHINERY, in an article on "Profiling Operations at Factory of Savage Arms Co." As those who read this article will recall, the ends of the magazine opening in the frame are profiled by means of an indexing fixture; that is, after one end is milled to the required shape to a depth of about 3/4 inch, the work and fixture is revolved one-half of a revolution, thus locating the frame for profiling the opposite end of the opening. The method of removing the metal between these profiled ends to complete the magazine opening is illustrated in Fig. 2.

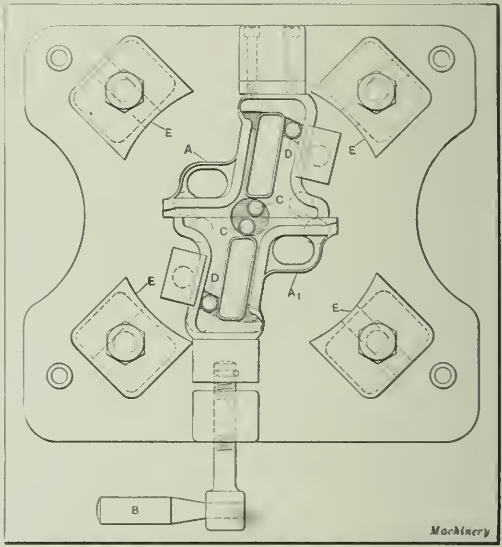


Fig. 3. Plan View of Fixture with Two Pistol Frames in Position for sweep-milling Sides

A shaper is used and the frame is held in a special fixture attached to the shaper table. A plan view of this fixture is also shown in Fig. 4. The planing or shaving tool has two cutters C and C_1 (Fig. 4), which are not used at the same time, but first on one side of the opening and then on the other. These cutters are attached to a bar A which passes through guides on each side of the work and is attached to the shaper head. The pistol frame is located by the two circular bosses on the lower side (formed as previously described), which enter holes in the fixture, and the frame is clamped by an upper bar B which has an equalizing clamp E that bears against the work.

The shaper takes a draw shaving cut. The work is fed first in one direction and then the other, by feeding the toolslide *F* laterally, handwheel *L* being used for this purpose. The stop-nuts *G* and *H*, which are on a screw attached to the cross-slide, strike the stationary stop *J* and control the width of the magazine opening. When a new frame is inserted, the work is centered with relation to the cutter-bar by inserting a swinging plate at *K* of the required thickness between stopnut *G* and stop *J*, thus avoiding any danger of taking a heavy cut and breaking the form cutter when first starting the shaper, after inserting a rough part. In order to remove the finished frame and insert another forging, the base *N* of the fixture is pulled back in a direction parallel to the cutter-bar, so that the frame can be slipped over the end of the cutter-bar, which is then out of guide *O*. It might be mentioned, incidentally, that in the Savage factory shapers are used for a number of shaving operations with formed cutters on both rifle and pistol parts, when the surfaces are so located that they cannot be finished on milling machines. F. D. J.

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BLANKS FOR RECTANGULAR AND ELLIPTICAL SHELLS*

BY FRITZ J. W. SPARKUHL†

Considerable time and labor are often involved in establishing the proper blank dimensions for drawn parts of square, rectangular, and elliptical shapes, and the writer believes that many of those who are engaged in the manufacture of press tools will be glad to learn of a simple method of determining the size and shape of blanks for drawn work of this class. Many formulas and rules have been published for obtaining the blank dimensions for round shells, but little, if any, information has been given on finding the blanks for rectangular or oval shells. It is not claimed that the dimensions obtained by the methods to be described will be absolutely correct or close enough for the final dimensions of the blanking punch. However, they will enable the diemaker to determine quickly the approximate shape for the blank, and the results will be sufficiently accurate to eliminate many trial drawing operations.

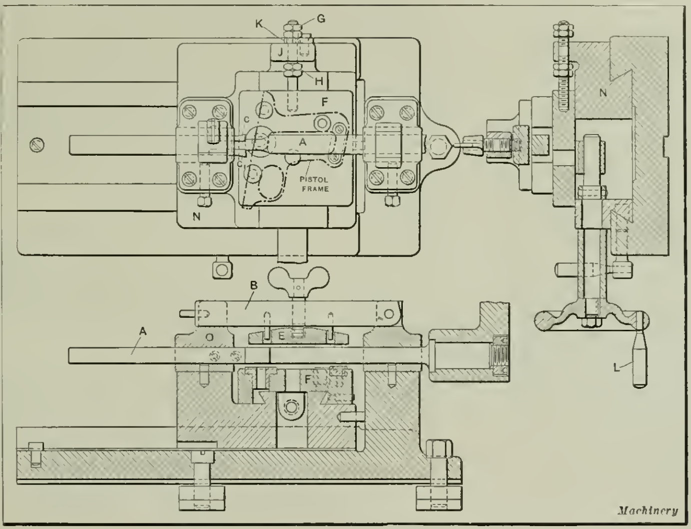

Fig. 4. Plan View of Attachment illustrated in Fig. 2

Shape of Blank for Rectangular Work

When a rectangular part is to be drawn, it is common practice to cut out a trial blank having a width equal to the required width of the drawn part at the bottom plus the height of each side, and a length approximately equal to the length of the drawn part plus the height at each end. The rectangular blank thus obtained is beveled and rounded at the corners until by repeated trial "draws" the correct shape is obtained. The method to be described will make it possible to secure the required blank shape in a more direct and accurate way.

When laying out a blank by this method, first draw a plan view of the finished shell or lines representing the shape of the work at the bottom, the corners being given the required radius, as shown by the diagram *A*, Fig. 1. Next draw the sides and ends, making the length *L* and the width *W* equal to the length and width of the drawn part minus twice the radius *r* at the corners. We now have a blank that would produce a rectangular piece without corners. To provide just the right amount of material for the corners is the chief problem, which may readily be solved. The first step is to find what blank diameter would be required to draw a cylindrical shell having a radius *r*. This diameter can be obtained by the well-known formula $D = \sqrt{d^2 + 4dh}$, in which $D =$ blank diameter; $d =$ diameter of drawn shell; and $h =$ height of shell. This formula may be expressed as a rule as follows: Multiply the diameter of the finished shell by the height; then multiply the product by 4, and add the result to the square of the finished shell diameter. The square root of the sum equals the blank diameter.

After determining the diameter *D*, scribe arcs at each corner having a radius *R* equal to one-half diameter *D*. The outline of the blank for the rectangular part is then obtained by drawing curved lines between the ends and the sides, as indicated by the illustration. These curves should touch the arcs *R*. The exact shape of the curve depends somewhat upon the proportions of the drawn part, but it can readily be determined by drawing a few trial blanks in the die, and making whatever changes may be necessary to secure a more even edge along the top of the drawn part.

It will be noted that the width x at the corner is considerably less than the width or height h at the side and, at first thought, one not experienced in rectangular drawing might naturally suppose that there would be insufficient metal at the corner. It must be remembered, however, that the stock in passing through the die tends to fold and wrinkle at the corners, but as there is not enough space between the punch and die to prevent wrinkling, the metal is packed up or "upset" and is forced upward, thus increasing the height of the corner so that the upper edge is about the same height as the sides and end. If the drawn part is quite narrow in proportion to the length, the dimensions h_1 at the ends of the blank, should be slightly less than the height required for the work, because the metal tends to stretch more at the ends, thus increasing the height.

After laying out the trial blank, as described in the foregoing, and trimming or cutting the edge to conform with the outline obtained, the shape of the blank should be transferred to another piece of the same stock. The trial blank is then drawn in the die, and the outline showing its shape prior to the drawing operation serves as a record and enables the diemaker to see what changes in the outline should be made in order to secure a more even edge along the top of the drawn rectangular part. When a blank of the correct shape is obtained, it is used in laying out the blanking die. Of course if the part must be drawn quite deep, it is not feasible to secure an even edge along the top, and the usual practice is to finish this edge by the use of trimming shears, or a separate trimming die in the case of flanged work.

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* For a complete set of blank-diameter formulas for round shells of various shapes see "Formulas for Blank Diameters of Drawn Shells," published in the January number.

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Blanks for Rectangular Flanged Shells

When a flange is to be left on a drawn rectangular part, the shape of the blank may be determined in practically the same way as described in the foregoing, except that the width of the flange must be considered. Referring to Fig. 1, the dimensions h and h_1 on the flat blank are made equal to the height of the drawn part plus the width w of the flange (se sketch B), whereas, the radius R at the corners should be established from the formula for a shell of radius r, having a flange corresponding to the width required. The blank diameter for a cylindrical shell having a flange can be determined by the formula $D = \sqrt{d_2^2 + 4d_1h}$, in which $D =$ blank diameter; $d_1 =$ diameter of the drawn shell; $d_2 =$ diameter measured across the flange; and $h =$ height of shell. After determining diameter D and the corresponding radius R, the outline of the blank is drawn the same as for a rectangular shape without the flange.

Blanks for Rectangular Tapering Shells

If a rectangular part is to have tapering or slanting sides, the dimensions h and h_1 (see plan view A, Fig. 1) should be made equal to the slant height s or the height measured along the slanting surface, as indicated by the diagram C. To determine the blank radius R at the corners, find the blank diameter for a tapering shell corresponding to the size of the corners. This diameter $D = \sqrt{d_1^2 + 2s\ (d_1 + d_2)}$, in which $D =$ blank diameter; $d_1 =$ diameter of drawn shell at bottom; $d_2 =$ diameter at top; and $s =$ slant height. The radius R is made equal to one-half D, and the outline of the blank is then drawn as previously described for a plain rectangular part. If the work should have slanting sides and a flange, the width of the flange should, of course, be added to the slant height, and radius R established from the formula for a flanged tapering shell. This formula is as follows: $D = \sqrt{d_2^2 + 2s\ (d_1 + d_2) + d_3 - d_2^2}$, in which $D =$ blank diameter; $d_2 =$ diameter of drawn shell at bottom; $d_2 =$ diameter at top; $d_3 =$ diameter across flange; and $s =$ slant height.

Blanks for Elliptical Shapes

The establishing of blanks for drawn parts of elliptical or oval shapes requires a little more time than laying out the blanks for rectangular shells. In order to determine the outline of the blank for an elliptical shell, first lay out an ellipse of the same size as the bottom of the drawn part, as shown in Fig. 2. Then draw a rectangle $abcd$ and a diagonal line ad. Next draw from corner b a line bg perpendicular to ad; the intersection of line bg with the center line xx locates center D; and the intersection with center line yy locates center C. Now determine what blank radius R would be required for a plain cylindrical shell of radius Ca and a height h; then draw arcs having a radius R corresponding to the blank radius from the centers C and C_1. In a similar manner determine the blank radius r for a plain cylindrical shell of radius Dd and height h. Then draw an arc having a radius r and also an arc r_1 at the opposite end.

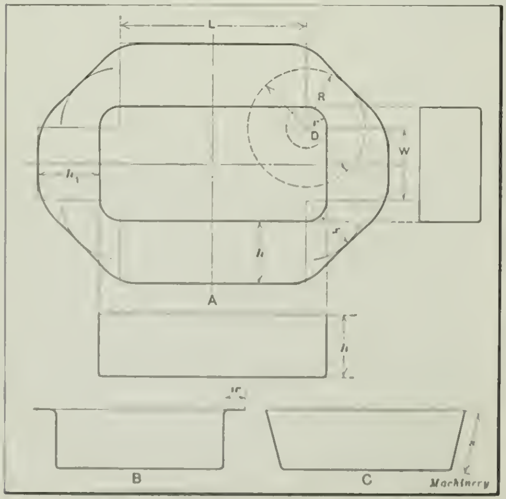


Fig. 1. Diagram illustrating Method of laying out Blank for Rectangular Shell

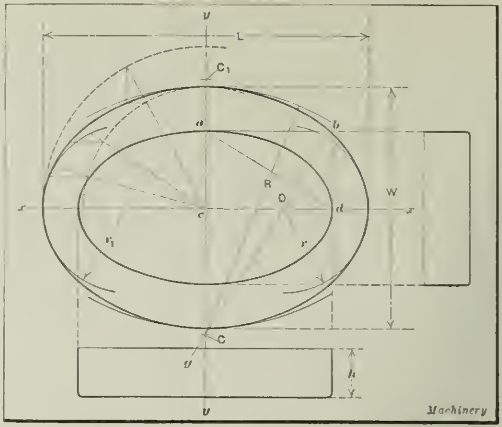


Fig. 2. Method of laying out Blanks for Parts of Elliptical Shape

We now have the major or longer axis L and the minor or shorter axis W of the elliptical blank. The ellipse representing the outline of the blank is then drawn through points located by the well-known method partially illustrated by the dotted lines. The method is briefly as follows: Two circles are first described with c as a center and W and L as diameters. A number of radial lines are than drawn from center c, and from the points at which these lines intersect the inner and outer circles, horizontal and vertical lines are drawn, as shown. The intersections of these horizontal and vertical lines are points on the curve of the ellipse, which is then traced through these points and represents the required outline for the blank.

If an elliptical part is to have a flange, the blank radii R and r are found for round shells having a flange of whatever width may be required. The ellipse is then constructed as described in the foregoing. Similarly, if a blank for an elliptical part having slanting sides is required, the blank radii R and r are found for tapering shells by the formula previously given.

By following the methods described in this article, anyone engaged in this work should be able to lay out, in a comparatively short time, a blank which will have approximately the correct shape. Of course it is impossible to lay out a blank which will give an absolutely even edge along the top of the drawn part, because the shape will be varied more or less by the surface condition of the dies and the physical properties of the metal being drawn.

* * *

ENTERING FOREIGN MARKETS

As an example of the proper method of approaching export trade on the part of a manufacturer, the *Commerce Reports* mention a large plumbing supply house in the Middle West hitherto solely engaged in domestic business. The president of this company discussed first with the Bureau of Foreign and Domestic Commerce at Washington the possible markets for his products abroad. He followed up this discussion with a careful study of the publications bearing upon the subject, and then again visited the Washington office of the bureau for further information. Through the assistance of a commercial organization, he then selected three capable salesmen with previous experience in the handling of trade in the countries in which he was interested. These salesmen had been put through a thorough training for several months in the factories, salesrooms and offices of the company, and when considered well acquainted with the product and methods, they were sent out to study their respective fields and form permanent connections. Such careful preparation for entering foreign markets is necessary in order to meet with success.

PERSONALS

William Siebenmorgen, formerly chief engineer of the C. & C. Electric & Mfg. Co., Garwood, N. J., resigned his position early in February.

W. C. Chapman, for several years connected with the sales force of the Philadelphia office of Manning, Maxwell & Moore, Inc., has been appointed manager of the Philadelphia branch.

Carlton R. Mabley, for the past five years general manager of the R. I. V. Ball Bearing Co., has joined the selling organization of the S. K. F. Ball Bearing Co., 50 Church St., New York City.

Walter M. Wood, manager of the Boston branch of Manning, Maxwell & Moore, Inc., has resigned on account of ill health, after fifteen years' service. J. S. Wainwright, formerly of the Detroit branch, has been appointed manager of the Boston branch.

Arthur E. Meyer, formerly with the Toledo Machine & Tool Co., Toledo, and later in the Chicago office of the E. W. Bliss Co., has resigned, and will open an office in Chicago about April 1, as agent for several lines of material and equipment for metal-working plants, particularly sheet metal and can manufacturing.

Arthur C. Pletz has resigned his position as secretary and general manager of the Aurora Tool Works, Aurora, Ind., but will retain his financial interest in the concern. Mr. Pletz will manufacture a line of machine tool specialties, and design, develop and build special machinery and tools. He will be located at 910 Commercial Tribune Bldg., Cincinnati, Ohio.

Carl D. Wilder, for the past four years chief tool designer of the Norton Grinding Co., Worcester, Mass., and formerly with the United Shoe Machinery Co. and the Bresnahan Shoe Machinery Co., has opened an office at 26 Brittan Lane, Worcester, to do independent work as a tool and production engineer, designing tools, standardizing output, increasing production and installing systems.

G. Burki, formerly with the E. L. Essley Machinery Co. of Chicago, has acquired an interest in the Badger-Packard Machinery Co. of Milwaukee, Wis. He has been made vice-president and will have charge of the machinery end. Mr. Burki has had many years' experience in the machinery business, and is widely and favorably known, both by manufacturers and users of all kinds of metal-working and woodworking machinery.

R. Stanley Smith, chief engineer of the A. O. Smith Co., Milwaukee, Wis., and designer of the Smith motor truck, has resigned his position to take up work as a consulting engineer, with offices in Detroit, beginning May 1. Besides his work in connection with the pressed steel frame and automobile parts business, Mr. Smith is well known as the inventor of the Smith motor wheel which has recently created so much interest in the bicycle world.

E. R. Miner, for over two years advertising manager with the Baird Machine Co., Bridgeport, Conn., builder of wire-working and special machinery, has resigned to become an advertising specialist with office at 125 E. 23rd St., New York City. Mr. Miner will handle the accounts of a few concerns only, giving them specialized service. He has had experience in the chemical, paint and mechanical lines, and will give his principal attention to the latter.

Walter C. Allen was elected president of the Yale & Towne Mfg. Co. at a meeting of the directors in Stamford, Conn., March 11. Mr. Allen succeeds Henry R. Towne, who, on retiring after forty-six years in that position, was made chairman of the board of directors. Mr. Allen has been employed by the Yale & Towne Mfg. Co. for the past twenty-three years, starting as a laborer and advancing from one position to the next as he demonstrated his ability to fill it.

B. H. Bryant, civil engineer, has returned from Guatemala, Salvador and Honduras, where he has been locating railroad lines as chief locating engineer of the International Railways of America, and is taking a vacation in Washington, D. C. Mr. Bryant, who has acted in the capacity of division engineer, chief engineer, construction engineer and general superintendent of steam railroads in the United States, Canada, Mexico, Brazil and South American countries for many years, is well known among railroad men. He expects to return to active work in the spring.

* * *

OBITUARIES

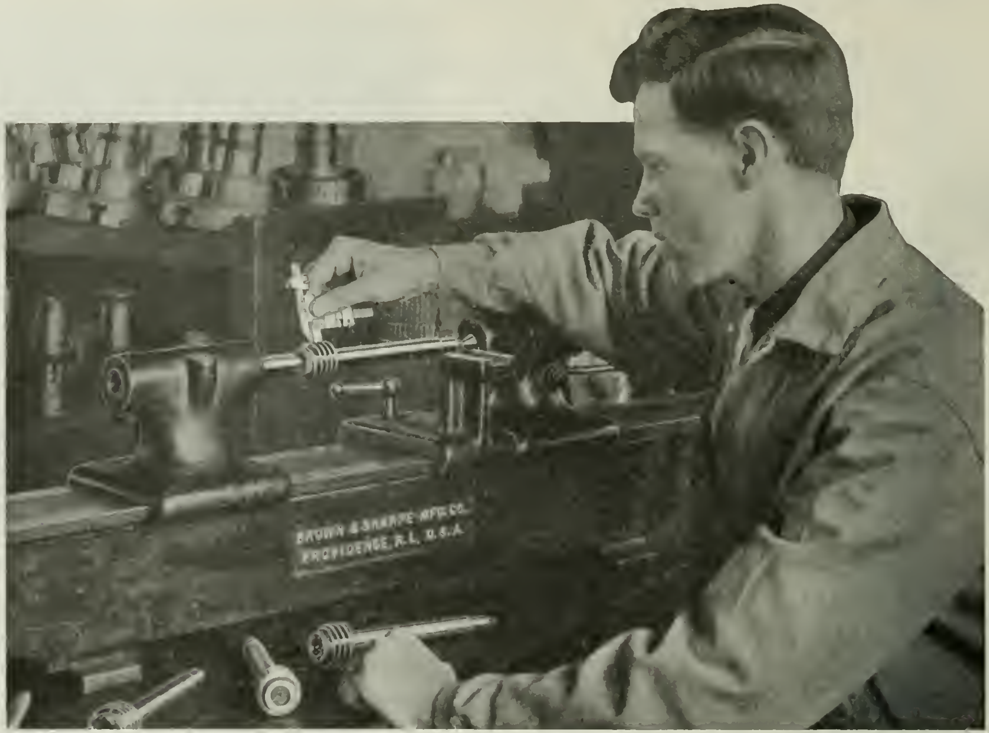
Charles A. Schieren, founder of the Charles A. Schieren Co., New York City, one of the largest leather manufacturing concerns in the world, and ex-mayor of Brooklyn, died at his home in Brooklyn, March 10, aged seventy-three years. Mr. Schieren was born in Düsseldorf, Germany, and came to America when fourteen. He worked first as a cigarmaker, and in 1863 went to work in a leather belt factory. In 1868, with a capital of only $1100, he founded the Charles A. Schieren Co. Mr. Schieren leaves four children.

Frederick W. Taylor

Frederick W. Taylor, the well-known originator of the modern scientific management movement, co-discoverer of high-speed steel and past-president of the American Society of Mechanical Engineers, died at the Medico-Chirurgical Hospital, Philadelphia, Pa., March 22 of pneumonia, aged fifty-nine years. Mr. Taylor was born in Germantown, Pa., and was prepared at the age of eighteen to take a course in Harvard College, having taken a preparatory course in Phillips-Exeter Academy, but his eyes gave out and he had to give up study temporarily. He turned his attention to industrial work and served an apprenticeship as patternmaker in a small steam pump works in Philadelphia. In order to make rapid progress and get special advantages, he worked for less pay than the other apprentices, and finished his apprenticeship, both as a patternmaker and a machinist, in four years. When he had finished his apprenticeship in 1878, times were so dull that he could not get work at his trade so he went to work in the machine shop of the Midvale Steel Co. as a laborer. He was rapidly promoted, being successively shop clerk, tool-room foreman, gang boss, assistant foreman and general foreman of the machine shop. Next he became master mechanic in charge of repairs and maintenance of works, then chief draftsman, and in 1884 chief engineer of the works. Thus, in the short period of six years, Mr. Taylor worked up from laborer to chief engineer of a great plant. During this busy period in the employ of the Midvale Steel Co. he nevertheless found time to study at home, and soon after becoming chief engineer of the works he felt the need for a more complete engineering education. In 1880 he took the engineering course of Stevens Institute of Technology, studying at night and continuing to work ten hours a day as usual. He graduated with the degree of mechanical engineer in 1883.

Leaving the employ of the Midvale Steel Co. in 1890, he organized and managed some pulp mills, and after accomplishing this work, he devoted his time to the organizing of various manufacturing establishments. One of Mr. Taylor's most important engineering works was the design of a large part of the plant and machinery of the Midvale Steel Co., including a large steam hammer which was built on new and original lines. His name in the engineering world, however, is chiefly identified with the systems of shop management and the Taylor-White process of treating tool steel which was announced to the world in 1898. High-speed steel has perhaps worked the greatest revolution in machine shop production of any discovery of recent times. Although Mr. Taylor and Maunsel White were the first to recognize the great economic value of tungsten steel treated in the manner prescribed in their patent, the patent, nevertheless, was overthrown in 1909 by decision in a suit brought by the Bethlehem Steel Co. (to whom it had been assigned) against the Niles-Bement-Pond Co. Messrs. Taylor and White were awarded a gold medal for the process at the Paris Exposition in 1900, and the Elliott Cresson medal of the Franklin Institute. Mr. Taylor patented about one hundred inventions applying to machine shop practice, foundry work, concrete construction, etc.

Mr. Taylor was president of the American Society of Mechanical Engineers in 1905-1906. He presented several papers before the society including "On the Art of Cutting


BROWN & SHARPE MFG. CO.
PROVIDENCE, R.I., U.S.A.

Testing Index Worms For B. & S. Spiral Heads

This is a characteristic example of the care exercised in the making of B. & S. Spiral Heads. Manufacturing methods may be ever so efficient, but unless care is exercised to check up the results and maintain a high standard of accuracy grave errors are likely to appear. Our methods of manufacturing this important part of a spiral head produce highly satisfactory results, but we take no chances on possible error. Rigid inspection supplements careful manufacture.

The steel index worm in every B. & S. Spiral Head is carefully hardened after the threads are cut. The threads are then ground true to form and pitch on special machinery we have developed for this purpose. The ground worms are carefully tested with a gear tooth vernier as shown above. By these means we secure a worm that is not only accurate, but permanently so, which means accurate indexing and long life.

The same care is taken in making other parts so that the finished head is reliably accurate, strong and rigid in construction and convenient to operate.

A great convenience in operation is the graduated index sector by means of which the arms can be set to include any desired number of holes without counting. Another convenience when making delicate adjustments is the radial and circumferential adjustment of the index crank. The index pin can be moved to the nearest hole without disturbing the work, or the work adjusted without moving the pin.

BROWN & SHARPE MFG. COMPANY,

OFFICES: 20 Vesey St., New York 654 The Bourse, Philadelphia, Pa.; 620-630 Washington Blvd., Chicago, Ill.; 305 Chamber of Commerce Bldg., Rochester, N. Y.; Room 419, University Block, Syracuse, N. Y.

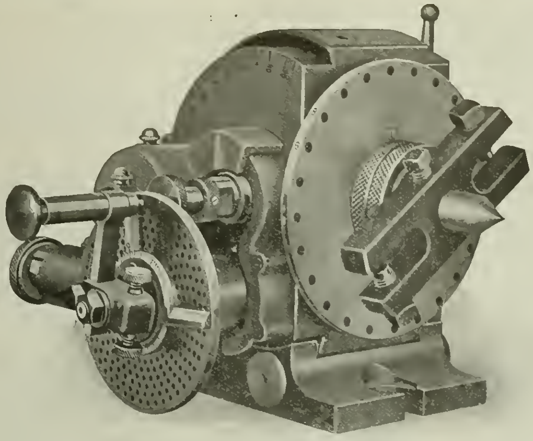
REPRESENTATIVES: Baird Machinery Co., Pittsburgh, Pa., Erie, Pa.; Carey Machinery & Supply Co., Baltimore, Md.; E. A. Kinsey Co., Cincinnati, O., Indianapolis, Ind.; Pacific Tool & Supply Co., San Francisco, Cal.; Strong, Carlisle & Hammond Co., Cleveland, O., Detroit, Mich., Colcord Wright Machinery & Supply Co., St. Louis, Mo.; Perine Machinery Co., Seattle, Wash.; Portland Machinery Co., Portland, Ore.

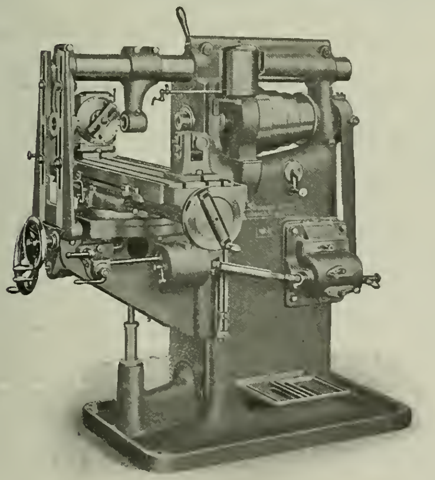
Over 70% of Universal Milling Requires the Spiral Head

Hence it is an important consideration when the purchase of a Universal Milling Machine is contemplated. The type furnished with B. & S. Universal Milling Machines has the advantage of being arranged for rapid, plain, and *differential* indexing.

The differential method of indexing permits of a wide range of divisions with little possibility of error. The index crank is moved in one direction only as in plain indexing, thus obviating the constant watchfulness necessary in the compound method. Three index plates with the change gears furnished give all divisions from 2 to 382 and many beyond.

The construction of these Spiral Heads is very rigid. A heavy base and a wide bearing on a large portion of the circumference make it practically a solid piece when clamped, thus enabling resistance to stresses in all directions.





A Milling Machine that is Equally Efficient in Tool Work and Manufacturing

How does a machine of that character fit in with your needs—a machine that can be used on your finest tool-room work or put to work on your shop floor with results that will satisfy all reasonable demands.

Brown & Sharpe Universal Milling Machines offer such a range of possibilities in any shop. Whatever your work in milling may be, there are machines in this extensive line for your purpose. Built with both cone and constant speed types of drive, an important element—ample power—is well provided for. The careful and permanent alignment of all parts, the accuracy and fineness of all adjustments, and the ease with which these machines can be handled make them indispensable in a well-equipped tool-room.

For the shop that can keep such a machine busy on tool work only part of the time, the ample power and sturdy construction allow of it being used to profitable advantage in manufacturing. One of these versatile machines will prove a safe and economical investment and a valuable addition to your shop equipment.

Write for descriptive literature and investigate their possibilities *now*.

No. 3 Universal Milling Machine

shown herewith is representative of the line. Capacity. Feeds, longitudinal, 30". Transverse 10". Vertical 19". Cone drive. All feeds automatic.

PROVIDENCE, RHODE ISLAND, U.S.A.

CANADIAN AGENTS: The Canadian Fairbanks-Morse Co., Ltd., Montreal, Toronto, Winnipeg, Calgary, Vancouver, St. John, Saskatoon.

FOREIGN AGENTS: Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow; F. G. Kretschmer & Co., Frankfurt, a/M., Germany; V. Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway; Schuchardt & Schutte, Petrograd, Russia; Fenwick Freres & Co., Paris, France; Liege, Belgium; Turin, Italy; Zurich, Switzerland; Barcelona, Spain; The F. W. Horne Co., Tokio, Japan; L. A. Vail, Melbourne, Australia; F. L. Strong, Manila, P. I.

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Metals," his presidential address at the December meeting in 1906, which was perhaps the most important paper ever presented before the society. In management, Mr. Taylor endeavored to reduce to a science the handling of men, methods and materials. Scientific management, so-called, is now used successfully in many large establishments. It is difficult to say what will be the ultimate effect of his ideas on the industrial conditions of the world, or how future generations will regard them, but he undoubtedly succeeded in creating a new conception of efficiency in the minds of engineers having to deal with the problems of management and production.

COMING EVENTS

April 12-15.—Annual convention of the National Metal Trades Association, New York City. Hotel Astor, headquarters. H. D. Sayre, secretary, Peoples Gas Bldg., Chicago, Ill.

April 24-May 1.—Second Efficiency Exposition at the Grand Central Palace, New York City. Organized by the Efficiency Society, Inc., 41 Park Row, New York City.

May 20-21.—Spring convention of the National Machine Tool Builders' Association at Atlantic City. Marlborough-Blenheim Hotel, headquarters. Charles E. Hildreth, general manager, Worcester, Mass.

June 8-11.—Third annual convention of the National Association of Corporation Schools at Worcester, Mass. H. W. Dunbar, general chairman of the convention committee, Norton Co., Worcester, Mass.

June 9-11.—Annual convention of the American Railway Master Mechanics Association. Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

June 14-16.—Master Car Builders' annual convention, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

June 14-17.—Summer meeting of the Society of Automobile Engineers on board the steamer "Noronic" of the Northern Navigation Co., leaving Detroit June 14. Coker F. Clarkson, secretary, 1745 Broadway, New York City.

June 19-26.—Annual convention of National Graphic Arts Exposition in the Coliseum, Chicago, Ill. Publicity manager, A. D. V. Storey, National Exposition Co., 200 Fifth Ave., New York City.

July 19-21.—Seventh annual convention of the American Railway Tool Foremen's Association, Chicago, Ill. Hotel Sherman, headquarters. Owen D. Kinsey, secretary and treasurer, 7223 Ridgeland Ave., Chicago, Ill.

August 17.—Annual meeting of the International Railroad Blacksmiths' Association, Philadelphia, Pa. A. L. Woodworth, secretary-treasurer, C. H. & D. Railway, Lima, Ohio.

September 9-11.—Swedish engineering convention in the United States; meeting in Chicago. Secretary, Eastern organization committee, E. Oberg, 183 68th St., Brooklyn, N. Y.; secretary Western organization committee, C. G. Axell, 601 City Hall Square Bldg., Chicago, Ill.

SOCIETIES, SCHOOLS AND COLLEGES

Polytechnic Institute of Brooklyn, Brooklyn, N. Y. Catalogue of the College of Engineering, 1915-1916.

University of Illinois, Urbana, Ill. The College of Engineering recently installed a high-production drilling machine in its machine shop, which is to be used in a series of tests on drilling in metals. It is of sufficient power to drive high-speed drills to their ultimate capacity, and will feed through cast iron at the rate of fifty-three inches per minute. The machine is of the all-geared type, no belts being used for the power drive, and all gears run in a bath of oil. The machine is driven by a 7½-horsepower motor.

University of Wisconsin, Madison, Wis., has prepared and is offering to Wisconsin motorists an interesting and effective course of lectures on the gasoline automobile. The work was planned by Prof. Earle B. Norris, in charge of the mechanical engineering work of the extension division, assisted by George W. Hobbs, formerly of the Buick Motor Co. and the Weston-Mott Axle Co., and Ben G. Elliott, formerly with the McKeen Motor Co. The instruction is given in a series of ten lectures with lantern slides, models and other demonstrations necessary to make clear the principles of motor car construction and operation. The subjects of the lectures are as follows: 1. Types of machines—arrangement and construction of chassis. 2. The power plant—the gasoline engine. 3. Fuels and carburetors. 4. Electrical principles—battery ignition systems. 5. Magneto ignition systems. 6. Lubrication—cooling systems. 7. Power plant groups—self starters. 8. Transmission systems. 9. Motor car troubles and their remedies. 10. Driving—selecting a car.

NEW BOOKS AND PAMPHLETS

Electric Wire and Cable Terminology. 13 pages, 7 by 10 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Circular of the Bureau of Standards No. 37.

Insulating Properties of Solid Dielectrics. By Harvey L. Curtis. 62 pages, 7 by 10 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Scientific Paper of the Bureau of Standards No. 234.

Temperature Coefficient of Magnetic Permeability Within the Working Range. By Raymond L. Sanford. 10 pages, 7 by 10 inches. Illustrated. Published by the Department of Commerce, Washington, D. C., as Scientific Paper of the Bureau of Standards No. 245.

Bulletins 68—74: Vol. 10. 6 by 9 inches. Illustrated. Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill.

Vol. 10 contains the following bulletins, which were issued at intervals and noticed in previous numbers of MACHINERY. Bulletin No. 68, "The Strength of I-Beams in Flexure," by Herbert F. Moore; No. 69, "Coal Washing in Illinois," by F. C. Lincoln; No. 70, "The Mortar-making Qualities of Illinois Sands," by C. C. Wiley; No. 71, "Tests of Bond Between Concrete and Steel," by Duff A. Abrams; No. 72, "Magnetic and Other Properties of Electrolytic Iron Melted in Vacuo," by Trygve D. Yensen; No. 73, "Acoustics of Auditoriums," by E. R. Watson, No. 74, "The Tractive Resistance of a 28-ton Electric Car," by Harold H. Dunn.

Packing for Export: Suggestions for Preparation of American Merchandise for Shipment to Foreign Countries. 170 pages, 6 by 9 inches. Illustrated. Published by the Bureau of Manufactures, Department of Commerce and Labor, Washington, D. C., as No. 5 of the Miscellaneous Series.

This government publication should be in the office of every concern exporting goods to foreign countries. It deals with the general aspects of foreign shipment, methods of transportation, climatic conditions, port conditions, pilfering, marking of shipments, consular regulations, effect of packing on customs duties, packing of machinery, packing for domestic shipment, billing goods and parcel post shipments. It also contains a great variety of general information regarding exports to Europe, South America and other countries.

Oxy-acetylene Welding and Cutting. By C. H. Burrows. 134 pages, 6 by 9 inches. 65 illustrations. Published by the Vulcan Process Co., Minneapolis, Minn. Price, $1.50.

This book, which now appears in the third edition, was published in the interest of the Vulcan Process Co., manufacturer of oxy-acetylene welding and cutting equipment. It treats of the use of the oxy-acetylene flame; the chemistry of the gases used and the physics of gases; the properties of cast iron, malleable iron, wrought iron, steel, copper, brass, aluminum and alloys; acetylene generators; oxy-acetylene cutting and welding torches of the low pressure and high pressure types; regulators and indicators; the Vulcan automatic acetylene generator; operation of plants; welding rods and fluxes; welding; cutting; boiler and sheet metal work; carbon burning as applied to cleaning of automobile cylinders.

A. S. M. E. Boiler Code. 114 pages, 6 by 9 inches. Illustrated. Published by the American Society of Mechanical Engineers, 29 W. 39th St., New York City.

This boiler code is the report of the committee appointed to formulate standard specifications for the construction of steam boilers and other pressure vessels and for care of same in service. The work of the code committee was confined to the rules for construction of steam boilers only, and is divided into two parts, one for new installations and the other for existing installations. The rules for new installations cover all details of new steam boilers and they provide for allowable working pressures, the details being referred to in the following order: Materials of construction, including the material specifications, maximum allowable working pressures, boiler joints, braced and stayed surfaces, combustion chambers, tubes, riveting and calking, manholes and handholes, safety valves, water and steam gages, and fittings and appliances. A section of Part I is devoted to heating boilers. Part II, which is devoted to existing installations, deals with the subjects in the order given in the foregoing, but is less complete and the requirements are less exacting.

Keeping Up With Rising Costs. By Wheeler Sammons. 192 pages, 5½ by 8¼ inches. Illustrated. Published by A. W. Shaw Co., Chicago, Ill. Price, $2 net.

While this work is essentially one for the retail merchant, certain methods and principles treated are of interest and value to manufacturers and salesmen generally. It deals intimately with the method of retailing, costs of doing business, manner of handling customers, rents, locations, etc. Everyone knows that the cost of doing business has increased greatly during the past ten years. The cost figures from 1500 stores are analyzed, twelve general lines of business having been chosen for grouping the cost figures. These show where the merchants' money goes and indicate how store leaks may be located. The retailer is shown how clerks waste material and how to make the services of clerks more valuable. He is told what percentage of sales should properly be paid for rent and what the costs of getting trade should be. Delivery costs and methods, bad debts and hidden losses, how to keep down miscellaneous expenses, are subjects treated in the third chapter. An attractive feature of the book are small illustrated inserts showing the right and the wrong way to display goods, how to close a sale, etc.

Oxy-acetylene Welding and Cutting. By Calvin F. Swingle. 100 pages, 3¼ by 6½ inches. 75 illustrations. Published by Frederick J. Drake & Co., Chicago, Ill. Price, bound in cloth, $1; in leather, $1.50.

The oxy-acetylene process used successfully for welding steel, cast iron, malleable iron, brass, bronze, copper, aluminum, sheet iron and other metals, and for cutting iron and steel, was introduced into the United States only a few years ago, but it has become generally recognized as an indispensable process for manufacturing and repairs. Welding and cutting equipments are being installed for manufacturers, contractors, machine shops, garages, blacksmith shops, repair shops, boiler shops, steel mills, foundries, railroad shops and for other plants in which metal working of any form is done. The widespread use of oxy-acetylene welding apparatus should give general interest to any book on the subject like this, which has been prepared for the practical man. It treats of welding, welding flames, oxygen, acetylene, acetylene gas purifications, handling oxy-acetylene torches, the characteristics of welding apparatus, welding installations, preheating and annealing, operating a welding installation, metal welding practice, oxy-acetylene cutting and oxygen carbon removal.

500 Plain Answers to Direct Questions on Steam, Hot Water, Vapor and Vacuum Heating. By Alfred G. King. 214 pages, 6 by 9 inches. 127 illustrations. Published by Norman W. Henley & Son, New York City. Price, $1.50.

This work, which is put up in the question-and-answer, or catechism form, treats of the theory and laws of heat, methods of heating, chimneys and fuels, boilers for heating, boiler trimmings and settings, radiation, steam heating, boiler, radiator and pipe connections for steam heating, hot water heating, the two-pipe gravity system of hot water heating, the circuit system of hot water heating, the overhead system of hot water heating, boiler radiator and pipe connections for gravity systems of hot water heating, accelerated hot water heating, expansion tank connections, domestic hot water heating, valves and air valves, vacuum, vapor and vacuo-vapor heating, mechanical systems of vacuum heating, non-mechanical vacuum systems, vapor systems, atmospheric and modulating systems and heating greenhouses. The work is one suitable for the progressive steamfitter who realizes the need of keeping abreast of the rapid advancement in methods of heating and ventilation. Being compiled in the question-and-answer form it is well suited to the use of those who wish to obtain direct information quickly without reading several pages.

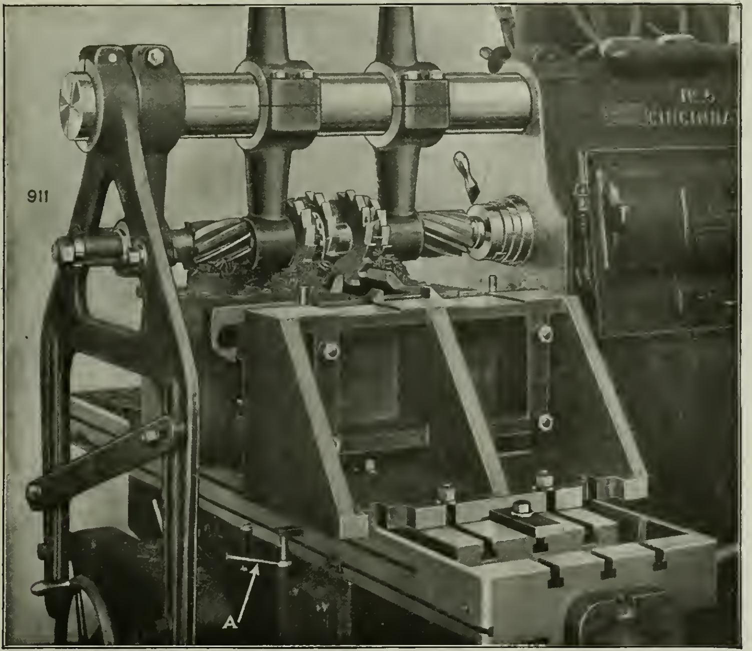
The Art of Estimating the Cost of Work. By William B. Ferguson. 97 pages, 5 by 7¾ inches. Published by the "Engineering Magazine," New York City. Price, $1.

This book by U. S. Naval Constructor Ferguson was written in the light of experience gained by the author in the hull estimating and planning staffs at certain navy yards, and it undertakes to show how construction and repair work can be standardized in unit operations. These unit operations can be given definite time and cost values, thus permitting estimates to be made with an accuracy usually regarded as unattainable. While the work deals with naval construction exclusively, the principles are applicable to all lines of building and repair work generally. After establishing definitions of an estimate and a standard, the art of estimating is discussed and then follow estimating curves or graphs, estimating on new construction work and repair work, the classification of variable conditions, cost data on new construction, piecework prices, unstandardized work, symbolizing labor operations, needs for good estimates, planning and estimating by operations, the preparation and use of curves, estimating overhead expense, the use and danger of "rough" estimates, developing of an estimating section. An appendix gives the scale of wages at the Navy Yard, Charleston, S. C., for various trades and a bibliography of reference works useful to the estimator.

Preventing Losses in Factory Power Plants. By David Moffat Myers. 360 pages, 5 by 7¼ inches. 88 illustrations. Published by the "Engineering Magazine," New York City. Price, $3.

The first part of Mr. Myers' book appeared originally in a series of articles in the "Engineering Magazine" which attracted much attention from proprietors and managers, who were chiefly addressed. In these articles the author undertook to put the engineering and economic argument in such clear general terms that it could be readily understood by the directing officials to whom the engineer must look for approval and support in the efforts to better the operation of the power plant. In the book these ten chapters are addressed to the executives, and are supplemented by nine more, taking up a detailed study of the principal power plant questions for the special advantage of the mechanical superintendent and factory manager. An interesting introduction was written by Prof. F. R. Hutton, past president of the A. S. M. E. The contents by chapter heads follow: The Determination of Existing Losses; Attainable Efficiency and Ordinary Wastes. The Boiler Plant; Steam Piping and the Engine Plant; Preventable Losses in the Engine Plant. The Heating System; The Human Factor, Efficiency Systems for Boiler Plants; Boiler Tests with Bituminous and Anthracite Fuel; Com-

No More Tired Backs



CINCINNATI NO. 4 PLAIN HIGH-POWER MILLER
Material close gray iron. Longest cutter 8" diameter, 25 R. P. M., 6 1/8" feed, 6 1/2" width of cut, 1/4" to 5/16" stock removed. Time per piece floor to floor—10 minutes.

The "CINCINNATI" Power Quick Table Traverse

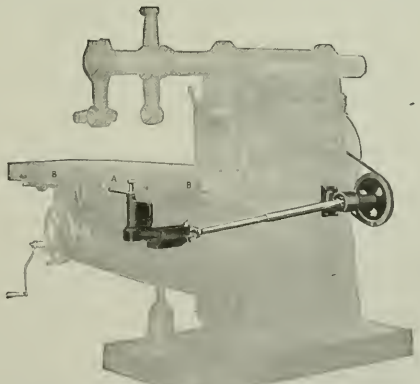
on work like this relieves the operator from the strain and time-consuming labor of moving the heavy table by hand when setting up or returning after cut.

Greatly increases the already large production of "CINCINNATI" High Power Millers by reducing the non-productive operating time.

SIMPLEST POSSIBLE OPERATION. Direction of lever "A" indicates direction of table movement. Operation independent of all other reverses.

Reasonable power movement of 100" per minute. Entirely separate from the feed mechanism, acting on the longitudinal feed only.

The other productive features of "CINCINNATI" High Power Millers are also worth your investigation. Catalog describes them.



THE POWER QUICK TRAVERSE ARRANGEMENT ON CINCINNATI MILLERS
(Patent rights fully reserved)

The Cincinnati Milling Machine Co.

CINCINNATI, OHIO

bustion; Surface Combustion. Natural Gas as a Boiler Fuel; The Economic Combustion of Waste Fuels; Boiler Feed Pumps—Steam Consumption Tests; Modern Types of Prime Movers and Reports.

NEW CATALOGUES AND CIRCULARS

Gripwell Pulley Covering Co., Hollis, Long Island, N. Y. Circular on "Gripwell" covering for pulleys which is applied to stop belts slipping and to increase driving power.

Chambersburg Engineering Co., Chambersburg, Pa. Catalogue 66 of single- and double-frame steam hammers, steam drop-hammers, board drop-hammers and accessories.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Form 212 giving detailed specifications of No. 11 "Boyer" riveting hammer for driving rivets up to 1½ inch.

Henry & Wright Mfg. Co., 760 Windsor St., Hartford, Conn. Catalogue on Henry & Wright single- and multiple-spindle vertical drilling machines and sensitive radial drilling machines.

Canton Foundry & Machine Co., Canton, Ohio. Pamphlet entitled "Your Garage and Your Cars," illustrating "Universal" turntables for automobiles, auto trucks, etc., and portable floor crane and hoist.

Charles E. Wright Co., Kenilworth, N. J. Circular of a horizontal band saw machine for cutting angle iron, hollow shell moldings and building materials that can be handled most advantageously in a horizontal position.

Hardinge Bros., Inc., 1770 Berteau Ave., Chicago, Ill. Catalogue illustrating and describing in detail the "Cataract" quick-change-swing precision lathe and attachments. "Cataract" vertical bench millers and double bench units are also illustrated.

Allen-Bradley Co., 495-7 Clinton St., Milwaukee, Wis. Bulletin B-7 describing in detail the Allen-Bradley direct-current automatic motor starters. The directions for ordering and price lists given will be found useful by the prospective purchaser.

American Tool Works Co., Cincinnati, Ohio. Bulletin 1500-B illustrating and describing the various sizes of "American" projectile and shrapnel turning lathes. The bulletin also contains estimated time required to produce 3¼-inch (18-pound) shrapnel.

Link-Belt Co., Chicago, Ill. Bulletin 207 descriptive of the Link-Belt electric hoist; and bulletin 212 treating of the Wendell centrifugal coal drier. This type of coal drier is a compact self-contained machine which dries the coal automatically by the use of centrifugal force.

Fisher & Norris, Trenton, N. J. Catalogue 30, illustrating and giving sizes and prices of the company's products, which include "Eagle" anvils, double-screw parallel leg vises, machinists' vises, quick-acting lever vises, swage blocks, saw-makers' hammers and striking hammers.

De Laval Steam Turbine Co., Trenton, N. J. Pamphlet entitled "Steam Turbine Drives for Rolling Mills," describing the recent installation of a De Laval geared steam turbine in the plant of the Carpenter Steel Co., Reading, Pa. The turbine drives an 18-inch three-high roughing mill.

J. Faessler Mfg. Co., Moberly, Mo. Catalogue of Faessler boilermakers' tools, illustrating and describing many sizes of boiler tube and superheater flue expanders of the sectional and roller types for hand or power operation. It also shows flue cutting tools and machines, countersinking tools, etc.

Bristol Co., Waterbury, Conn. Bulletin 192 describing the new Bristol long-distance electric transmitting and recording system. This system is adapted for indicating and recording pressures, liquid levels, temperatures, mechanical motions, etc., and transmitting the records electrically over long distances.

Shaw Blueprint Machine Co., 9-11 Campbell St., Newark, N. J. Leaflet describing the Shaw continuous blueprint machine, which will make continuous blueprints at the rate of three linear feet per minute. It is claimed that the power consumption is very low, the cost of operation (based on a rate of ten cents per kilowatt hour) not exceeding fifteen cents per hour.

Abrasive Material Co., Philadelphia, Pa. Pamphlet on boro-carbone, a new abrasive for grinding wheels. Boro-carbone grinding wheels are especially useful in grinding materials of high tensile strength, such as steel. The pamphlet contains miscellaneous information of interest to the grinder, and gives prices of emery wheel dressers made by this company.

Automatic Electric Co., Chicago, Ill. Pamphlet descriptive of the automatic-phone intercommunicating system, which works without the attention of an operator, all connections being made by an automatic switchboard. The advantages claimed for this system are efficiency, secrecy and economy. A special pamphlet shows the adaptation of the automatic phone to railway service.

Canedy-Otto Mfg. Co., Chicago Heights, Ill. Circular of blacksmith's hand and motor-driven forges, electric blowers, hand blowers, tire and axle shrinkers, combination punches and shears, floor grinders, wall or post radial drills, power drilling machines, sensitive bench drills, a line of equipment especially designed for blacksmith shops, foundries, repair shops, machine shops and garages.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin E-35, superseding E-30, illustrating the line of universal electric drills made by this company. These drills can be operated interchangeably on direct current or single-phase alternating current of 60 cycles or less. The heavy-duty side-spindle drills are made in even sizes for drilling holes in metal from 3/16 inch up to 1¼ inch in diameter.

Abrasive Material Co., Philadelphia, Pa. Catalogue 5 on abrasive grinding wheels. Information on vitrified wheels, silicate wheels, elastic wheels, and shapes of faces is given, as well as price lists for the various wheels, directions for ordering, and suggestions concerning use and care of wheels, weights of wheels, protection hoods, etc. A large number of halftone illustrations show sections of special shaped wheels for use on different special grinding machines, and the dimensions and prices of each are given.

Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. Bulletin 5001 illustrating and describing this company's 30-ton hydraulic pipe bender, a press primarily designed for bending pipe of various sizes, but which is also adaptable for miscellaneous work, such as bending and straightening light axles, small structural shapes, bars, shafts, etc. Pipe up to 4 inches in diameter can be bent by the use of bending blocks. The machine has a pressure capacity of 30 tons, and a length of pressing bed of 27 inches.

Statistics Bureau, 5 E. 42nd St., New York City. Catalogue of materials for the graphic presentation of facts for the use of executives, sales managers, advertising managers, educators, draftsmen, accountants, engineers, statisticians, health officers, secretaries of commercial organizations and social service workers, comprising map and pin cabinets, swinging leaf display fixtures for maps, maps for use of executives, map head pins, ring pins, large size coordinate papers, curve cards for executive use, logarithmic paper, gummed letters, etc.

Pittsburg Emery Wheel Co., Rochester, Pa. Booklet containing the code of standard safety grinding regulations, as adopted by the abrasive wheel manufacturers of the United States and Canada, and a reprint of an article by Charles G. Smith on "Emery Wheel Practice in Foundries." It will be seen by the illustrations that the safety collar system, safety hoods, etc., used in connection with the emery, electrolite and incordite wheels made by the Pittsburg Emery Wheel Co. conform closely to the specifications given in the safety code.

Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. Souvenir booklet entitled "About Hydraulic Presses and Pumps," prepared for distribution from the company's exhibit booth at the Panama-Pacific exposition, San Francisco. The booklet contains a brief historical sketch of the development of the business, and shows some representative types of "Hydraulic" presses and pumps. A list of catalogues ready for distribution, covering the complete line of hydraulic presses, pumps, valves, accumulators, and intensifiers made by this company, is included.

Titanium Alloy Mfg. Co., Niagara Falls, N. Y. Pamphlet entitled "The Ultimate Bronze for Your Castings," giving information on the properties of titanium aluminum bronze. In the tables giving the yield point, ultimate stress, elastic ratio, elongation, limit of resistance, etc., of a 10 per cent titanium aluminum bronze and a 35 per cent carbon steel, it will be noted that the figures are practically the same for both materials. Although this company specializes on aluminum bronzes, it also manufactures a general line of brass and bronze castings, on which it will be pleased to submit quotations to those interested.

Whitman & Barnes Mfg. Co., Akron, Ohio. Catalogue 86 on machinists' supplies. 170 pages, 6 by 9 inches. The book contains tables giving dimensions and prices of carbon and high-speed steel twist drills, reamers, drop-forged and screw wrenches, spring cotters, flat spring and riveted keys, cold chisels, files, etc. It will be noted that the list prices on carbon and high-speed steel drills, countersinks, reamers, etc., are arranged in parallel columns, the prices of the high-speed steel tools being given in red, thus facilitating comparison of the costs in the two different grades of metal. This catalogue is also published in a pocket edition —3¾ by 6 inches in size.

Max Ams Machine Co., Mount Vernon, N. Y. 1915 edition of the "Seal of Safety" year book. 258 pages, 6 by 9 inches. The 1915 edition of this book, like the previous editions, contains much miscellaneous matter of interest to those in the canning and packing industries. Some of the subjects treated are: The Canning Industry; Salmon Canning—An Industrial Romance; Swells and Springers, by W. D. Bigelow, chief chemist, bacteriologist research laboratory, National Canners' Association, Washington, D. C.; Legal Matters for the Canners; Associations in the Canning and Packing Industries; Reference Tables. The last forty-five pages of the book contain illustrations and descriptions of the line of can-making machinery manufactured by the Max Ams Machine Co.

Keystone Lubricating Co., Twenty-first, Clearfield and Lippincott Sts., Philadelphia, Pa. Booklet entitled "The Grooving of Bearings and Their Care." This little treatise on a subject that has received comparatively little attention in publication should be of much practical value to designers and builders of machinery of every description. It treats of various lubricants, the functions of lubricant grooves, width and depth of grooves, and illustrates a large number of bearings with various systems of grooving to distribute the lubricant. Lining bearings with babbitt metal are described and illustrated, and a simple method for testing babbitt metal is given. Cramp's test of "Keystone" grease and other semi-solid lubricants is described, and the results of the tests are shown in diagram form.

Shore Instrument & Mfg. Co., 555-557 W. 22nd St., New York City. Pamphlet on the Shore scleroscope for measuring the hardness of metals, and its application to the arts. The Shore scleroscope differs from other instruments designed for testing the hardness of metals in that it employs the rebound principle, a small hammer pointed with a diamond being released by suitable mechanism and allowed to fall on the part to be tested; the height to which the hammer rebounds as indicated on a vertical scale is the index of the elastic limit and hardness. The general scope of the pamphlet is indicated by the following chapter contents: Modern conception of hardness, physical hardness, purchasing raw and finished material to scleroscope specifications, carbon tool steels, high-speed steel, hardness and cutting, relation of hardness to other physical properties, alloy steels, hardness standards adopted by automobile engineers, cementation and casehardening, springs, description and operation of mechanism, the effect of mass on rebound.

TRADE NOTES

Steel Improvement Co., Cleveland, Ohio, has installed two ten-foot furnaces for the heat-treatment of steel. The new furnaces will double the company's capacity on certain classes of work.

Chapman Double Ball Bearing Co. of Canada, Ltd., 339 Sorauren Ave., Toronto, Ontario, Canada, has recently completed arrangements to have the Chapman ball bearing elevating truck manufactured in Buffalo for distribution in the United States.

Etna Machine Co., Toledo, Ohio, has purchased the business of the Holton Machine Co., Jackson, Mich., and will manufacture the Holton cutting-off and centering machine. The machine has been redesigned to make it stronger, and a larger size will be brought out.

Rockford Lathe & Drill Co., Rockford, Ill., is building a large addition to its plant which will about double the capacity. The company has purchased considerable new equipment, and it reports a continuously increasing demand for its lathes and drilling machines.

W. M. Pattison Supply Co., Cleveland, Ohio, has opened a branch office at Detroit, Mich., in the Dime Savings Bank Bldg. E. B. Barker, who is in charge, is well known in the trade. Mr. Barker will push the Hendey lathes, shapers and milling machines in the Detroit territory.

Sprague Electric Works of the General Electric Co., 527-531 W. 34th St., New York City, has opened a branch sales office in the Illuminating Bldg., Cleveland, Ohio. This new branch office will be in charge of Charles H. Hill, who also has charge of the Pittsburg office.

Rockford Milling Machine Co., Rockford, Ill., has broken ground for a large addition to its present plant. The addition is necessary to provide facilities for meeting the rapidly increasing demand for the company's milling machines. The capacity of the present plant will be doubled when the new addition is completed and fitted up for manufacturing.

E. H. Mumford Co., Front and Franklin Sts., Elizabeth, N. J., has taken over the business of the Mumford Molding Machine Co., and will place on the market a complete line of molding machines that will be interchangeable, as far as practicable, with all previous Mumford machines. The new machines will embody many points of merit made possible in redesigning and suggested by long experience.

Kelly Reamer Co., Cleveland, Ohio, made a shipment in early March of three large combination reaming outfits weighing approximately 800 pounds to the McIntosh & Seymour Corp., Auburn, N. Y. One of these reaming outfits, hardened and ground throughout to extreme accuracy, and fitted with several interchangeable adjustable reamers, weighed nearly 400 pounds; it probably is the largest multiple reaming outfit ever produced in this country.

S. K. F. Ball Bearing Co., 50 Church St., New York City, announces that Carlton R. Mabley, for the past five years general manager of the R. I. V. Ball Bearing Co., has joined its selling organization. The growth of the S. K. F. business since its introduction into this country from Sweden in 1910 has necessitated many additions to its force. Mr. Mabley, who has a wide acquaintance in the automobile and machine manufacturing lines, is regarded as a strong addition to the selling organization.

Royal Mfg. Co., Rahway, N. J., has undertaken to market cotton and wool waste on a new plan, which insures that the purchaser will be furnished with exactly the same grade of waste specified on all repeat orders and that he will receive the weight ordered. Customers are supplied with sampling folders containing twelve grades of cotton waste, six white and six colored. They order from this folder by name and thereby safeguard themselves as to the quality of waste supplied. "Royal" waste is guaranteed to be packed six per cent "tare," and the company agrees that the difference on all bales upon which the "tare" is over-weight will be refunded to the purchaser. The third important feature of the new plan of marketing waste is the guarantee of actual weight bales. Heretofore it has been the trade custom to "pad" orders for waste from 25 to 50 per cent, not in the number of bales, but in the weight per bale. For instance, a customer who ordered ten 100-pound bales would receive 1250 and sometimes 1500 pounds of waste.

Results Obtained with Ground Hobs

by
Edward K. Hammond[*]

This article outlines the results of an investigation conducted for the purpose of determining the relative accuracy of hobs before and after grinding to eliminate the distortion produced while hardening; and to determine the improvement of the gears generated with the ground hobs over those produced by the unground hobs. For the purpose of securing the data on which the article is based, four unground hobs were tested to determine the lack of uniformity in the lead of the thread and diameter of the hob. Two gears were then generated with each of these four hobs, and the gears tested to determine their running properties and the relative accuracy of the contour of the teeth. Similar experiments were then conducted with four hobs which had been ground to correct for the distortion produced in hardening. The hobs tested were regular commercial tools and received no special treatment, so the results are representative of standard practice.

WHENEVER a discussion is started concerning the relative merits of gears produced on the hobbing machine or by any of the other recognized methods of gear cutting, the advocate of hobbing is almost sure to be confronted with the argument that the distortion of the hob in hardening results in the production of corresponding inaccuracies in the gear teeth generated with it. This fact is conceded by authorities on the subject, but it must be clearly understood that the error in gear teeth produced by a properly made hob which has been carefully heat-treated is very slight. In view of this fact, it is unfortunate that so much has been made of this point that many manufacturers who have not had much experience with hobbing machines and hobbed gears are inclined to think that the error assumes serious proportions, whereas it is really so slight as only to be objectionable in such cases as automobile transmissions, the gearing of cream separators, and similar mechanisms where the highest possible accuracy of the gearing is absolutely necessary. For all ordinary classes of gears, the distortion of the hobs that is produced in hardening does not prevent them from turning out work of the required accuracy.

The error in gears generated by properly made hobs that have been distorted in hardening is chiefly due to the production of flats on the gear teeth; and this results in noisy gears and the development of vibration in the machine on which they are used. The flats on such gear teeth are due to the distortion of the lead of the hob thread. A little thought will suffice to show that where the thread of the hob is distorted one way or the other—making the lead variable instead of uniform, as it should be—there will be points where the hob will cut too deep into the gear teeth, and other points where it will fail to cut to the required depth; and in either case the gear teeth will be of irregular form instead of following the required involute contour. For those classes of machines where great accuracy of the gearing is of primary importance, the distortion of the hobs that is produced in hardening must be eliminated if the hobbing method is to be used with satisfactory results. The amount of unavoidable distortion of the hobs varies considerably, even where the best steel and most approved methods of hardening are employed. Some hobs of the same steel, which have been heat-treated in the same manner, may be distorted to quite a noticeable extent, while others show virtually no distortion. But in order to be sure of the truth of all hobs which are to be used for generating very accurate gears, the only feasible method of procedure is to grind all of the hobs after they have been hardened, in order that the accuracy and uniformity of the lead of the thread may be insured.

At the present time there are several firms working on the development of machinery and methods for grinding hobs and, as the matter is new and one in which the mechanical public is taking a considerable interest at the present time, the writer went to the plant of the Illinois Tool Works, 154 East Erie St., Chicago, Ill., where every facility was offered him in securing the data which forms the basis of the present article. This firm is a pioneer in the art of grinding hobs and its product is being used by many of the best known automobile manufacturers in the country. Before starting to present the results which were obtained, it will not be out of place to briefly outline the information which was sought. The ultimate purpose was to determine the amount of improvement which was made in the gears by grinding the hobs with which they were generated; and it was also desired to learn how the accuracy of the hobs compared before and after grinding to correct for the distortion produced during the process of heat-treatment. For this purpose a series of tests was made, the first of which consisted of taking four 8-pitch hobs as they came from the furnace and grinding them in the gashes to sharpen the cutting faces of the teeth ready for use; but no attempt was made at this time to correct for the error in the uniformity of the lead of the thread produced in hardening. These hobs were then tested to determine the amount of error in the uniformity of the diameter, and the distortion of the lead of the thread. After this had been done for all four hobs, they were taken to an Adams-Farwell

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[*] Associate Editor of MACHINERY.

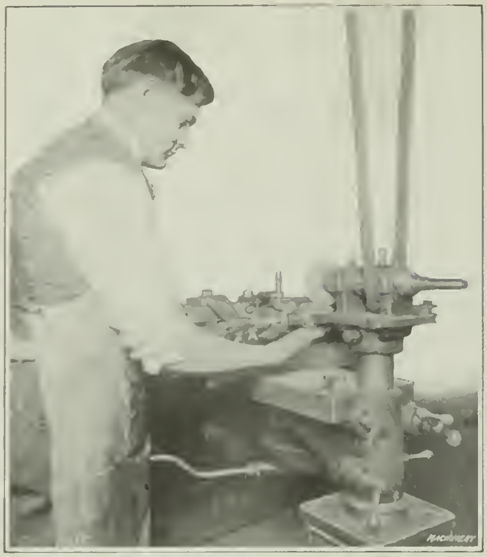

Fig. 1. Grinding Hobs in Gashes to sharpen Cutting Faces of Teeth

gear hobber and two gears were cut with each hob. These gears were then tested to determine their running properties and the accuracy of the teeth.

After this part of the test had been completed, four other 8-pitch hobs, after they had been ground to correct for the distortion of the lead of the thread, were sharpened ready for use. These hobs were next tested in the same way as the unground hobs, to determine the error in the uniformity of the diameter of the hob and the lead of the thread; and after this had been done, two gears were cut with each hob as in the preceding case, after which these gears were tested. With the data obtained from these tests—which is presented in Tables I to IV—it is possible to draw a definite conclusion as to the improvement of the gears which is secured through grinding the hobs.

Testing the Unground Hobs—Grinding the Gashes

In testing the first four hobs, which had not been ground to correct for the distortion of the lead of the threads, the first step was to sharpen the hobs, thus bringing them to the condition of the ordinary commercial hob made by the Illinois Tool Works. For this purpose, the hobs were transferred to a No. 2 tool grinder made by the Cincinnati Milling Machine Co. Each hob was mounted on a mandrel, as shown in Fig. 1, and an index plate *A* with the same number of spaces as there are gashes in the hob was mounted on the end of this mandrel. A spring steel leaf *B* carried by an adjustable arm *C* engaged the notches of the index plate to provide for locating the work in the proper position for grinding each gash.

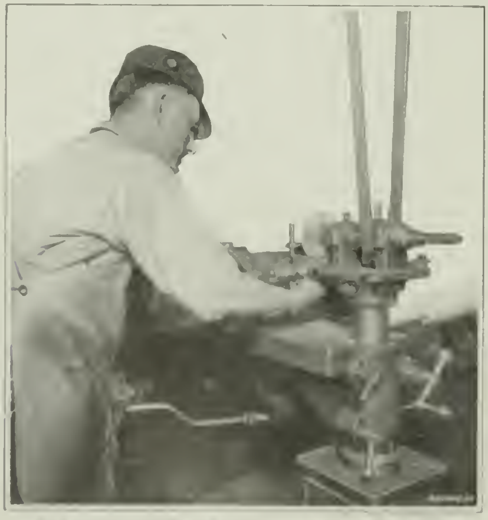

Fig. 2. Grinding Backs of Hob Teeth to provide Locating Surfaces for Use in regrinding Hob

In this connection, it may be mentioned that all of the hobs made by the Illinois Tool Works have the gashes accurately ground on both sides, *i.e.*, on the cutting faces of the teeth and the backs of the teeth. The reason for grinding the teeth on the back is that it provides accurately spaced finished surfaces which may be used for indexing when it is necessary to regrind the hobs in the shop where they are used. In grinding the backs of the teeth, the same adjustable arm *C* and spring leaf *B* are employed that were used in connection with the index plate *A* when grinding the cutting faces of the teeth; but in grinding the backs of the teeth, the index plate is not used, the spring leaf *B* being engaged by the finished cutting faces of the teeth, as shown in Fig. 2. After the teeth have been ground in this way, the diameter is tested with a special form of indicator, and must be uniform in order to pass inspection. The method of making this test will be described in a subsequent paragraph.

Testing the Accuracy of the Hobs

After the four hobs had been sharpened, they were taken to the inspection department in order to determine the amount of error in the uniformity of the diameter of the hob and the lead of the thread. In making these tests, a special form of indicator known as a "testometer" was used. For testing the diameter of the hobs, this indicator was provided with the flat button-contact *D*, shown in Fig. 3, which runs over the outer cutting edges of the teeth. The diameter of each hob was tested at both ends. In this connection it must be clearly understood that the lack of uniformity in the diameter is not necessarily the result of distortion which occurred in the hardening process, as any inequality in the spacing of the cutting edges of the teeth will result in a variation of the results obtained from the diameter test. If such an error is found, the hob is returned to the grinding department where the required amount is removed from the cutting faces of the "high" teeth until the tests can be made with satisfactory results.

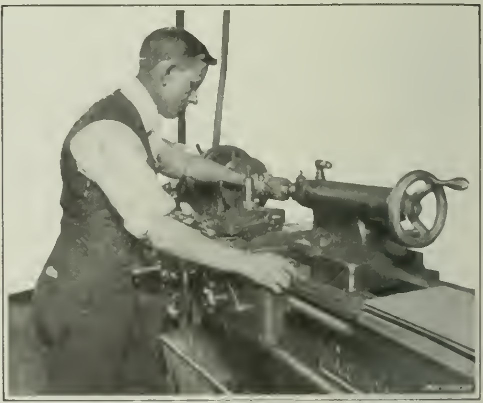

Fig. 3. Method of testing Uniformity of Hob Diameter

After the accuracy of the diameter had been determined, the hobs were tested to ascertain the amount of distortion of the lead of the thread which had occurred in hardening. For this purpose, a different form of contact was used on the testometer, this contact being a small sphere *E* which runs over the thread of the hob at approximately the pitch line, as shown in Fig. 4. Referring to Figs. 3 and 4, it will be seen that these tests were made on a Pratt & Whitney engine lathe, the hob being carried on a mandrel supported between centers, and the indicator or testometer mounted in the toolpost. The lathe was used as if a thread cutting operation was being performed, the proper gears being engaged to traverse the carriage forward at the required rate to keep the indicator point in contact with the thread of the hob as it rotated. The indicator is graduated to read direct to 0.001 inch and the graduations on the dial are far enough apart so that quarter thousandths can be estimated with a very fair degree of accuracy. The readings were taken as the indicator point passed over the cutting edge of the tooth. The cone pulley was turned by hand, as the power would run the lathe too fast to enable accurate readings of the indicator to be taken. Before starting the test, the cross-slide was adjusted to make the first reading of the testometer 0.010, so that any variation in the lead is shown by the difference of the testometer reading from the initial reading. All four hobs were tested in this way and the results obtained are shown in Table I, the results being expressed in thousandths of an inch.

The Special Hob Testing Machine

The use of the engine lathe for testing hobs has been found unsatisfactory, owing to the inconvenience of operation, although the results obtained are all that can be desired from the standpoint of accuracy. To provide for handling this work in a more efficient manner, the Illinois Tool Works recently designed the special hob testing machine shown in Figs. 7 and 8. This machine was in course of construction at the time the writer obtained the data presented in this article. As the tabulated results were obtained from tests made on the engine lathe, this method of conducting the tests is illustrated; but as the lathe has now been replaced by the special testing machine, it seems desirable to present a brief description of the features of the equipment which is now used.

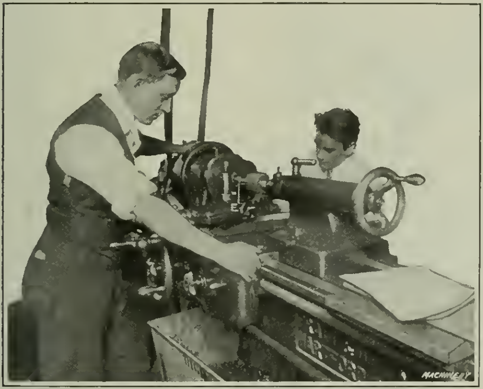
Fig. 4. Testing to determine Error in Uniformity of Lead of Thread produced in Hardening Process

By providing a special testing machine, it is only natural that far greater convenience of operation should be provided for. Referring to Fig. 7, it will be seen that the hob testing machine is provided with centers, between which the hob to be tested is supported on a mandrel. Located above the centers there is a slide on which the indicator carriage is supported. This carriage is provided with two indicators, and is traversed along its slide by the usual form of lead-screw which is turned by a handle *F* at the right-hand end of the machine. The carriage can be swiveled for spiral-gashed hobs, to enable both of the indicator needles to engage the cutting edges of the teeth at the same time. At the left-hand end of the lead-screw there is mounted the first of a set of change gears, which makes connection with the head of the machine. As in the case of the engine lathe, these gears are provided to enable the proper relation to be obtained between the traverse of the carriage and the rotation of the hob, so that the indicator points keep in proper contact with the thread as the hob rotates. It will be seen that the two indicators are employed, one indicator testing the uniformity of each side of the hob thread. This enables the tests to be conducted much more rapidly than was possible when the lathe was used, because if it was required to test both sides of the thread when the test was made on the lathe, the test had to be repeated, it only being possible to take readings for one side of the thread at a time.

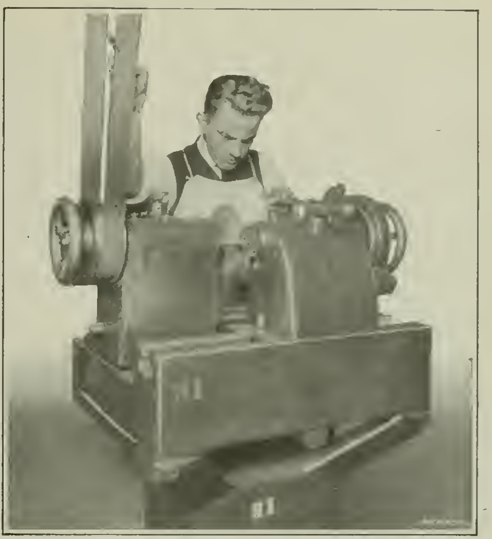
Fig. 5. Gleason Machine for testing Running Properties and Tooth Bearing of Spur Gears

Connection is made from the indicators to the hob by means of two small bellcrank levers *G*. As in the case of the tests conducted on the engine lathe, an initial reading of 0.010 inch is the starting point; and the indicators are adjusted to give this reading by regulating the position of the small cross-slide on the carriage. It will be seen that there is a graduated dial at the left-hand end of the lead-screw. Ordinarily, the indicator readings are taken as the points of the bellcrank levers *G* pass over the cutting edges of the hob teeth. In certain cases, however, it may be desired to take readings at some other specified point on the thread of the hob, as when it is required to prove the accuracy of the lead of the hob thread, when an error is found in the spacing of the gashes; and this would not be possible without the graduated dial which shows when the contact points of the bellcrank levers are in the proper position to take the reading. This machine is now being used for testing all of the hobs made by the Illinois Tool Works and is said to be giving very satisfactory results. Suitable charts have been laid out for each pitch and size of hob, and the use of these charts greatly simplifies the making of the tests.

Fig. 6. Brown & Sharpe Machine for testing Accuracy of Gears

Generating and Testing the Gears

After all four of the hobs had been tested in the manner described, they were taken out to the shop and one hob after another was set up on an Adams-Farwell gear hobber. A gear and a pinion were generated with each hob and these gears were then tested to determine their running properties and the accuracy of their teeth. For use in testing the running properties, the Gleason spur gear testing machine shown in Fig. 5 was employed. This machine has only been on the market for about a year, and so it will not be out of place to refer briefly to the purpose for which it is used and the method of operation. There are two draw-in spindles on the machine on which the gears to be tested are mounted; and the position of one of the heads may be varied to adjust the center distance between these spindles as required. One of the spindles is driven from the countershaft in the usual way, and the other is provided with a band brake for use in applying a load on the gear teeth. In this way it is possible to form an idea of the running properties of the gears by the amount of noise which they make when running at high speed; and the character of the bearing surface of the teeth is shown by the fact that those portions of the teeth which engaged with each other are smoothed down, while the remainder of the tooth surface still shows the tool marks left by the hob.

In conducting the series of tests with which this article is concerned, the gear and pinion generated by each hob were run together in the machine, and the results of the test are shown for the unground hobs in Table II and for the ground hobs in Table IV. In running the gears generated by the unground hobs, there was quite a noticeable amount of noise, while in the case of gears generated by the ground hobs, the only noise produced was a dull humming sound. Although the bearing of the gear teeth generated by the unground hobs was fairly good in all cases, it was not so uniform over the full working surface of the teeth as in the case of the gears generated by the ground hobs.

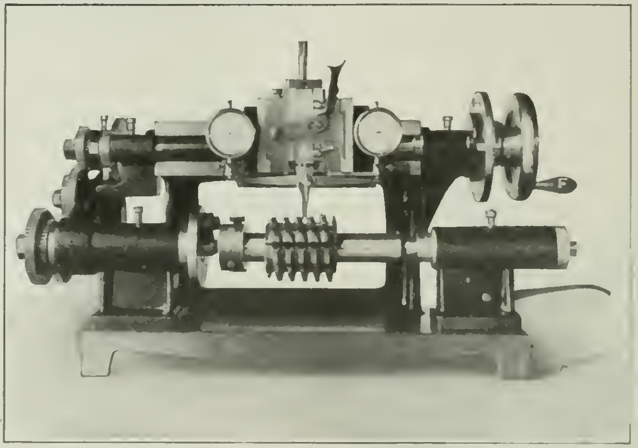
Fig. 7. Special Hob Testing Machine now used by Illinois Tool Works

In order to determine the accuracy of the tooth contour of the test gears generated by the hobs, the gears were taken to a Brown & Sharpe gear tester, where they were set up successively in mesh with a master gear. For the benefit of those readers who are not familiar with this machine, we will refer briefly to the way in which it is used. The master gear and the gear to be tested are mounted on two studs, the position of one stud being fixed while the other is carried by a slide. At the opposite end of this slide there is a stud of smaller diameter, and carried in the same bearing with the slide on which the gear stud is supported there is a second slide carrying another small stud to which a dial test indicator is secured. The set-up of the machine is clearly shown in Fig. 6. The gears are rotated by hand, and any inaccuracy causes a longitudinal movement of the slide on which one of the gears is supported, the amount of this movement being shown on the dial of the test indicator. A whole revolution of the gears shows the amount of the eccentricity of the bore, but the machine can also be satisfactorily employed for showing an error in the contour of the teeth by noting the deflection of the indicator needle while passing over a single tooth. This was the purpose for which the machine was used in conducting the present investigation. Each gear was moved through a complete revolution and the deflection of the indicator needle was noted for each tooth. In the tabulated data, the maximum error of the teeth of each gear represents the greatest error that was found for any one tooth in going all the way around the gear.

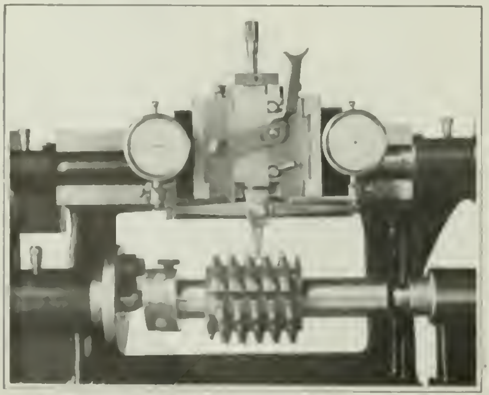
Fig. 8. Close View of Indicator Carriage and Hob to be tested

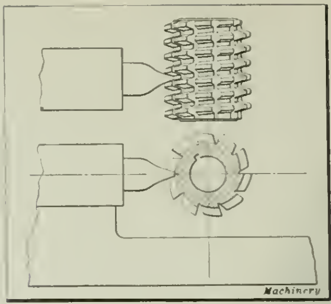

Fig. 9. Diagram showing Method of grinding to correct for Errors in Uniformity of Lead of Thread

How the Hobs are Ground to Correct for Lack of Uniformity in Lead

It will be evident to anyone who has given much thought to the subject that the only way of grinding the sides of the thread of a hob is by providing a mechanism of the general character of a relieving attachment. By the method used in the plant of the Illinois Tool Works, a small conical shaped wheel is mounted on a reciprocating slide which enables the wheel to follow the contour of the hob teeth as produced on the backing-off lathe. The principle of the mechanism of this special grinding machine is shown in Fig. 9. To allow for the grinding operation, from 0.002 to 0.0025 inch of metal is allowed on each side of the thread at the pitch line, and from 0.008 to 0.012 inch on the diameter, this allowance being varied somewhat according to the pitch of the hob and the kind of steel from which it is made. The hobs are completely ground on the sides and top face of the thread, after which they are taken to the tool grinder and the cutting faces and backs of the teeth are ground as previously described for the ordinary commercial hobs.

In making the test of hobs on which the thread has been ground to eliminate the distortion produced in hardening, it

TABLE I. RESULTS OF TESTS OF HOBS BEFORE GRINDING TO REMOVE DISTORTION PRODUCED IN HARDENING*

Test of Hob No. 1

Circumferential Row No.	Cross Row No.							Deviation in Cross Rows
	7	6	5	4	3	2	1	
1	7¾	9¼	9	8¾	10½	9¾	10	2¾
2	7¾	8¼	9¼	8½	10¼	9¾	9½	2½
3	7¾	6¾	9	8¾	8¾	10	9¾	3¼
4	7¾	7	8¼	9¼	8¾	9¼	10	3
5	7½	8	7¾	9	8¾	8¼	9¾	2¼
6	6	8½	7¾	8	8½	8¼	7¾	2½
7	5½	8¼	8½	8	8¾	9	7½	3½
8	6	7½	8¼	8½	8¼	9¾	8¾	3¾
9	6½	7¼	7½	8¾	8¾	9¾	9½	3¼
10	5½	7¼	7¼	9¼	9¾	9¼	11	5½
11	5½	8¾	7¼	8½	10½	9¾	10¼	5
12	..	8¾	9¼	8½	10¼	9¾	9¼	1¾
Deviation in Circumferential Rows	2¼	2½	2	1¼	2¼	1¾	3½	..

Hob runs out 0.00125 inch on the diameter.

Test of Hob No. 3

Circumferential Row No.	Cross Row No.							Deviation in Cross Rows
	7	6	5	4	3	2	1	
1	11	9¾	11	12	10	12	10	2¼
2	10¾	11¼	10¾	12	10¾	11	11¼	1½
3	10	12	10¾	10¾	12¼	10½	10¾	1¾
4	9¾	11¾	12½	10½	12¼	10¾	11	2¾
5	10	10½	13	11	11½	12¼	9¾	3¼
6	10¾	9¾	11¾	12½	10¾	12	12	2¾
7	10¼	10½	10¾	12¼	10½	11	12¼	2
8	9¾	11¼	9¾	10¾	11¼	10¼	11¾	2
9	11	11¼	11	9¾	10½	10¼	10½	1½
10	12¼	10¼	12	9¾	10¼	11½	9¾	2½
11	11½	9¾	11¼	11½	9½	11	10¾	2
12	11¼	9¾	10¼	11¾	10	10¼	12	2¼
Deviation in Circumferential Rows	2½	2¼	3¼	2¾	2¾	2	2½	..

Hob runs out 0.0015 inch on the diameter.

Test of Hob No. 2

Circumferential Row No.	Cross Row No.							Deviation in Cross Rows
	7	6	5	4	3	2	1	
1	7¼	7	9½	9	9¾	10	10	3
2	7¼	6¾	8½	9	8¾	10	9¼	3¼
3	7	6½	7	8¾	8¾	8¼	9	2½
4	5½	6½	6¼	8	8¾	7	8¼	3¼
5	4½	6½	6¼	7¾	8¾	8	6½	4¼
6	5¼	5½	7¼	7	8	9	7	3¾
7	5	5¾	7½	8	7¾	9¾	8¼	4¾
8	5¾	6½	6¾	9¼	9	9¾	9¾	4
9	5	8	7¼	9	10¼	9½	10¼	5¼
10	4¾	8¾	7½	8½	11½	10	10	6¾
11	..	7	9¼	9	10¾	10¾	9¾	3¾
12	..	7	8¾	9¼	9½	11	10	4
Deviation in Circumferential Rows	2¾	3¼	3¼	2¼	3¾	4	3¾	..

Hob runs out 0.0015 inch on the diameter.

Test of Hob No. 4

Circumferential Row No.	Cross Row No.							Deviation in Cross Rows
	7	6	5	4	3	2	1	
1	10½	9¾	10	10½	9½	11	10	1½
2	10¼	10	9	11½	10½	10½	11¾	2¾
3	9¼	10½	9½	11	12½	10¾	12¼	3¼
4	9¼	11	10¾	10½	13¼	11½	10¾	4
5	9¼	10	12	11¼	12¼	12¼	11	3
6	10¾	10¼	12	12	11¾	13¾	12¼	3½
7	10¼	11	10¾	13	11¾	12¼	12¾	2¾
8	8¼	11	10	11½	12	11¼	12½	4¼
9	8¼	11	10	10½	12½	11¼	10½	4¼
10	9	10¼	11¼	10¼	10¾	12	9¼	3
11	9	8¾	10¾	10¼	9½	11½	9¼	2¾
12	..	9	9¾	10¾	9¾	10¼	10	1¾
Deviation in Circumferential Rows	2½	2¼	3	2¾	3¾	3½	3½	..

Hob runs out 0.0015 inch on the diameter.

Machinery

* Note: Tabulated values represent thousandths of an inch.

is often found that there are places where the lead of the thread is not sufficiently uniform to pass the rigid inspection to which these hobs are subjected; and such hobs must be returned to the grinding department to be "touched up." Where the error on the thread occurs at a point where the thread is slightly too thick, the correction is made by merely grinding the required amount of metal from the side of the thread. In case the error is due to too much metal having already been removed from the thread, the correction is made by grinding down the top of the tooth and increasing the depth of the tooth space a similar amount, thus making a reduction of the pitch radius of the hob at this point. It must be clearly understood in this connection that the amount of error which is being eliminated in this way is exceedingly small, and while such an amount of error on the side of the hob thread would be objectionable, the error in the pitch radius introduced by the method of correction referred to is quite negligible. The heading illustration shows a ground hob to the left and an unground hob at the right, and illustrates the complete way in which the teeth of the "ground" hobs are gone over on the grinding machine. The sides of the thread are ground right to the bottom, and the bottom of the thread can be ground if necessary. This is done in the case of hobs used for generating worm-wheels, where the bottom of the hob thread finishes the top of the teeth on the worm-wheel. The same is true of some hobs used for generating spur gears. As previously stated, four of the ground hobs were tested in the manner that has already been described for the "unground" or ordinary commercial hobs; two gears were then cut with each of the ground hobs, and tested. The results are shown in Tables III and IV.

TABLE II. RESULTS OBTAINED WITH UNGROUND HOBS*

	Hob No. 1	Hob No. 2	Hob No. 3	Hob No. 4
Maximum deviation in the cross rows of hob teeth..........	5½	6¾	3¼	4¼
Maximum deviation in the circumferential rows of hob teeth	3½	4	3¼	3¾
Running properties of the gear and pinion.............	Rather Noisy	Rather Noisy	Rather Noisy	Fair
Character of bearing on the teeth...	Not uniform	Bearing at one side of tooth and from pitch line to point	Poor at one side of the tooth	Fairly uniform
Maximum error in the gear teeth.....	1	2½	2	2
Maximum error in the pinion teeth...	2½	1¼	2	2

Machinery

* Note: Tabulated values represent thousandths of an inch.

Conclusion

In order to reach a conclusion as to the amount of improvement which has been made through grinding the hobs to secure uniformity of the lead of the thread, reference should be made to Tables II and IV, where it will be seen that the horizontal rows of data in Table II give the results for the four unground hobs which were tested, and in Table IV data is presented for the four ground hobs. The first two rows in each of these tables are a recapitulation from Tables I and III, respectively, and nothing need be said by way of emphasizing the improvement in the uniformity of the lead of the hob threads which has been effected by the grinding process. In regard to the running properties and character of the bearing surface of the teeth of the gears generated by the two sets of hobs, it has already been stated that the gears produced by the ground hobs were far superior in that they ran more quietly and that the bearing surface on the teeth was far more uniform. As regards the maximum error found in the teeth of the gear and pinion generated with each hob, it will be seen from the tables that in the case of the gears produced with the unground hobs the average error is about double that in the gears produced by the ground hobs.

In this connection, it must be understood that the results obtained on the Brown & Sharpe gear testing machine, which was used for making these tests, afford a reliable means of getting comparative values of the error in the contour of different gear teeth, but the results do not represent the actual amount of error which existed. A comparison of these results will show that a very marked improvement has been made through grinding the hobs to eliminate the distortion produced in hardening; and for those cases where the greatest possible accuracy of the gearing is required, the use of ground hobs is highly desirable. The development of the method for producing these accurate hobs has undoubtedly been of great service to manufacturers who desire to make use of the hobbing machine for producing very accurate gears. But for all ordinary classes of gears, the additional expense of ground hobs is not justified, as the required accuracy can be easily attained with hobs which have not been ground to correct for the relatively small error produced in hardening.

TABLE IV. RESULTS OBTAINED WITH GROUND HOBS*

	Hob No. 5	Hob No. 6	Hob No. 7	Hob No. 8
Maximum deviation in the cross rows of hob teeth................	1	1	½	1
Maximum deviation in the circumferential rows of hob teeth....	¾	½	½	1
Running properties of the gear and pinion...	Quiet	Fair	Quiet	Quiet
Character of bearing on the teeth..........	Uniform	Uniform	Uniform	Uniform
Maximum error in the gear teeth.......	1	¾	1	1
Maximum error in the pinion teeth	1	1	1	¾

Machinery

* Note: Tabulated values represent thousandths of an inch.

TABLE III. RESULTS OF TESTS OF HOBS AFTER GRINDING TO REMOVE DISTORTION PRODUCED IN HARDENING*

Test of Hob No. 5

Circumferential Row No.	Cross Row No. 7	6	5	4	3	2	1	Deviation in Cross Rows
1	9¼	9½	9½	9½	9¾	10	10	¾
2	9¼	9½	9½	9½	9¾	9¾	10	¾
3	9	9¼	9½	9¼	9½	9¾	10	1
4	9	9¼	9¼	9¼	9½	9¾	10	1
5	9	9¼	9	9¼	9¼	9¼	10	1
6	9	9	9	9	9¼	9¼	9¾	¾
7	9	9	9	9	9	9¼	9½	½
8	8¾	9	9	9	9	9¼	9¾	1
9	8¾	9	9	9¼	9¼	9¼	9¾	1
10	9¼	9	9¼	9¼	9½	9½	10	1
11	9¼	9¼	9¼	9¼	9½	9½	10	¾
12	..	9¼	9¼	9½	9½	9¼	10	¾
Deviation in Circumferential Rows	½	½	½	½	¾	½	½	.

Hob runs out 0.0005 inch on the diameter.

Test of Hob No. 7

Circumferential Row No.	Cross Row No. 7	6	5	4	3	2	1	Deviation in Cross Rows
1	10¼	10	10	10	10	10	10	¼
2	10¼	10	10	10	10	10	10	¼
3	10¼	10	10	10	10	10	10	¼
4	10	10	10	10	10	10	10	0
5	10	10	10	10	10	10	10	0
6	10	10	10	10	10	10	10	0
7	10	10	10	10	10	10	10	0
8	10	10	10	10	10	10	10	0
9	10	10	10	10	10	10	10	0
10	10¼	10	10	10	10	10	10	¼
11	10½	10	10	10	10	10	10	½
12	10	10¼	10	10	10	10	10	¼
Deviation in Circumferential Rows	½	¼	0	0	0	0	0	.

Hob runs out 0.001 inch on the diameter.

Test of Hob No. 6

Circumferential Row No.	Cross Row No. 7	6	5	4	3	2	1	Deviation in Cross Rows
1	9	9	9	9¼	9¾	9¾	10	1
2	9	9	9	9¼	9½	9¾	10	1
3	9	9	9	9¼	9½	9¾	10	1
4	9	9¼	9	9¼	9½	9¾	10	1
5	9	9¼	9	9¼	9¼	9¾	9¾	¾
6	9	9	9	9¼	9¼	9¾	9¾	¾
7	9	9	9	9¼	9¼	9¾	9¾	¾
8	9	9	9	9¼	9¼	9¾	9½	¾
9	8¾	9	9	9	9¼	9½	9¾	1
10	9	9	9	9	9¼	10	9¾	1
11	9	9	9	9	9¼	9¾	9¾	¾
12	9	9	9	9	9¼	9¾	9¾	¾
Deviation in Circumferential Rows	¼	¼	0	¼	½	½	½	

Hob runs out 0.0[illegible] inch on the diameter

Test of Hob No. 8

Circumferential Row No.	Cross Row No. 7	6	5	4	3	2	1	Deviation in Cross Rows
1	10	10	10	10	10	10	10	0
2	10	10	10	10	10	10	10	0
3	10	10	10	10	10	10	10	0
4	10	10	10	10	10	10	10	0
5	10	10	10	9¾	10	10	10¼	½
6	10¼	10	10	10	10	10	10	¼
7	10	10	10	10	10	10	10	0
8	10	10	10	10	9¾	9¾	10	¼
9	10	10	10	10	9¾	9¾	9¾	¼
10	10¼	10¼	10	10	10	10	10	¼
11	11	10¼	10	10	10	10	10	1
12	11	10	10	10	10	10	10	1
Deviation in Circumferential Rows	1	¼	0	¼	¼	¼	½	

Hob runs out 0.0005 inch on the diameter

Machinery

* Note Tabulated values represent thousandths of an inch.

THE FLOATING PRINCIPLE AS APPLIED TO FIXTURE WORK

EXAMPLES OF FIXTURES IN WHICH THE FLOATING PRINCIPLE IS ILLUSTRATED

BY ALBERT A DOWD*

THERE are many instances in the design and construction of fixtures for machine tool equipment work that require application of the floating principle in order to make them thoroughly efficient. When thin castings are to be handled, the application frequently takes the form of a system of floating clamps, which are arranged in such a way that pressure sufficient to hold the work can be applied without danger of distorting it. It may also be necessary to have the locating points so designed that they too will float to a certain extent so that they will adapt themselves to varying conditions. The latter application is most frequently indicated in cases where rough castings are to be machined so that inequalities in the work will not affect the product by imperfect locating. Abnormal or extraordinary conditions sometimes require the application of the floating principle to the location of work which has two or more finished surfaces in different planes, and considerable ingenuity is apparent in some of the devices used in cases of this kind.

The nature of the castings for which the fixtures are designed has a strong influence on their construction, and the type of machine tools on which they are to be used is also a prominent factor in the design. The accuracy required in the finished product, and the number of pieces to be machined must also be considered in connection with the design.

Fixtures of this kind may be adapted for work on various kinds of machine tools, such as drill presses, milling machines, lathes (turret and engine types), boring mills or grinding machines. All of these require fixtures of somewhat different construction, according to the machines on which they are to be used, and the purpose for which they are intended.

It is naturally out of the question to cite examples of every kind of device to which the floating principle can be applied, but an attempt will be made to cover the field in such a way that various applications of the devices shown may be made to cover a wide range of work.

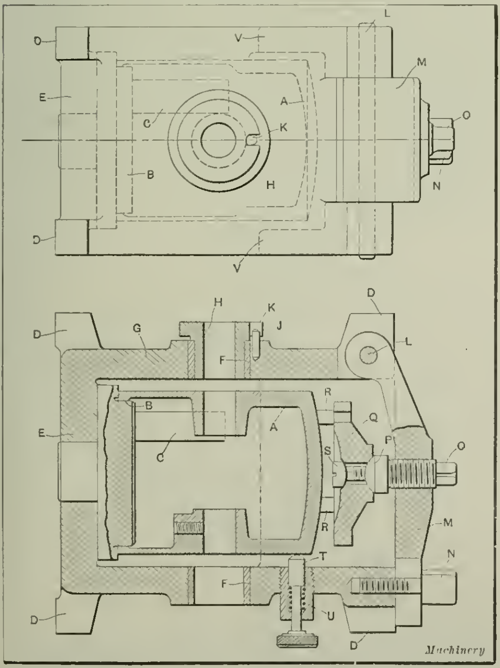

Fig. 1. Piston Drill Jig with Floating Clamps

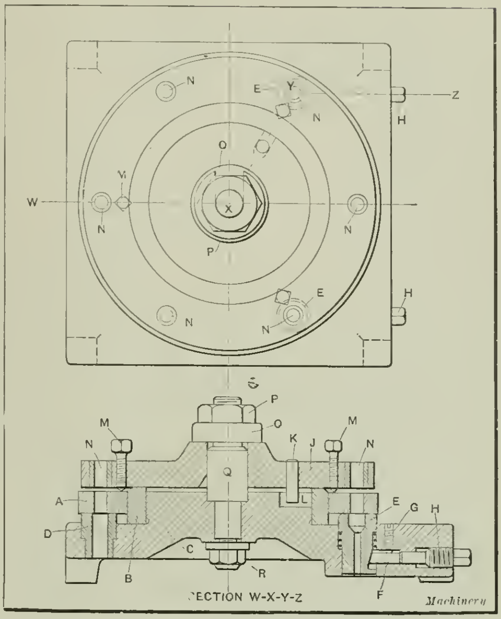

Fig. 2. Drill Jig for Rough Steel Collar

It is well to state that in connection with the application of the floating principle, the greatest care must be used in the design in order to make sure that it is correctly applied, for it is quite possible to obtain a "float" in some portion of a device or tool, which, being of faulty construction, will not produce the results desired. (Several examples of both good and bad floating reamer types are noted in a discussion of this subject which appeared in the July, 1913, MACHINERY, under the heading "Floating Reamer Holders.")

Important Points in the Application of the Floating Principle

In order to obtain the most satisfactory results in its application, a few points are here noted which are worthy of attention.

1. As applied to clamping or holding methods, the greatest care must be used in order to make sure that the floating action is not constrained in any one direction, but will operate equally well and with uniform pressure on the required area. Frictional resistance may at times be sufficient in cases of this kind to cause imperfect work by reason of unequal pressures on the work itself. When the clamping action is applied to a rough surface, still greater care must be used in this regard, and the amount of float must be so proportioned that it will take care of a considerable variation in the castings or forgings. When a great number of pieces are to be handled, several patterns are often used and these will be found to vary somewhat so that there are slight differences in the resulting castings. For this reason due allowance must be made.

2. When applied to methods of locating the work, or as supporting points on which it rests, the construction must be such that it will not by any possibility cause distortion. If springs are used under supporting plugs which are afterward to be locked in position, the springs must be proportioned so that they will not be strong enough to cause any trouble by

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forcing the piece out of its true position. Also when supports are placed against finished surfaces they should be so arranged that they will not injure them. In locating a piece of work from two previously machined surfaces which are in different planes, the float-action must be very carefully studied, and every refinement provided so that the contacts are positively assured, and no "cocking" of the work will result. There are occasional instances which require the location of a piece of work from a previously machined surface, in connection with a threaded portion by which it must be clamped. In a case of this kind the "float" must be made so that it will take care of a possible lack of concentricity between the thread and the other finished surfaces and at the same time provide means of equalizing variations in the alignment of the thread.

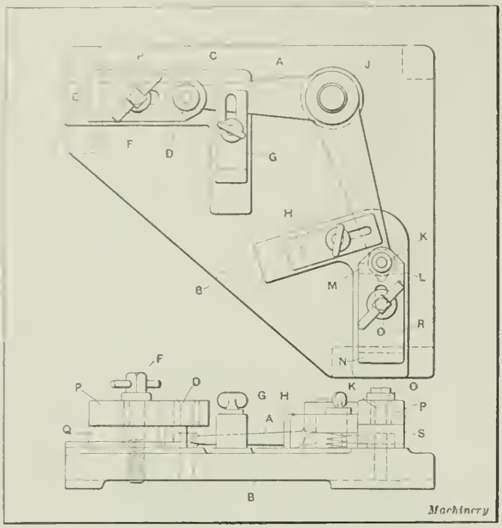

Fig. 3. Drill Jig with Floating Bushings and Locating Vees

3. Locking devices for floating members must be arranged so that the members can be positively locked or clamped without causing any change in their positions. A turning action such as might be caused by the end of a screw against a locating point is sometimes sufficient to throw the work out of its correct position. The interposing of shoes between the screws and the floating members will prevent any trouble of this kind.

Other points in construction and design will be noted in connection with the examples given during the progress of this article.

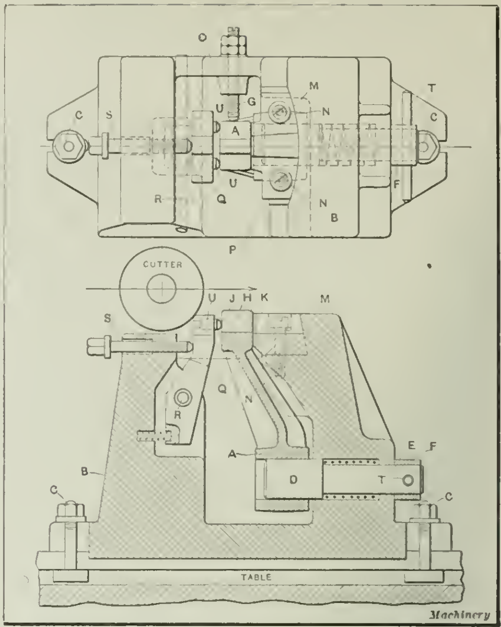

Fig. 4. Milling Fixture with Floating Clamps and Locator

Piston Drill Jig with Floating Clamps

A very good example of a drill jig which is provided with a floating clamp to work on a rough surface is shown in Fig. 1, the work in question being a piston casting *A* which has been previously machined at *B*. The body of the jig *G* is of semi-box section and is provided with feet *D* on which it may be rested, both during the loading and when under the drill. A hardened and ground steel stud *E* is let into the casting at one end and served as a locating point for the machined interior of the piston *B*. A stud *C* is further provided to give the correct location to the wrist-pin bosses.

As the end of the piston is of spherical shape and in the rough state also, it is necessary to provide a means of clamping which will so adjust itself to the inequalities of the casting that an equal pressure will be obtained so that there will be no tendency to cock or tip the work. A heavy latch *M* is pivoted on the pin *L* and is slotted at the other end to al-

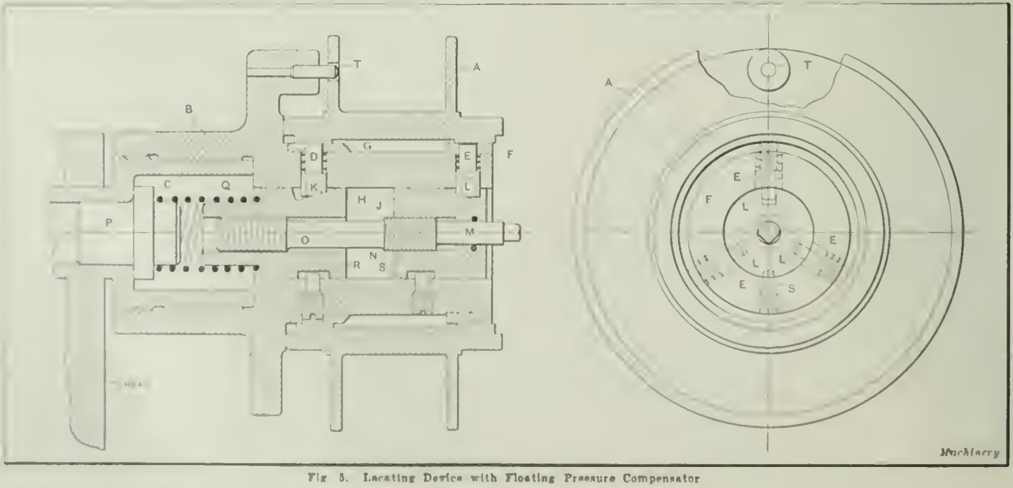

Fig. 5. Locating Device with Floating Pressure Compensator

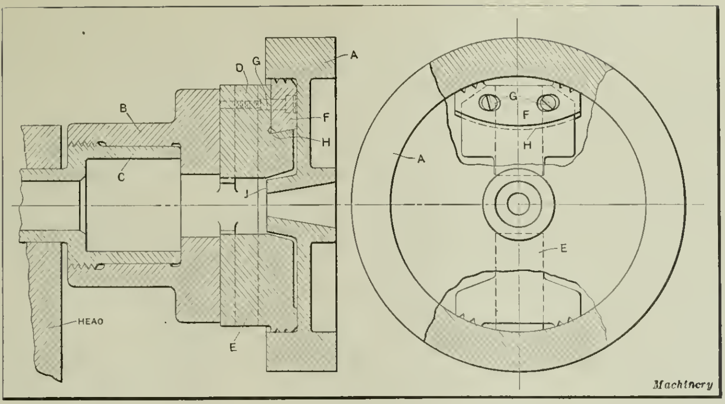

Fig. 6. Two-jawed Chuck arranged with a Floating Jaw

low the passage of the thumbscrew *N* which is used to clamp it in position. A special screw *O* is threaded into the latch, and is ball-ended at *P* so that it has a spherical bearing against the floating clamp *Q*. The screw *S* keeps it in position, but it will be noted that clearance is provided to allow for the floating movement around the body of the screw. Three pins *R* are set 120 degrees apart in the face of the floating clamp so that a firm three-point bearing is assured. In order to assist in supporting the work under the pressure of the drill, two spring pins *T* are provided, these being set in the form of a vee near the front end of the piston. They are encased in a screw bushing *U* and are locked in position by means of set-screws, not shown, after they have been allowed to spring up against the piston casting. (In order to avoid confusion in the drawing, one of these pins is shown at an angle of 45 degrees from its actual position.)

The steel liner bushings *F* are provided in the body of the casting so that the main bushings, which are of the removable type as shown at *H*, may not produce too much wear in the jig body itself. A slot is provided in the head of the bushing so that the pin *K* will prevent it from turning under the twisting action of the drill. It should be noted that in the construction of the spring-pins which are used to help support the casting, the springs themselves should be very light so that they will not force the piston out of its true position, determined by the locating stud.

Drill Jig for a Rough Steel Collar

The steel adjusting collar *A* which is shown in Fig. 2 has been previously bored, but no other work has been done upon it, the sides being left in their natural forged shape. Six holes are to be drilled around the rim, as shown at *N*, and it will be seen that some care is necessary in the locating and clamping arrangements so that the resulting holes will be parallel with the axis of the collar. The jig body *C* is of cast iron, and is provided with a hardened and ground steel locating collar *B* on which the previously machined interior of the ring is located. The ring is placed on this steel collar resting against the single steel bushing *D* which is inserted in the body of the jig. Two other bushings *E* are arranged 120 degrees apart, and are provided with very light coil springs which force them up against the under side of the ring. The shoes *F* are then set up against the angular cut on these bushings by means of the screws *H*. The small set-screws *G* bear against the flattened side of the shoes and prevent them from turning. It will be noted that the angular cut on the body of the bushings is such as to prevent them from pushing down under the pressure of the drill.

The bushing plate *J* is located on the stud *Q* and is prevented from turning by the pin *K* which fits the slot *L* in the body of the jig. Six bushings *N* are set into the plate at equal intervals. A nut *P* and a C-washer *O* provide for ready removal of the plate and draw it down solidly on the top of the locating ring *B*. The three pointed screws *M* are set into the work slightly to prevent any change in its location. It is well to note that it would have cost no more to machine one side of the work while it was being bored, thus obviating the necessity of the floating locating bushings.

Drill Jig with Floating Bushings and Locating Vees

A somewhat peculiar condition is shown in Fig. 3, the work *A* being a bell-crank of ordinary construction such as is used in large quantities in automobile work. There are some instances on work of this kind when a variation of 1/32 inch

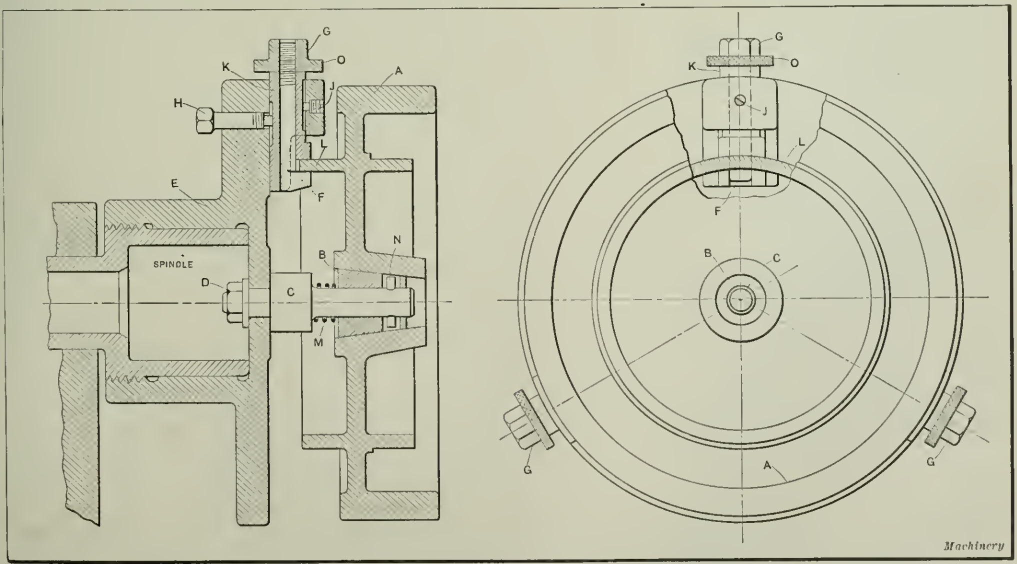

Fig. 7. Chucking Fixture with Floating Clamp and Taper Locating Plug

or more in the center-to-center distances is not considered of extreme importance, but it is quite important to have the holes as near the center of the bosses as possible. In order to counteract variations in the castings and still obtain holes which are central on the bosses, it was necessary to adopt some sort of floating construction such as that shown in the illustration. A number of jigs of this kind are in use in a large automobile factory in New England, and their action is very satisfactory. In the instance shown the work is located on a stud *J* from the previously reamed hole in the hub. It should also be noted that both hubs and bosses have been faced to size previous to the drilling operation. A sliding V-block *Q* is carefully fitted to the slot *E* in the body of the jig, and on it is mounted the bushing plate *P* in which the bushing *D* is carried. After the piece has been placed in position the sliding block is pushed forward by the operator until the vee *C* comes up against the boss on the casting and locates it. The thumb-screw *F* locks the block firmly in position, and the sliding clamp *G* holds the work. Another block *S* is also cut out in the form of a vee at *L*, but is not tongued on its lower side to fit a slot, as in the other instance. A bushing plate *R* is mounted on it with a bushing *K* at the forward end. The under side of the block has two narrow bearing surfaces *N* and *M* and it is free to swivel in any direction required by the slightly varying positions of the boss. The thumb-screw *O* holds it in place after it has been located by the operator. The other clamp *H* is then used to hold the piece firmly. A drill jig of this kind is not suited to all classes of work, but the floating action gives excellent results when absolute accuracy is not required.

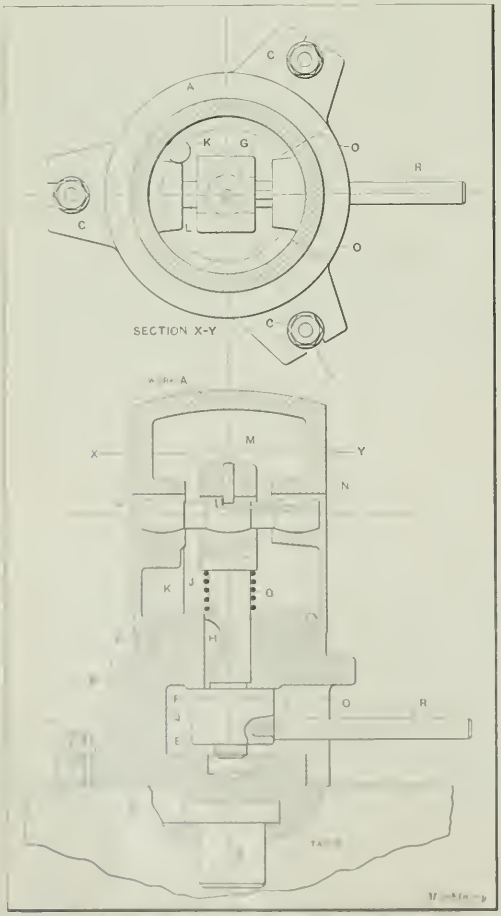

Fig. 8. Piston Chuck having Floating Clamping Features

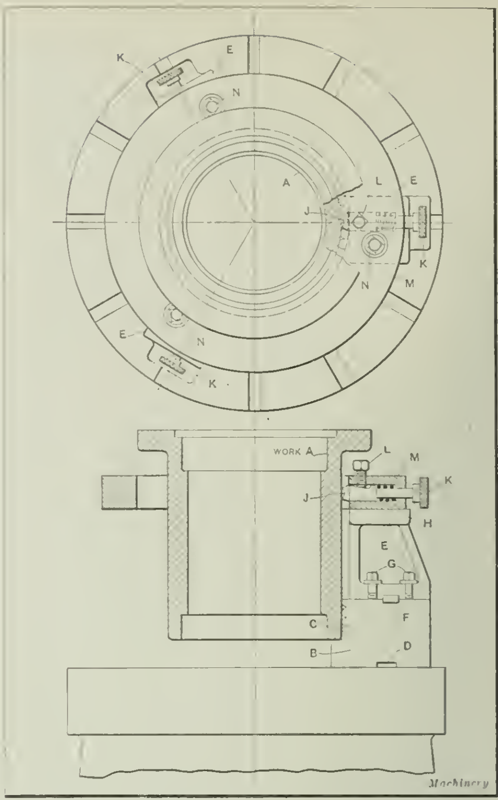

Fig. 9. Chuck Jaws with Floating Locating Points

Milling Fixture with Floating Clamps and Locator

In the design of milling fixtures a point which is of extreme importance is that of so arranging the various clamping devices that they will not produce undue strain or distortion. In addition to this all members used must be of sufficiently heavy construction to avoid all possibility of chatter. The work *A* as illustrated in Fig. 4 has been previously chucked and it is desired to mill the slot *H* at its upper end in a certain relation to the reamed hole. The two portions of the casting *J* and *K* are left rough, and as a consequence it becomes necessary to arrange the clamps and locating points so that they will equalize the inequalities of the casting. The body of the fixture *B* is cast iron and of somewhat heavy section, being tongued at its lower side to fit the slot in the table and held down in the usual manner by the tee-bolts *C* at each end. The work is placed on the adjustable plunger *D* which is pulled back by the pin *T* passing through the outer end. A stop collar *F* is forced onto the end of the shank *E* in order to prevent too great a movement of the plunger. The upper end of the work is swung over against the stop-screw *G* which is set in a boss in the rib *O* that ties the two sides of the fixture together. One of the rough sides *K* of the casting strikes against the rocker *M* which automatically adjusts itself to the variation in the casting. It will be noted that the fixture is bored out radially and slightly under-cut to fit this rocker, and that it is held in place by the screws *N*. The holes which these screws enter are slightly enlarged to permit the necessary movement. Two steel pins *U* bear against the other side of the rough casting, these pins being set in swinging floating clamp *Q*, the provision for float being supplied by an over-sized hole at *R*. The set-screw *S* bears against the center of this rocking clamp and gives the pressure necessary to hold the work. A small coil spring throws the clamp back out of the way when assembling or disassembling the work. Attention is called to the fact that

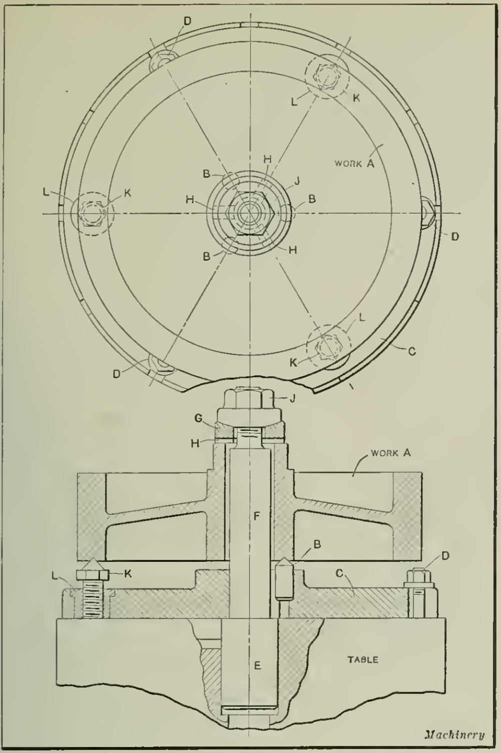

Fig. 10. Roughing-out Fixture for a Motor Gear

the direction of the cut in machining the slot is such that the pressure comes against the solid body of the casting and not against the clamp.

Locating Device with Floating Pressure Compensator

The work *A* shown in Fig. 5 has been partially machined in a previous operation, and the flange has also been drilled so that one of the holes can be used for driving purposes. The machine to which this device is applied is a turret lathe of the horizontal type, and the body *B* is screwed to the spindle end *C* in the usual manner. The pin *T* is set into a boss in the face of the fixture and acts as a driver in one of the flange holes. Two steel rings *F* and *G* act as approximate locators for the work when it is first placed on the fixture. Two cylindrical steel cams *H* and *J* are accurately ground to fit the central hole in the fixture, and are operated by the rod *M* which is threaded right- and left-hand, respectively, at *N* and *O*. Each cam is milled to a 20-degree angle at *K* and *L*, three of these slots being equally spaced around the periphery so that their angular surfaces control the movement of the locating pins *D* and *E*. The coil springs return the pins to an inactive position when released by the cams. A plug *P* is placed in the spindle as shown in the illustration, for the purpose of providing a seat for the coil spring *Q* which assists in the releasing of the pins after the machining has been done. The two stop-pins *R* and *S* limit the movement of the cams and take all the thrust of the twisting action of the operating screw.

In this connection it is well to note that these stop-pins are a nice fit in the cam slots, while the locating pins have a side clearance in the angular slots of 0.010 inch so that there is no possibility of trouble being caused by friction at these points. Attention is further called to the fact that the action of the cams is such that a true floating motion is produced when the screw is operated so that all of the locating pins are set up with an equal amount of pressure. A floating action of this nature may be readily applied to holding fixtures for a great variety of work.

Chucking Fixture with Floating Clamps and Taper Locating Plug

A somewhat unusual condition is shown in Fig. 7, the work *A* being a special clutch flywheel which has been partially machined in a prior setting. In order to obtain concentricity of the various surfaces, it is obviously necessary to locate the work from the taper in the hub. In order to compensate for slight variations between the taper and other finished surfaces, a tapered shell locating bushing *B* is centrally located on the stud *C* which is held in place in the faceplate fixture *E* by the nut and washer at *D*. A light coil spring *M* insures a perfect contact with the tapered surfaces, while a small pin *N* restrains the movement. As the outside of the work is to be finished during this setting, it is necessary to grip the casting in such a way that the clamps will not interfere with the cutting tools, nor cause distortion in the piece itself. With this end in view the three lugs around the rim of the fixture are provided with shell bushings *K*, each of which is squared up at its inner end to form a jaw which is bored to a radius corresponding with the rim of the casting *L*. It is splined to receive a teat screw *J* which prevents it from turning, and it also gets a good bearing directly under the point where the work is held so that there is no danger of springing out of shape.

The bolts *F* pass through the shell bushings and are furnished with nuts *G* at their outer ends, the nuts having a knurled portion *O* which permits of rapid finger adjustment before the final tightening with a wrench. It will be seen that this construction automatically obtains a metal-to-metal contact with the thin flange of the casting without distorting it in the least, as the floating action of the bushings equalizes all variations and yet holds the work very firmly. After the clamps have been set up tightly, they are locked in position by the set-screws *H* at the rear of the fixture. This application of the floating principle may be adapted to many kinds of work, and the results obtained leave nothing to be desired. The machine on which this device is shown is a turret lathe of the horizontal type.

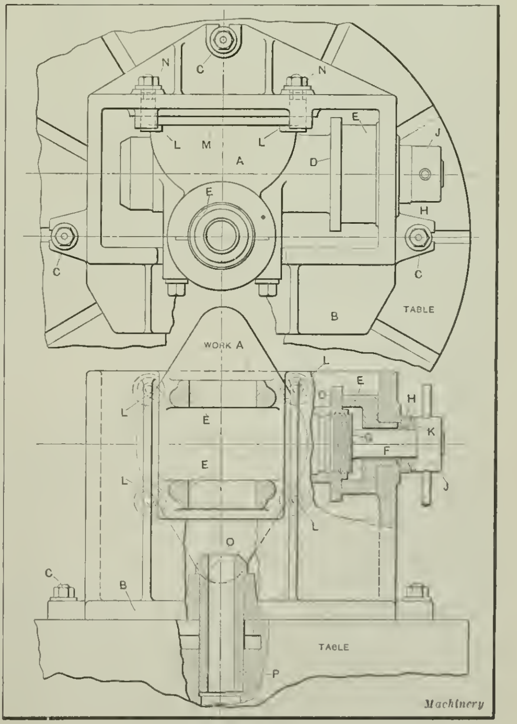

Fig. 11. Fixture with Floating Locators to take Care of Two Finished Surfaces

Two-jaw Chuck Arranged with a Floating Jaw

The work *A* shown in Fig. 6 is a motorcycle flywheel which it was desired to machine in one setting complete. The machine to which the equipment was applied was a horizontal turret lathe. Several lugs on the interior of the casting made the matter of holding the work in a three-jaw chuck out of the question on account of interferences with the jaws. A two-jaw chuck was therefore utilized, and interferences thereby avoided. As the centering action of a chuck of this type is very uncertain when used for holding work by an interior surface of comparatively large diameter, some method of locating was necessary which would at the same time center the casting, and yet not cause trouble by interfering with the lugs on the interior of the flywheel. (The lugs on the interior of the casting are not shown in the illustration, in order to avoid confusion.)

The chuck body *B* is screwed to the spindle *C* in the usual manner and is provided with two special jaws, one of which, *E*, is of plain design having two bearing surfaces on the inner rim of the flywheel casting. The other, *D*, is grooved to fit the chuck like the regular jaw, but is very much wider as it comes above the face of the chuck. This portion is turned to a radius at *H* and given an angle of 10 degrees at the same time in order to counteract the lifting tendency which might cause trouble when the jaws were tightened. The floating member or "rocker" *F* is mounted on this jaw as shown in the illustration, and is limited in its movement by the two screws *G* and the elongated holes in the rocker. This construction gives a very good centering action, and the rocker jaw has sufficient "float" to take care of variations in the casting.

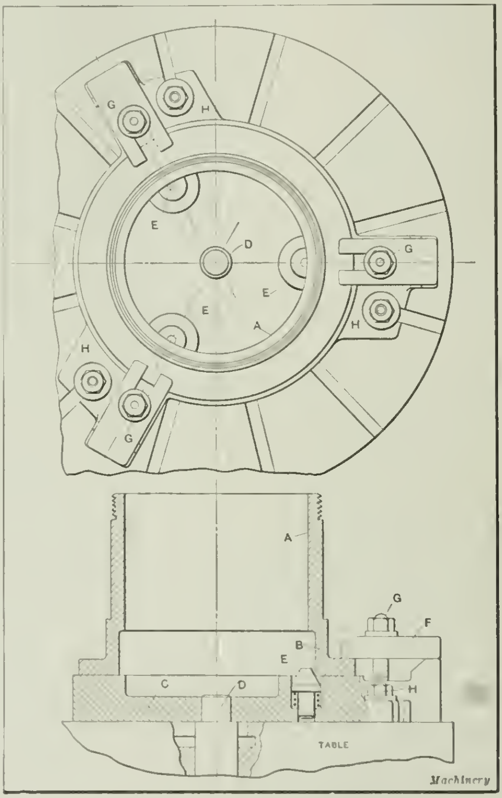

Fig. 12. Fixture with Floating Locating Points

Piston Chuck Having Floating Clamping Features

The work *A* shown in Fig. 8 is a large automobile piston which has been bored and faced on the open end to a predetermined size and which is to be completed in this setting, concentric and square with the finished portion. Previous to this setting and after the boring and facing operation, the wrist-pin hole is rough-drilled in a jig in order to facilitate the holding of the work on the fixture.

The casting is located on a hardened and ground steel ring *F* which is forced onto the body of the fixture *B*, and a small annular groove on the ring prevents trouble or errors in locating, which might be caused by the presence of chips or dirt on the locating surface. The body of the fixture is held in place on the table of the machine by the bolts *C* which enter the table tee-slots, and it is centered on the table by the plug *D* which is forced into it at *S*. The clamping pin *L* is ball ended, and has a spherical portion in the center also. It is slotted at *N* so that the pin *M* in the draw-bar *O* will enter the slot as it is passed through the wrist-pin holes, and bring up against the shoulder so as to center the clamping pin in the piston. A great deal of strain is taken by this clamping pin, and for this reason it is made of tool steel and spring tempered, so that there will be less chance of breakage.

The draw-bar *O* is also of tool steel, and it is keyed with a Woodruff key at *H* to prevent its turning, the key being a sliding fit in the body of the fixture. The lower end of the rod is threaded with a 4-pitch Acme thread, double, left-hand, to fit the operating nut *Q*, this latter being provided with a handle *R* which extends out through a cored opening *O* in the fixture. The permissible movement of this handle is sufficient to produce a vertical movement of 3/16 inch of the draw-bar, which is ample for the purpose of clamping and releasing. A thrust collar *P* is interposed between the operating nut and the boss on the under side of the fixture, and a coil spring *J* keeps the rod up so that the clamping pin may be easily placed in position. The pocket *E* in the upper end of the centering plug is for clearance only. A heavy pin *K* acts as a driver against one of the wrist-pin bosses, so that the draw-rod and pin are not called upon to perform this part of the work.

It will be noted that while this chucking device is very rapid in its operation, there is no tendency to "cock" the piston or distort it in any way, as the floating action of the pin with its three-point bearing equalizes all pressures, and at the same time provides a very secure method of clamping the work.

Chuck Jaws with Floating Locating Points

The work *A* shown in Fig. 9 is to be bored, shouldered and faced complete in one setting, and on account of its length it was considered necessary to provide additional supporting points besides the jaw surfaces. A set of special jaws *B* is keyed to the sub-jaws in the table at *D*, each special jaw being shouldered at *C* to support the work.

The brackets *E* are tongued at *F* to fit the special jaws and are secured thereto by the screws *G*. These brackets act as a support for the steel floating ring *M* in which the three spring-pins *J* are placed. Elongated holes at points *N* allow the required floating action, the ring being clamped by the collar-head screws. The brackets on which the ring rests are provided with a shelf *H* which is offset slightly from the center so as to give the necessary width for the screws. In using the device, the screws *L* and *N* are loosened, and the work placed in the jaws, which are then tightened while the ring floats sufficiently to allow for variations. It will be noted that the pins, being spring-controlled, adapt themselves to the casting and are there locked by the screws *L*, after which the ring itself is clamped by the collar-head screws *N*.

Although the floating action of this device was satisfactory, the driving or gripping power was found insufficient to hold the work securely, and it became necessary to replace the spring pins with square-head set-screws, cup-pointed, the ring being tapped out to receive them. The ring was then allowed to float while these screws were lightly set up on the work, after which the clamping screws *N* were tightened. After this change in construction, the action of the mechanism was much improved, and the driving power was found sufficient.

Roughing Out Fixture for Motor Gear

A very unusual condition is shown in Fig. 10, as the work *A* is a steel forging which is to be roughed out all over within limits of 1/8 inch plus or minus. After the roughing operations, the work was machined (all except the web) to the required dimensions, other fixtures being used for the finishing operations.

The amount of metal to be removed was considerable so that it was necessary to provide a good means of driving the work in order that no slippage might occur, due to the pressure of the cut. A fixture *C* is centered on the table by the stud *E* which is turned down at *F* to a size small enough to enter the hole in the hub. The three bolts *D* are used to hold the fixture down on the table, the table tee-slots being utilized for the purpose. Three studs *B*, which are of tool steel with conical hardened ends, serve as locating points and drivers for the hub of the forging. The floating collar *G* has a concave surface on which the special nut *J* bears, and it is provided with a three-point bearing on its under side to equalize variations in the end of the hub, as shown at *H* in the illustration. As the diameter of the hub is somewhat small, it is evident that the amount of driving surface accessible at this point would be insufficient for heavy cuts to be taken. As an additional precaution, the threaded bushings *L* are set in the body of the fixture and are provided with the screws *K* which are cone-pointed and of hardened tool steel. These screws are set up into the rim of the forging to assist in the driving.

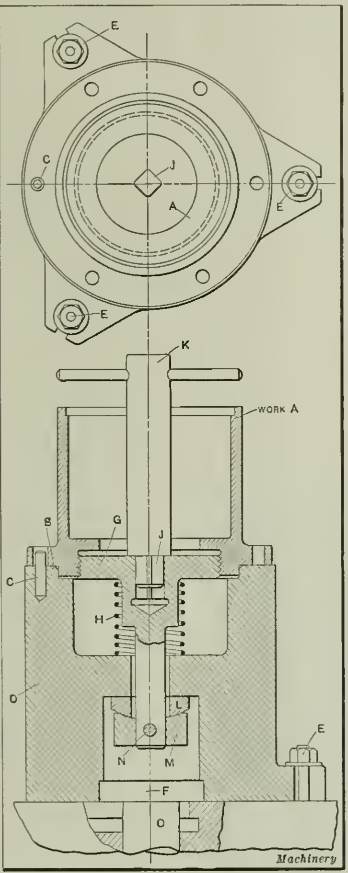

Fig. 13. Fixture with a Floating Threaded Locator

Fixture with Floating Locators to take Care of Two Finished Surfaces

It is occasionally necessary to make up a fixture in such a way that it will locate a piece of work correctly from two finished surfaces in different planes. An example of this kind is shown in Fig. 11, which is an automobile housing, surface-milled at *M* and faced and threaded on the flange *D*. It is necessary to locate the work from these two surfaces in order to bore the bearings *E*. The fixture *B* is located on the table by the centering bushing *P* which is of tool steel hardened and ground and which acts as a guide at *O* for the pilots of the boring tools which are used in machining the work.

The work is placed in the fixture with the finished flange *M* against the pad and is held in place against this surface by the four hook-bolts *L*, the nuts *N* being used to draw them up tightly. A screw plug *G* enters the threaded end of the flange *D*, and the shank *F* passes through the bushing *E* and obtains a spherical bearing at *K* on the floating washer *H*, clearance being provided in the enlarged hole in the bushing so that slight inequalities both in the alignment of the thread and the surface of the flange will be equalized by the floating action. The collar *J* is provided with a handle by which the screw may be operated. The nature of this work is such that the accuracy required is compensated for by this method of locating.

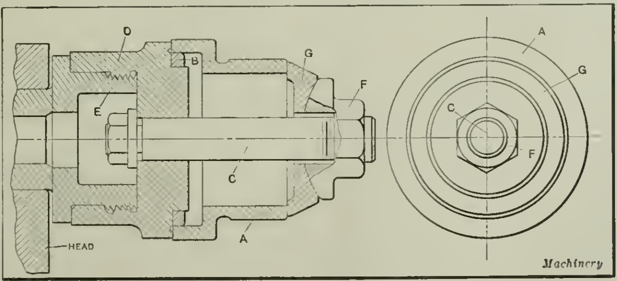

Fig. 14. Grinding Fixture for Steel Collars

Fixture with Floating Locating Points

We sometimes learn more by the observance of mistakes in design than we do by those which are perfectly satisfactory. An example of a fixture which was incorrect in design and which did not give satisfactory results is shown in Fig. 12. In this case the work *A* is a large cast-iron pot which is located on the cored interior surface *B* by the three conical spring points *E*, these points being so designed that they will approximate the center of the cored surface. The fixture *C* is centered on the table by the plug *D* and is held down by the three bolts *H* which enter the table tee-slots. Three clamps *F* are slotted at their inner end to allow a rapid withdrawal and are clamped down upon the rim of the work by the nuts and washers at *G*.

The principal fault in this device was the fact that although the conical points *E* permitted a floating action, there was nothing to prevent any one of these points being forced downward more than the others so that there was naturally a tendency toward faulty locating, caused by the unequal distribution of pressure on these points. A single spring plug having three points of location would undoubtedly be more satisfactory, for then the pressure would be more evenly distributed.

Fixture with a Floating Threaded Locator

Fig. 13 shows a piece of work *A* which has been previously faced and threaded. Six holes have also been drilled in the flange, one of which is used for driving through the medium of the pin *C*. The fixture *D* is of cast iron, located on the table by the plug *O* which is centered in the fixture *F* and is held down by the bolts *E* in the usual manner. The work itself locates on the fixture by the shoulder portion *B* and is driven by the pin *C* in one of the flange holes. In order to equalize any variation between the faced surface and the threaded portion the floating threaded plug *G* is provided with a spherical collar *M* at its lower end, this collar being pinned to it by the pin *N*. The floating collar *L* also has a spherical bearing which matches that of the collar *M*. Sufficient clearance is provided in the body of the fixture to allow the plug to float in any direction. A spring *H* keeps the threaded plug up in its proper position. A socket wrench *K*, squared at *J*, is provided for drawing the threaded plug up into the work.

Grinding Fixture for a Steel Collar

The work *A* shown in Fig. 14 is a steel casting which is to be ground on the two exterior surfaces. A nose piece *D* is screwed to the end of the spindle *E* and is provided with a hardened and ground locating ring *B* on which the work locates. The stud *C* is forced into the nose piece and is threaded on its outer end to receive a spherical nut *F*. The collar *G* is concaved to the same radius as the spherical portion of the nut so that it floats against the end of the work.

THE VALUATION OF MACHINE TOOLS*

FUNDAMENTAL PRINCIPLES GOVERNING THE MAKING OF AN ACCURATE APPRAISAL

BY GEORGE L. COLBURN†

As soon as a machine is installed and ready for operation, it begins to depreciate in value. This depreciation takes place at a variable rate and is more or less compensated for by repairs and renewals. But although depreciation takes place at a variable rate, an average can be determined by estimating the probable working life of the machine and then distributing over this period the difference between the cost of the machine and its junk value. The cost of the machine includes the original price, the expense of installation, the cost of all repairs and renewals, and the expenditure for special tools and fixtures. The installation expense includes the cost of freight, carting, millwright material and labor. The junk value of the machine is the net value received for the old metal in it after making the proper deduction for the expense of dismantling the machine, preparing the junk for shipment, carting and all other incidental expenses. For example, suppose it is required to determine the average depreciation per year of an engine lathe, which originally cost $500, and for which the working life is estimated at twenty years. The installation cost was $65; the total cost of repairs, renewals, and special tools and fixtures is estimated at $100; and the junk value is approximately $5. The depreciation per year will be:

$$\frac{500 + 65 + 100 - 5}{20} = \frac{660}{20} = \$33.$$

$$\frac{33}{660} \times 100 = 5 \text{ per cent.}$$

An average depreciation arrived at in this way is generally found more convenient for purposes of accounting than the use of figures obtained from annual appraisals of the plant. Some firms establish an average annual rate of depreciation on all machine tools, this rate being not far from 5 per cent; but very cautious concerns allow as much as 10 per cent for the annual rate of depreciation on all machinery in the plant. The preceding method of figuring the average depreciation rate on individual machine tools is more accurate than any general average is likely to be, although it requires more time from the cost clerks and the expense of additional bookkeeping. The office records of mechanical equipment should show the original price of each machine; the date of purchase; the name and address of the builder; and the cost of installation, repairs and renewals, and special tools and fixtures.

In figuring an average rate of depreciation for a given machine, the probable cost of special tools and fixtures is difficult to estimate in advance, but this part of the work is greatly simplified when the builder of the machine has a listed stock of such tools and fixtures from which the purchaser can select those which are necessary for handling his work. The probable working life of the machine and the cost of repairs and renewals naturally depend upon the care which the machine receives, the number of hours it is used per day and the character of the work for which it is used. In estimating the probable life of a machine and the cost of repairs, renewals and special tools and fixtures, the cost clerk could be greatly assisted by a factory committee consisting of the superintendent and foremen of departments, including the repair foreman. It is customary in most factories to take an annual inventory of stock, supplies, small tools, machinery, furniture and fixed plant. Then by reference to the records of the purchasing and bookkeeping departments, data is available which may be used in connection with the predetermined rates of depreciation to enable the cost clerks to place inventory values on all items.

Machine Tool Appraisals

As a check on the cost clerk's work, it is advisable for the factory manager or some other official who is acquainted with the technical details of the equipment to annually appraise the value of the machinery and fixed plant. In making such an appraisal it would be of great assistance to have each machine provided with a nameplate giving its inventory number, the date when it was built and the name and address of the manufacturer. Whenever there is any doubt about the value which should be placed upon a machine tool, the office records should be consulted to determine the original price, the installation expense and the cost of repairs, renewals, and special tools and fixtures. Additional information may often be obtained by consulting the foreman of the department in which the machine is used and the repair foreman. An appraisal of machine tools conducted by a factory official should be thoroughly and scientifically carried out without reference to the tax and insurance rates or the relation of dividends to capital invested.

In order to obtain a thoroughly impartial appraisal, or as a check on their own method of valuation, many firms employ an expert appraiser to place a value on their furniture, supplies, small tools, machinery and fixed plant. Some appraisers also place a value on stock, but as a rule manufacturers prefer to fix their own value on this item. Among the numerous factors which such an expert appraiser has to consider before being able to place an accurate value upon a machine tool, the following may be mentioned: productive efficiency of the machine, original price, expense of installation, cost of repairs and renewals, investment in special tools and fixtures, and the probable working life of the machine.

Productive Efficiency of a Machine

The productive efficiency of a machine, or the ratio of its actual output to the maximum output, is the real basis in fixing its value in dollars and cents. Many conditions exert an influence in fixing this productive efficiency. For instance, a low efficiency may be due to an insufficient supply of stock, lack of skill on the part of the operator, lack of power or operation at too slow a speed; and it will be noted that the builder of the machine is in no way responsible for any of these causes of poor efficiency. The appraised value of a machine tool is not necessarily affected by such conditions, the points of cardinal importance in fixing its value being the actual condition of the machine itself, such as the style; age; state of repair and rate of production under the most favorable conditions, as compared to that of a similar machine of the most modern design.

Original Price, Installation Expense and Final Junk Value

The maximum value of a machine is the current price of a similar machine that is available for immedate delivery plus the expense of installation. The final junk value is the net price which can be obtained for the materials in the machine after deducting the expense of dismantling the machine and preparing the junk for shipment.

Additions, Attachments and Tools

Additions or improvements in the design of various parts of a machine are frequently made in order to accomplish certain results, and the cost of such additions should be included in fixing the appraised value of the machine. The number, size and condition of each machine and its special attachments and tools, i.e., whether in good, fair or poor condition, should be stated in the inventory in addition to giving the appraised value.

Repairs and Renewals

Through continued use the working parts of a machine necessarily experience a certain amount of wear and tear, which requires the making of repairs and renewals from time to time. The lack of a proper foundation, and the provision of insufficient metal in the frame or a poor distribution of this metal, will cause vibration and result in excessive wear and breakage of machine parts. A record of the cost of repairs and renewals should be carefully kept in the office for each individual machine, where it is available for use in connection with the fixing of appraised values.

Type of Machine and Probable Working Life

Machine tools are divided into the various familiar classes, such as engine lathes, milling machines, etc., and a further subdivision of these classes is made as plain, semi-automatic, full automatic, etc. Owing to the general use of high-speed steel, machine tools are now designed and built to enable them to stand up under much greater speeds, feeds and depths of cut than was the case fifteen or twenty years ago. This change in the design of machine tools is also due to a desire on the part of manufacturers to get the maximum amount of work out of the machines, this increase in the rate of production being carried almost to the point where breaking or excessive wearing down of the cutting tools will occur. The employment of these high speeds, feeds and depths of cut, together with overtime work or the employment of night shifts, and lack of care in adjusting the machines, causes a great increase in wear and tear and a consequent reduction in the working life of the machines.

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* [illegible] "Modern Practice of Manufacturing Plant Appraisal," in Machinery for May, 1913.

† [illegible] Lawson Road, Wollaston, Mass.

Obsolete Machines

A machine may become obsolete before it is worn out. Another point in the efficient conduct of a manufacturing plant is the possibility of using a machine for performing roughing operations, which has become too badly worn to enable it to give satisfaction in the production of accurate work, after which the finishing operations are performed on a newer machine which is in good working condition. Where the labor necessary to operate an old style or obsolete machine greatly exceeds that of a more modern machine for doing the same class of work, or where its output is of considerably poorer quality than that of the more modern equipment, the obsolete machine should be dispensed with even if it is necessary to sell it at its junk value.

Machines in an Idle Factory

Machines in an idle factory depreciate rapidly in value due to rusting, etc., from lack of care. Where the machines in a factory which has stopped running are offered for sale, those types which are commonly used in many trades find the best market, and this is particularly true of those machines built by well known machinery manufacturers. Auction sales of machinery conducted under the direction of receivers of bankrupt concerns often bring high prices owing to the demand which may exist for machines for immediate delivery.

Fire Damage

Indemnity and not reinstatement is the principle on which fire insurance claims are usually settled, although insurance companies reserve the right of replacing the equipment instead of paying cash if the estimated loss is considered excessive. In the case of fires where the office records have been preserved, but where such records fail to show the original cost of the equipment, its age and probable depreciation, outside proofs of the original cost are generally secured from the dealers or manufacturers from which the equipment was purchased. When the machinery loss represents a considerable amount, the insurance companies often secure the services of a recognized expert appraiser, and in case a dispute arises arbitration is resorted to, the representatives of the insurance company and the assured conferring with a third expert appraiser obtained by them; and the agreement of any two members of this trio is accepted as final.

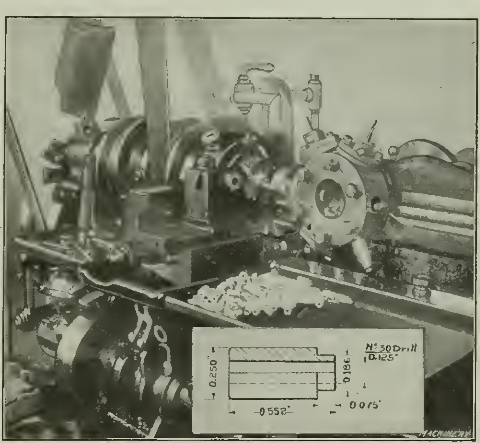
An appraisal made before a fire by a reliable expert appraiser is of great help in the settlement of a fire loss, but the results of such an appraisal are not always accepted by the insurance companies. Stock insurance companies generally state in their policies that in case the aggregate claim for any loss does not exceed 5 per cent of the total value, no special inventory or appraisement of the undamaged property shall be required of the assured. Insurance companies pay the actual value at the time of the fire of the equipment damaged by the fire, which is not the full value unless a total loss occurs. In case of a total loss, the cost of the removal of the debris is also included. With the factory mutual fire insurance companies, the equipment is appraised in advance by experts employed by the insurance companies, and standard rates of depreciation are adopted for various classes of machinery. The following items are usually recorded by the mutual companies: the number and name of the factory; the name of the appraiser who made the inventory; the date on which the inventory was made; the type of building in which the plant is housed; the location of each department in the plant; and a description of each unit of equipment including the builder, the date built, the present cost of a similar new machine, the cost of installation, the rate of depreciation on that class of machine and the approximate net value. With such information available, the settlement of fire losses becomes a relatively simple matter, as definite information is available covering all points which have a bearing upon the conditions which govern the making of a settlement.

* * *

A RECORD TEST ON SMALL DRILLS

Drilling deep holes in the automatic screw machine is a difficult proposition because of the fact that the drills generally become dull quickly and do not produce a straight hole in the work, or else the drill breaks. Even under the most favorable circumstances, it is difficult to produce a straight hole of any depth with one drill, and the general practice is to use one or more drills in the turret and only drill a short distance—from two to five times the diameter of the drill—until the full depth of the hole has been reached.

An interesting experiment with small drills was lately made in the plant of the Atlantic Mfg. Co., Bridgeport, Conn., on a No. 00 Brown & Sharpe automatic screw machine. The stock being drilled was 17/64 inch cold-rolled steel, which was rotated at a speed of 2600 R. P. M. The depth of the hole in the piece, as shown by the illustration, was ⅝ inch, and the diameter of the drilled hole was No. 30—0.125 inch. The drills which were found to give the best results were those made by the Detroit Twist Drill Co., Detroit, Mich. Four of these Detroit high-speed drills, as shown, were held in the turret in standard Brown & Sharpe floating holders. The first, which acted as a center drill, was fed in to a depth of 0.187 inch, at a feed of 0.005 inch per revolution of the work. The second drill was fed in to a depth of 0.312 inch, at a feed of 0.005 inch per revolution of the work. The third drill was fed in to a depth of 0.070 inch, at a feed of 0.003 inch per revolution of the work, while the fourth drill was fed in to a depth of 0.070 inch at a feed of 0.003 inch per revolution of the work.



No. 00 Brown & Sharpe Automatic Screw Machine on which the Drilling Test was made

It will be noticed in looking over this list that the second drill was fed in a much greater distance than the last two drills. The reason for this is that as the depth increases, greater difficulty is met with in getting rid of the chips, and the feed must be decreased as the depth increases to secure a straight hole. A most remarkable feature about this test was the length of time that the drills stood up without regrinding. The machine was stopped after 50,000 pieces had been turned out and the drills were still in good condition. It was also found that the most severe duty came on the drill that penetrated 0.312 inch into the work, as would reasonably be expected. D. T. H.

* * *

At least two automobile builders are planning to bring out eight-cylinder cars as their 1915 models. These two makers have, in the past, built only four-cylinder cars.

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WHEN THE WAR ENDS

In spite of the commercialism of which we have been justly accused, the thoughts of all men in our favored and happy country turn with longing toward the dawn of peace. But we fear peace will not come with the summer as some sanguine authorities foretell, because many great changes must come first. If the war is to end with victory for the allies, Belgium, the part of France held by the Germans, and Alsace and Lorraine, must first be reconquered, foot by foot. To realize what is involved in that task, remember the cost of the last ten-mile advance.

The longer the war continues, the more gradual will be the reduction in demand for machine tools used in the production of war material; and this condition should avert the danger of a sudden and wholesale cancellation of orders which some manufacturers fear. With peace will come a period of world-wide readjustment, and manufacturers who are tempted to over-extend by the present clamorous demand should consider what its cessation will mean to them.

To forecast our own commercial future after the close of the war is an undertaking the wisest would turn from. That the hundreds of millions disbursed in this country for war orders will partly offset the loss of manufactured exports is a hopeful fact. Some results for Europe we can figure out with reasonable certainty—greatly diminished buying power, higher labor and material costs, increased living expenses, heavier taxes to support the burdens of debt, but added power to the people living under autocratic governments to determine for themselves the questions of life and death which heretofore have been decided for them by their rulers.

* * *

CARRYING OFF THE HEAT

The investigation of Taylor into the laws of cutting metals showed the importance of carrying off the heat from the point of the tool as quickly as possible. Separating the chip from the body and curling it requires the expenditure of energy, which is transformed into heat. The development of high-speed steel has greatly increased the efficiency of metal-cutting tools, and notwithstanding its high cost, high-speed steel has displaced carbon steel generally for lathe tools, twist drills, milling cutters and other typical metal-cutting tools. But the discovery of high-speed steel did not solve the problem of carrying off the heat generated. It provided a cutting material that works efficiently at comparatively high temperatures. If the critical temperature is exceeded, the tool speedily breaks down.

There are various means of carrying off the heat and of reducing the amount generated. If a twist drill is ground so that the lips break the chips instead of curling them, the heat generated is lessened, but there is presented the difficulty of getting the chips out of the hole. Hence, the development of inverted drilling machines which let the chips fall out by gravity as soon as they are broken loose, using straight-fluted drills to facilitate clearing them from the point and breaking them up. Oil-tube drills also provide for cooling the cutting edges and ejecting the chips. Copious soda water streams on lathe tools reduce the temperature of the chip and permit increase of cutting speed.

But all these are palliatives that reduce but do not abate the deteriorating effect of heat generated at the extreme cutting point; buried in metal no liquid can reach it, lubrication being effective only at an appreciable distance from the point. Hence, the lubricating effect of cutting compounds is subordinate to their effect as cooling mediums after heat is generated. How can the efficiency of cooling mediums be increased?

The greatest need of better cooling in metal cutting is, perhaps, in grinding. The heat generated does not appreciably affect the wheel, but it distorts and injures the metal, especially if hardened. A fruitful field for scientific study is that of grinding with a minimum of heat generated and the rapid withdrawal from the work of the heat unavoidably produced. The investigation should result in a great improvement in grinding practice.

* * *

THE NARROW GUIDE

In many machine tools, guides are provided only at the outer edges of wide carriages. In order to permit the carriages or slides to move freely, it is necessary to allow a certain amount of looseness in the sliding fits, and this is often sufficient to change the alignment of the parts. If the feed-screw is at the front of the slide, far removed from the back guiding surface, there is also a tendency for the slide to bind. Observing these difficulties, machine tool builders have realized that the inaccuracy of alignment and the tendency to bind could be reduced to a minimum by making the guide-ways as narrow as practicable and as long as the character of the machine would permit. This type of guideway is generally referred to as the "narrow guide." Although the angle of deflection due to cross-winding is the same with wide as with narrow guides, other conditions being the same, the lateral pressure on the sides of the guide and slide is greater on a wide guide than on a narrow one, for any given eccentric load. Therefore the friction and wear are greater on wide guides than on narrow ones.

The advantages of the narrow guide are not obtained merely by having a guideway that is as narrow as possible, but depend mainly upon the correct location of the guide-ways. When a narrow guide is used, it must be arranged on the machine close to the resisting and feeding forces. A narrow guide strip at the back of a carriage having a feed-screw in front would probably be more harmful than the ordinary wide guide. In machine tool construction where one vee and one flat are used, the vee, being in effect a narrow guide, must be nearer to the feeding force and the resistance.

When the narrow guide is placed near the feeding forces, however, its advantage lies in the reduction of the moment of the frictional resistance and, hence, of the required feeding force. Some advantages are also derived from the better mechanical construction possible with the narrow guide, since the guiding surfaces can generally be made very rigid.

When the feed- or lead-screws of machine tools are so placed that they are in close proximity to the narrow guide, there is no question as to this design being an improved means of guiding the tool-carrying head or slide of any machine, but it should be fully understood that it is not the narrow guide as such, but rather its position relative to the feeding force, that accounts for the advantages gained.

ON FINDING THE TRANSFORMATION POINTS IN STEEL[*]

APPARATUS FOR DETERMINING THE DECALESCENT AND RECALESCENT PARTS OF THE TEMPERATURE CURVE

BY E. F. LAKE[†]

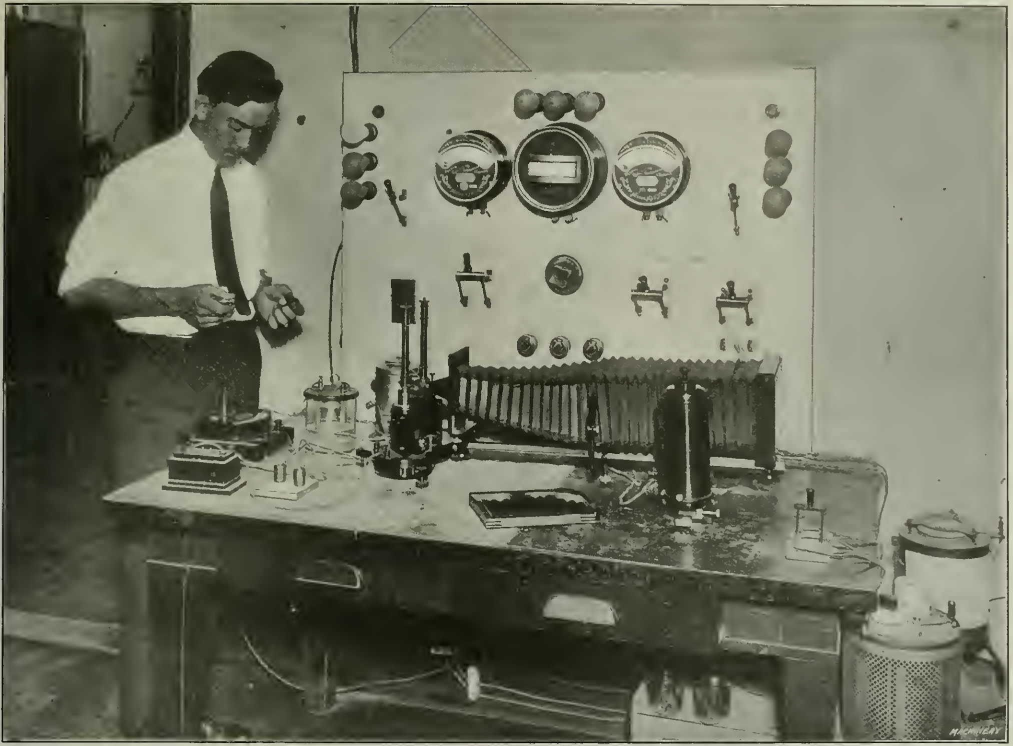

Fig. 1. Saladin Apparatus for determining Transformation Points in Steel, Iron, etc.

SO many improvements have been made in the heat-treatment of steel in the past few years that the temperatures should no longer be judged by color. Pyrometers and other heat measuring instruments have been brought into use which enable one to get the heat-treatment temperatures much more accurately than was ever done by the old eyesight method. The scientific investigators of the heat-treatment of steel have also laid down certain rules that can be followed to give very accurate results, and their investigations have shown that the variations in temperature by the old eyesight method resulted in considerable loss in the strength of the metal and in its resistance to fatigue.

The investigators discovered the fact that steels underwent certain transformations in their grain structure at definite degrees of temperatures; also that these transformation periods were of vital importance for obtaining the correct temperatures at which to heat-treat steels. In some steels there are several transformation points. The one that occurs at the highest temperature is the one that is very important for the annealing and hardening operations. At this temperature the molecules of the metal rearrange themselves in a manner that produces the finest and densest grain structure that the metal is capable of assuming. This also removes any internal strains that may have been set up in the metal by the mechanical working it received in the shaping operations. Lower transformation points are less important, but might be utilized when cooling the steel down or when preheating. Various other terms are used in place of transformation to designate these same points. Some of these are critical, decalescent, recalescent, Ac_1, Ar_1 and transition. At the upper transformation point steel loses its magnetism but it returns again when the steel cools down past that point.

Before annealing or hardening, one should always find what is the highest transformation point of the steel he is using and then regulate the furnaces so the metal can be heated to just above this temperature. Various ways and means have been devised for obtaining this transformation point. Some use quite complicated apparatus for definitely deciding the exact degree of temperature at which this transformation takes place. With such apparatus it might be located within one-quarter degree of the correct point, but for many kinds of commercial work this is like splitting hairs. Then a much simpler outfit can be used that indicates within ten degrees of the exact temperature at which the transformation occurs.

On large work one cannot expect to get the accuracy obtained on small work. When steel is heated in large furnaces it is almost impossible to keep the heating chamber within twenty-five degrees of the desired temperature. Then it would seem useless and impractical to have an accuracy of one-quarter degree in the location of the transformation point. The cheaper outfits that indicate within ten degrees of the correct temperature are all that are required for such commercial work. At present there are many small furnaces in use that vary twenty-five degrees or more in the heating chamber, but the accurate temperature furnaces now built seldom vary more than ten degrees. Temperature control instruments can be attached that automatically keep the furnace temperature within five degrees of any given point.

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[*] For additional information on determining the transformation points of steel see "Locating the Critical Range with the Brinnel Ball Tester," December, 1914; "Hardening Carbon Steels," January, 1910; "Recalescence and its Relation to Hardening," October, 1909; and MACHINERY'S Reference Book No. 63, "Heat-treatment of Steel."

[†] Address: 412 Pennsylvania Ave., Detroit, Mich.

For the smaller steel parts which are annealed or hardened in these furnaces, the more accurate apparatus can be utilized. Its importance can be seen when one realizes that each degree to which steel is heated above the transformation point adds to the coarseness of the grain structure and weakens the steel in like proportion. It might then be good business policy to use the more elaborate and costly outfits in order to heat-treat steels so they will have the maximum amount of strength that they are capable of attaining and also the greatest wearing qualities and longevity.

One of the most accurate outfits made for determining the transformation point of steel, iron, etc., is the Saladin apparatus made by Siemens & Halske in Berlin. This is shown in Fig. 1 as it is being marketed by Charles Engelhard of New York at an approximate price of $500.

It employs two Deprez d'Arsonval type mirror galvanometers which are optically coupled by mirrors and prisms. One gives a horizontal and the other a vertical movement to the beam of light which comes from a lantern containing a Nernst lamp. This combination of vertical deflection with horizontal deviation produces a curve on a photographic plate in the camera attachment as the temperature of the steel is being raised through the transformation point. A differential thermo-couple is used with two platinum arms thirty-six inches long and one platinum-rhodium arm twenty-four inches long. The transformation point can be visually determined by using a differential galvanometer that is supplied as an extra. This has the zero point in the center with 1.2 millivolt deflection on both sides.

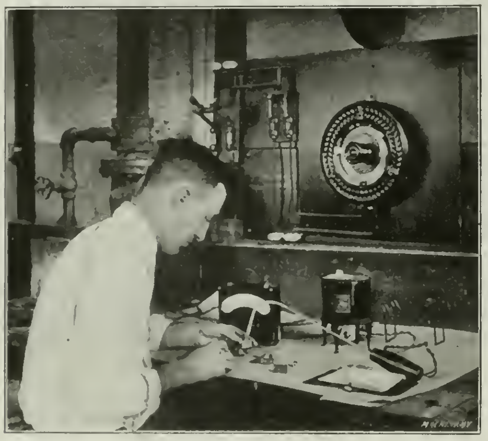
Fig. 2. Hoskins Recalescence Outfit

An accuracy of less than one degree F. is obtained with this apparatus. While it was originally designed for college laboratories it is now being used by some shops. The arguments used in its favor are: If we start with a ten-degree variation in the determination of the transformation point, then have a variation of ten degrees or more in the furnace, another variation due to the operator's judgment and other inaccuracies from other causes, we may soon be 50 or 100 degrees out. Then one may get so far away from the actual transformation point that it makes considerable difference in the quality of the part that is being heat-treated. However that may be, where great accuracy is desired and cost is not a factor, this apparatus will doubtless give the desired results.

In annealing steels the three rules that should be used are as follows:

1. The steel must be heated to a temperature above the highest transformation point of the steel, but as close to this point as possible.

2. This temperature must be retained long enough to allow the entire piece to reach an even temperature, but it should not be prolonged beyond that.

3. The rate of cooling must be slow enough to prevent any hardening taking place, even superficial hardening.

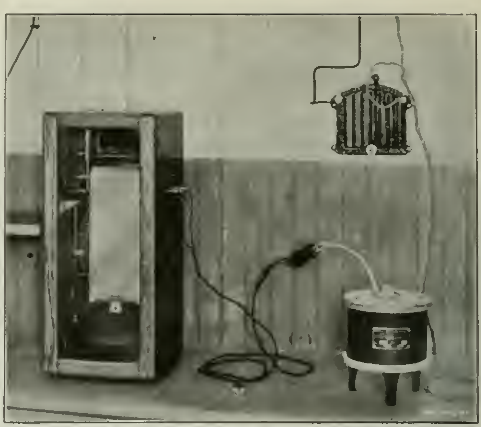
Fig. 3. Thwing's Equipment for determining Critical Temperatures in Metals

To harden steel these same rules apply except that Rule 3 is reversed. That is, the steel must be suddenly cooled or quenched instead of slowly cooled.

This shows the necessity of knowing the highest transformation point of any steel before attempting to heat-treat it in any way. The temperature at which this transformation occurs is different in different grades of steel, the variation being caused by the different elements that enter into its composition. With the proper apparatus it is only the work of a few minutes to find the transformation point. Thus one can be more positive of results if it is obtained on each batch of steel before it is annealed or hardened.

One of the more simple outfits is that shown in Fig. 2, made by the Hoskins Mfg. Co. of Detroit, Mich. This consists of a Hoskins stock pyrometer, a Hoskins small electric furnace and a rheostat. This outfit can be installed at an approximate cost of $100. The rheostat makes it easier to control the temperature in the furnace, but it can be used without the rheostat. Then the cost would be about $75. The electric furnace is not a necessity, as the pyrometer can be carried to any of the shop furnaces and the same results ob-

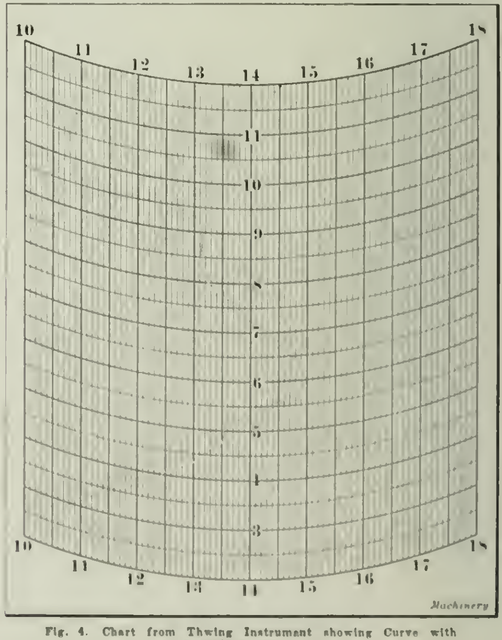

Fig. 4. Chart from Thwing Instrument showing Curve with Transformation Point

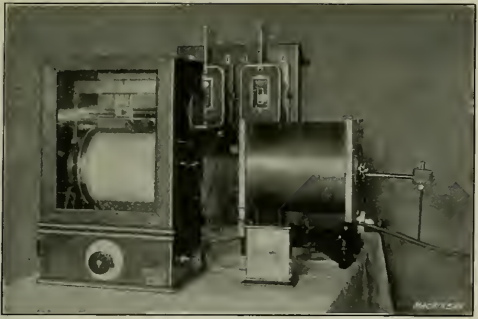

Fig. 5. Leeds & Northrup Apparatus for obtaining Transformation Points

tained. Then the pyrometer only is required, at a cost of about $50. A recording chart instrument can be used in place of the galvanometer, at an extra cost, if one so desires. A curve of the rise and fall of the temperature of the steel will then be scribed on the chart and the transformation point will be shown by a crook in the curve.

In Fig. 2 the operator is shown clamping two pieces of steel, of which the transformation point is desired, to the end of the thermo-couple. After that they are inserted in the electric furnace, and as the temperature rises the readings are taken from the galvanometer. Each rise of twenty-five degrees can then be timed until the highest transformation point has been passed. When the transformation point is reached the galvanometer will not show further rise in temperature until the internal change has been completed in every grain of the steel being heated. After that, the temperature rises about as fast as it did before. Thus it takes a much longer time to pass through the twenty-five degrees in which the transformation takes place than it does through any other twenty-five degrees. Often this period is four or five times as long, and while the galvanometer pointer is stationary a reading can be taken that will be within five degrees of the correct one. Usually each rise of twenty-five degrees will take from fifteen to twenty seconds until the transformation occurs and then from one to three minutes is consumed before the temperature will go above that particular twenty-five degrees. In the table is shown the time as it was taken down in one of these operations. In this specimen the transformation took place at 1465 degrees. The pointer hesitated for nearly two minutes at that temperature.

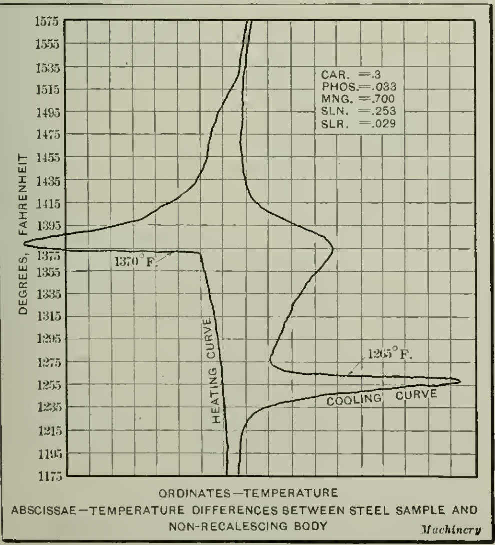

Fig. 6. Transformation Point Curves on Chart of Leeds & Northrup Instrument

TIMING RISE IN TEMPERATURE TO ASCERTAIN THE TRANSFORMATION POINT

Degrees F	Time of Rise in Temp., Seconds	Degrees F	Time of Rise in Temp., Seconds
1100 to 1125	15	1350 to 1375	16
1125 to 1150	17	1375 to 1400	18
1150 to 1175	15	1400 to 1425	17
1175 to 1200	16	1425 to 1450	23
1200 to 1225	14	1450 to 1475	115
1225 to 1250	15	1475 to 1500	32
1250 to 1275	17	1500 to 1525	20
1275 to 1300	16	1525 to 1550	19
1300 to 1325	17	1550 to 1575	20
1325 to 1350	18	1575 to 1600	22

Machinery

In Fig. 3 is shown an outfit marketed by the Thwing Instrument Co. of Philadelphia. In this case the recording chart instrument is used instead of the galvanometer. Like other companies, it gives the buyer the choice of having the galvanometer for optical determination or its capillary film recorder which scribes a curve on the chart. These can be used together if so desired. In this view, the steel specimen has been inserted in the furnace, to be heated.

If the specimen is large enough a hole is drilled in which the thermo-couple is inserted, instead of clamping the two pieces together over the thermo-couple end, as shown in Fig. 2. A small size of thermo-couple is made especially for these transformation point outfits and the hole in the steel need not be very large. The trouble of timing each rise of twenty-five degrees in the steel is done away with when the recording chart is used.

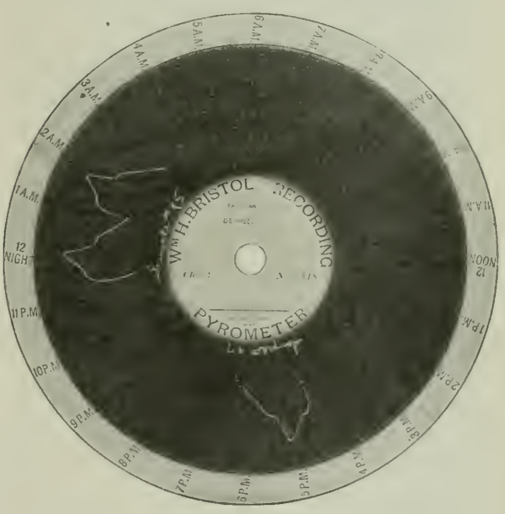

Fig. 7. Smoked Chart used by the Bristol Co. with Curves showing Critical Points

One of the charts on which a curve has been scribe shown in Fig. 4. The large figures, 10 to 18, on the lines of the chart are for hundreds of degrees F. Th 3 to 10, along the central vertical line, are for th the chart's travel. The curve is made by burning sm through the chart by means of an electric current passes through a needle in the end of the pointer that cates the temperature. The lines crossing the chart a curved to compensate for the swing of this pointer.

While the temperature of the steel was rising the lower part of the curve was scribed. It will be seen that this curve formed nearly a perfect arc until it reached a temperature of 1355 degrees. Then the pointer which indicates the temperature remained stationary while the chart was traveling. This accounts for the crook in the curve, which plainly shows where the steel underwent its transformation. After that, the temperature of the steel was raised to 1490 degrees and the curve formed the same regular arc that it did before the steel passed through the transformation period.

The upper part of the curve shows how the steel cooled down. On cooling there was the same transformation phenomena, but it occurred at a temperature of 1310 degrees. This is some forty-five degrees below the point where it occurred when the temperature was being raised. The same thing occurs with most steels, and there is often a difference of more than 100 degrees.

It is the transformation point on the rising curve that is important, as the temperature of steel has to be raised in order to get it hot enough to be properly annealed. It will not harden or cannot be thoroughly annealed until this transformation has taken place in the grain structure. Thus this particular steel should be heated to about 1380 degrees to be assured that the transformation has taken place. When quenching steel to harden it, this would also take care of any lag that might occur between the time it leaves the furnace and is cooled to atmospheric temperature.

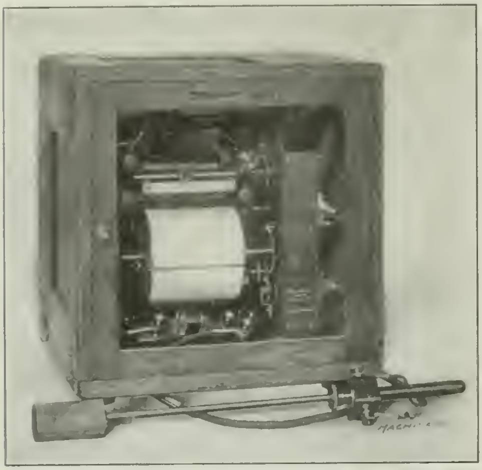
Fig. 8. Recording Chart Instrument made by the Taylor Instrument Co.

The speed at which the chart travels can be altered to suit conditions when scribing the curve. In this case it is traveling at the rate of ⅛ inch per minute, or 7½ inches per hour.

For this record it will be seen that, on the rising temperature, the chart traveled 3/16 inch while the transformation was taking place. Then the steel did not show any change in temperature. This would represent a time of 1½ minute. A rise of from fifty to seventy-five degrees took place during the same lapse of time in any other part of the curve. On the falling temperature it took more than three minutes to pass through this transformation period. Some of the alloy steels do not show such decided crooks in the curve, as their transformation is not so intense. This is especially so of high-speed steels.

In Fig. 5 is shown the recording chart apparatus which is made by the Leeds & Northrup Co. of Philadelphia. Here the electric furnace is placed horizontally and the rheostat is located underneath. The location is of no importance, however. The chart is also placed in the horizontal position. The pointer that indicates the temperature travels back and forth across the chart, instead of swinging like a pendulum. It scribes the curves with colored ink.

The method employed with this apparatus is to heat two bodies together in the same furnace, one being the steel under test and the other being a body which will heat uniformly without undergoing any changes. If their contact is sufficiently close they will remain equal in temperature while their temperature is being raised or lowered until the transformation begins to take place in the steel sample. Then this internal change involves an absorption or liberation of heat and a temperature difference is set up between the two. The curve on the chart records the difference in temperature between the two bodies being heated. Thus the transformation point of the steel is clearly shown.

In Fig. 6 is shown the curve scribed on one of these charts when the transformation point was being determined. The composition of the steel is shown in the upper right-hand corner. The curve for the rising temperature is shown to the left of the chart and that of the falling temperature to the right. It will be seen that the transformation took place at 1370 degrees F. on the rising temperature and at about 1265 degrees on the falling temperature. Determinations of an inaccuracy of not more than five degrees can be made with this outfit. As this is as close as any shop furnace can be operated, it is close enough for any kind of commercial work unless it should be parts similar to the hair-springs of watches.

Another style of chart is that used by the Bristol Co. of Waterbury, Conn., as shown in Fig. 7. This is a circular disk that revolves like the hands of a clock, while the pointer that indicates the temperature travels in and out from the center. It is called the smoked chart, as its surface is covered with lampblack. The temperature indicating pointer scratches through the lampblack, leaving a white line on the paper beneath. The transformation point on both the rising and falling temperatures will be plainly seen by the crooks on each side of the three curves. In Fig. 8 is shown still another style of instrument with a recording chart, manufactured by the Taylor Instrument Co., Rochester, N. Y.

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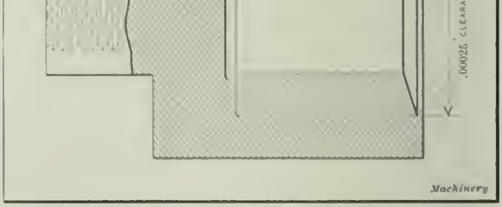
HOLDING ROLLER BEARING RACES FOR INTERNAL GRINDING

A simple yet practical and efficient method of holding roller bearing races for internal grinding at the Railway Roller Bearing Co.'s factory in Syracuse, N. Y., is shown in the illustration. These races are first ground on the outside and it is then necessary to mount them on the internal grinder spindle for grinding the inside.

For this purpose they are held in the sleeve shown in the illustration, which is merely a cast-iron block held on the spindle and bored out 0.00025 inch larger in diameter than the external diameter of the sleeve to be ground. These sleeves are approximately 4 inches outside diameter with an inside diameter of 3½ inches and a length of 3 inches. No clamping screws or bolts of any kind are used, it simply being necessary to slide the steel race into the socket and proceed with the grinding, which is done with the aid of a lubricant. If the work were ground dry, it would probably be necessary to have a smaller amount of play between the socket and sleeve. Contrary to what might be expected, there is not the slightest tendency for the race to slip or work out from the sleeve while the grinding is taking place.



Holding Work for Internal Grinding without using Clamps or Jaws

C. L. L.

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According to a pamphlet published by the New York Public Library, 487 books, pamphlets, magazine articles, etc., on oxy-acetylene welding have been published.

DISTANCE BETWEEN SHAFT BEARINGS*

EMPIRICAL FORMULAS WHICH TAKE INTO CONSIDERATION THE SPEED AND EFFECT OF CENTRIFUGAL FORCE

BY B. D. PINKNEY†

It is desirable to obtain a satisfactory maximum distance between bearings for lineshafting, both from a standpoint of total journal friction and of economy. An examination of existing data on this subject shows that precautions for the speed of the shaft are not considered, notwithstanding the fact that a general formula to cover a range of speed possibilities is a mechanical necessity on account of the high speed of lineshafting in certain factories—notably textile factories—and also special cases of high-speed lineshafts often met with in practice, which are coming more and more into use. The generally accepted safe maximum deflection of shafting is 0.01 inch per foot of shaft length. The Pencoyd Iron Works, in "Steel in Construction," showed that the distance L in feet between bearings to care for a deflection of 0.01 inch per foot, due to the weight of the bare shaft alone, was given by the following:

$$L = \sqrt[3]{873\,D^2}.$$

For a working formula for bare shafts, with allowance made for the weakening effect of keyseats, we have:

$$L = \sqrt[3]{720\,D^2}.$$

where D = diameter of shaft in inches;

L = maximum distance between bearings in feet.

These results are said to be correct within the range of velocities usual in practice.

Prof. Rankine, in "Millwork," showed that the centrifugal force of a shaft slightly bent was such that at short centers it restores itself to straightness; but that with a greater distance between centers, such a shaft is liable to keep rotating in its bent form. The same holds true for a shaft rotating at a high speed. Such a shaft at short centers will restore itself to straightness; but with a greater distance between centers, it will not have time to straighten out and will continue to rotate in a bent form. This condition is called the "centrifugal whirl," and in deducing a formula to determine the maximum distance between bearings, provision must be made to practically eliminate the centrifugal whirl. To deduce a fundamental formula to cover all the conditions and requirements met with in practice, is practically impossible, and reference must be made to a general formula. The following formulas take velocity into consideration as a precaution to reduce centrifugal whirling:

$$L = 5\left(\frac{1500}{N + 1500}\right)D^{\frac{2}{3}} \qquad (1)$$

$$L = 6.5\left(\frac{1500}{N + 1500}\right)D^{\frac{2}{3}} \qquad (2)$$

$$L = 9.5\left(\frac{1500}{N + 1500}\right)D^{\frac{2}{3}} \qquad (3)$$

where N = revolutions per minute.

Formula (1) is for head-shafts, or so-called "prime movers"; also, those shafts which are subjected to shocks and the bending action of pulleys, gears, etc., and which may be reversed under full load. Formula (2) is for the common type of lineshafts (except that part where the power is applied) and also for countershafts, with ample allowance for the bending action of pulleys, gears, etc., which are not reversed under full load. Formula (3) is for shafts and countershafts which are merely to transmit power without any bending action except that due to the weight of the bare shaft; and on such shafts all pulleys and gears are to be placed close to the bearings. The formulas hold good for

MAXIMUM DISTANCES BETWEEN BEARINGS FOR VARIOUS SIZED SHAFTS AND SPEEDS

Diam. of Shaft, Inches	Formula	Revolutions per Minute							
		100		200		300		400	
		Ft.	Ins.	Ft.	Ins.	Ft.	Ins.	Ft.	Ins.
	(1)	4	3	4	0	3	9	3	7
$\frac{7}{8}$	(2)	5	7	5	3	4	11	4	8
	(3)	8	2	7	8	7	3	6	10
	(1)	4	6	4	2	3	11	3	9
$\frac{15}{16}$	(2)	5	10	5	6	5	2	4	11
	(3)	8	6	8	0	7	7	7	2
	(1)	4	8	4	4	4	2	3	11
1	(2)	6	1	5	8	5	5	5	1
	(3)	8	10	8	4	7	11	7	6
	(1)	5	0	4	9	4	6	4	3
$1\frac{1}{8}$	(2)	6	7	6	2	5	10	5	6
	(3)	9	7	9	0	8	6	8	1
	(1)	5	3	4	11	4	8	4	5
$1\frac{3}{16}$	(2)	6	10	6	5	6	0	5	9
	(3)	9	11	9	4	8	10	8	4
	(1)	5	5	5	1	4	10	4	6
$1\frac{1}{4}$	(2)	7	0	6	8	6	3	5	11
	(3)	10	4	9	8	9	2	8	8
	(1)	5	7	5	3	4	11	4	8
$1\frac{5}{16}$	(2)	7	3	6	10	6	5	6	1
	(3)	10	8	10	0	9	6	9	0
	(1)	5	11	5	7	5	3	5	0
$1\frac{7}{16}$	(2)	7	9	7	3	6	10	6	6
	(3)	11	4	10	8	10	1	9	6
	(1)	6	1	5	9	5	5	5	2
$1\frac{1}{2}$	(2)	8	0	7	6	7	1	6	8
	(3)	11	8	11	0	10	4	9	10
	(1)	6	3	5	11	5	7	5	3
$1\frac{9}{16}$	(2)	8	2	7	8	7	3	6	10
	(3)	11	11	11	3	10	7	10	1
	(1)	6	7	6	3	5	10	5	7
$1\frac{11}{16}$	(2)	8	7	8	1	7	8	7	3
	(3)	12	7	11	10	11	2	10	7
	(1)	6	9	6	4	6	0	5	8
$1\frac{3}{4}$	(2)	8	10	8	4	7	10	7	5
	(3)	12	11	12	2	11	6	10	10
	(1)	7	3	6	10	6	5	6	1
$1\frac{15}{16}$	(2)	9	5	8	10	8	5	7	11
	(3)	13	10	13	0	12	3	11	7
	(1)	7	5	7	0	6	7	6	3
2	(2)	9	8	9	1	8	7	8	1
	(3)	14	1	13	3	12	6	11	10
	(1)	7	10	7	5	7	0	6	7
$2\frac{3}{16}$	(2)	10	3	9	8	9	1	8	7
	(3)	15	0	14	1	13	4	12	7
	(1)	8	0	7	6	7	1	6	9
$2\frac{1}{4}$	(2)	10	5	9	10	9	3	8	9
	(3)	15	3	14	4	13	7	12	10
	(1)	8	5	7	11	7	6	7	1
$2\frac{7}{16}$	(2)	11	0	10	4	9	9	9	3
	(3)	16	1	15	2	14	4	13	7
	(1)	8	7	8	1	7	8	7	3
$2\frac{1}{2}$	(2)	11	2	10	6	9	11	9	5
	(3)	16	4	15	5	14	7	13	9
	(1)	8	9	8	3	7	9	7	4
$2\frac{9}{16}$	(2)	11	4	10	8	10	1	9	7
	(3)	16	8	15	8	14	9	14	0
	(1)	9	0	8	6	8	0	7	7
$2\frac{11}{16}$	(2)	11	9	11	1	10	5	9	11
	(3)	17	2	16	2	15	3	14	6
	(1)	9	7	9	0	8	6	8	1
$2\frac{15}{16}$	(2)	12	6	11	9	11	1	10	6
	(3)	18	3	17	2	16	2	15	4
	(1)	9	9	9	2	8	8	8	2
3	(2)	12	8	11	11	11	3	10	8
	(3)	18	6	17	5	16	5	15	7
	(1)	10	1	9	6	9	0	8	6
$3\frac{3}{16}$	(2)	13	2	12	5	11	8	11	1
	(3)	19	3	18	1	17	1	16	2
	(1)	10	8	10	0	9	5	8	11
$3\frac{7}{16}$	(2)	13	10	13	0	12	4	11	8
	(3)	20	3	19	1	18	0	17	1
	(1)	11	2	10	6	9	11	9	5
$3\frac{11}{16}$	(2)	14	6	13	8	12	11	12	3
	(3)	21	3	20	0	18	10	17	10
	(1)	11	8	11	0	10	4	9	10
$3\frac{15}{16}$	(2)	15	2	14	3	13	6	12	9
	(3)	22	2	20	10	19	8	18	8
	(1)	11	9	11	1	10	6	9	11
4	(2)	15	4	14	5	13	8	12	11
	(3)	22	5	21	1	19	11	18	10
	(1)	12	2	11	5	10	9	10	3
$4\frac{3}{16}$	(2)	15	10	14	10	14	0	13	4
	(3)	23	1	21	9	20	6	19	5
	(1)	12	7	11	11	11	3	10	8
$4\frac{7}{16}$	(2)	16	5	15	5	14	7	13	10
	(3)	24	0	22	7	21	4	20	3
	(1)	12	9	12	0	11	4	10	9
$4\frac{1}{2}$	(2)	16	7	15	7	14	9	13	11
	(3)	24	3	22	10	21	6	20	5
	(1)	13	3	12	5	11	9	11	1
$4\frac{3}{4}$	(2)	17	2	16	2	15	3	14	6
	(3)	25	2	23	8	22	4	21	2
5	(1)	13	8	12	10	12	2	11	6
	(2)	17	9	16	9	15	10	15	0
	(3)	26	0	24	6	23	1	21	11
	...	..	..	..	..	..	..	..	..
..	...	..	..	..	..	..	..	..	..
	...	..	..	..	..	..	..	..	..

Machinery

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[*] For additional information on the strength of shafting and allied subjects, see also "The Angle of Torsion," by B. D. Pinkney, published in MACHINERY for November, 1914; "Heavy Duty Shafts with Two and Three Bearings," by W. G. Dunkley, April, 1914; "On Determining Shaft Diameters," by W. G. Dunkley, August, 1913; "Intermediate Supports for Long Shafts," by W. G. Dunkley, January, 1913; "Calculating Bending and Turning Moments for Long Shafts," by W. H. Herschel, July, 1911; "The Effect of Keyways on the Strength of Shafts," by H. F. Moore, January, 1911; and "Table for Computing Hollow and Solid Shafting," September, 1905.

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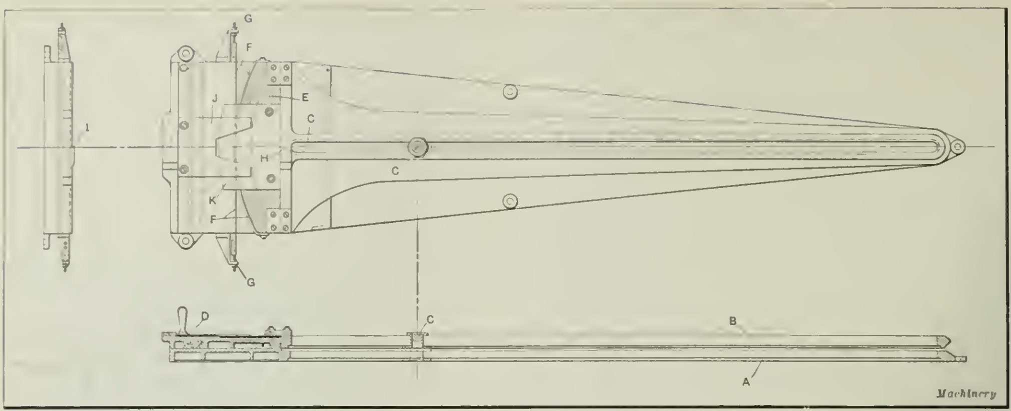

Fig. 1. Instrument for drawing Involute Curve Outlines for Gear-tooth Templets or Forming Tools, with Swinging Arm B in Central Position

either cold-rolled steel, turned steel, or wrought-iron shafts, the moduli of elasticity and torsional strength of these materials being nearly the same. The distance *L* for other materials varies directly as their moduli of elasticity, a complete table of which may be found on page 299 of MACHINERY'S HANDBOOK.

The writer experimented with shafts of different diameters at different velocities, for several years before deducing the preceding empirical formulas. Recently he connected a shaft 1 7/16 inch in diameter by 55 feet long to a variable speed transmission for experimental purposes, and tested for the conditions of Formulas (1), (2) and (3). For the conditions of Formula (1) at 100 revolutions per minute, a safe maximum distance of 6 feet between bearings was recorded, which had to be gradually reduced to 5 feet as the speed was raised to 400 revolutions per minute, the greatest deflection occurring during the reversal of the shaft at full load. When requirements were imposed to represent the conditions covered by Formula (2), a maximum distance between bearings of 7 feet 11 inches for 100 revolutions per minute, and 6 feet 5 inches for 400 revolutions per minute, was recorded. When tested for the conditions of Formula (3), a maximum distance between bearings of 11 feet 6 inches for 100 revolutions per minute, and 9 feet 6 inches for 400 revolutions per minute was recorded.

A number of tests have been made with shafts of larger and smaller diameters with like results, thus substantially corroborating the values obtained by Formulas (1), (2) and (3), all of which are for an elastic deflection of 0.01 inch per foot of shaft length between bearings. If the bearings are of the rigid type, the distance between them is measured from end to end; but if the bearing is in any way self-aligning, the distance is measured between the centers. The accompanying table of maximum distances between bearings is calculated according to these empirical formulas.

* * *

INVOLUTE GEAR TOOTH FORMING DEVICE

SIMPLE METHOD OF LAYING OUT A TEMPLET OR FORMING CUTTER

BY GUS LUCK[*]

It is the purpose of this article to describe a method of generating the involute curves for a gear tooth templet or forming cutter by purely mechanical means so that the use of mathematics is unnecessary. The method of using the instrument employed for this purpose is quite simple. The piece of steel on which the templet or forming tool is to be laid out is secured to the end of a pivoted arm, the work being moved under a space formed to correspond with the interval between two rack teeth of the same pitch as the gear tooth for which the templet is required. The work is moved by short steps, and after each movement the outline of the rack space is scribed on it. Referring to Figs. 2 and 3, it will be evident that a great number of these outlines are drawn and their points of contact with the imaginary gear tooth lie on the required involute curve. Having the work laid out in this way, the templet is finished in the usual manner.

Figs. 1 and 2 show the mechanical device used for laying

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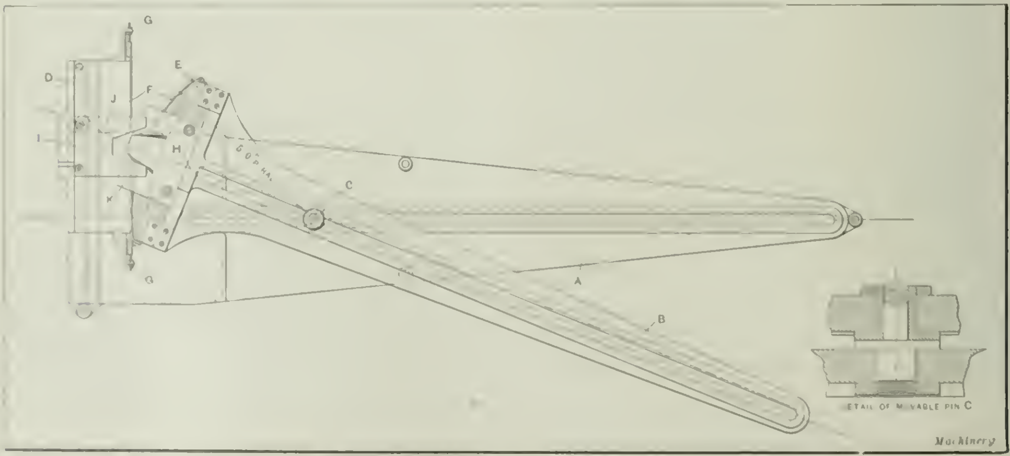
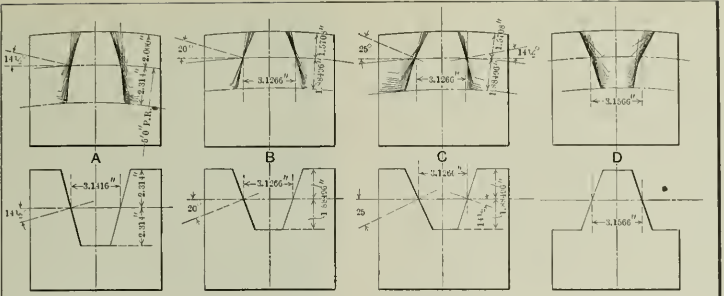


Fig 2 Instrument shown in Fig 1 with Arm B swung to Extreme Position—Detail of Adjustable Pivot Pin C

out a tool by this method. In Fig. 1 the arm is central, with the rack tooth templet and material for the gear tooth templet in place. In Fig. 2 the device has been moved over to one of its extreme positions, and this illustration shows the lines which have been scribed on the work. Fig. 3 shows various forms of rack templets and work laid out from them. In order to explain the use of this instrument, let us consider that it is required to generate a templet or forming tool for a gear of 10 feet pitch diameter with teeth of ½ diametral pitch and 14½ degree pressure angle, the teeth to be Brown & Sharpe standard with no clearance allowed. The templet shown at *A* in Fig. 3 would be used for this purpose. The first step is to take the material on which the templet or forming tool is to be laid out and scribe outside, pitch and root circles of the required radii on it. The work is then secured to the arm of the instrument ready to have the required tooth outline laid out on it.



RACK-TOOTH TEMPLET AND GEAR-TOOTH TEMPLET GENERATED FROM IT FOR A GEAR WITH TEETH OF ½ DIAMETRAL PITCH AND 14½ DEGREE PRESSURE ANGLE, NO CLEARANCE BEING ALLOWED. THE PITCH DIAMETER OF GEAR, 10 FEET.

RACK-TOOTH TEMPLET AND GEAR-TOOTH TEMPLET GENERATED FROM IT FOR A GEAR WITH TEETH OF ½ DIAMETRAL PITCH AND 20-DEGREE PRESSURE ANGLE. TO DETERMINE THE CLEARANCE, SUBTRACT ½ THE AMOUNT OF ALLOWABLE BACKLASH FROM THE THICKNESS OF THE RACK TOOTH AT THE PITCH LINE THE TEETH ARE OF THE STUB-TOOTH FORM.

RACK-TOOTH TEMPLET AND GEAR-TOOTH TEMPLET GENERATED FROM IT FOR A BASTARD GEAR HAVING A PRESSURE ANGLE OF 25 DEGREES ON ONE SIDE OF THE TEETH AND 14½ DEGREES ON THE OTHER SIDE. THE TEETH ARE OF ½ DIAMETRAL PITCH AND OF THE STUB-TOOTH FORM. FOR STUB TEETH THE ADDENDUM IS 0.25 OF THE CIRCULAR PITCH; THE DEDENDUM 0 30 OF THE CIRCULAR PITCH AND THE ALLOWABLE BACKLASH, 0.005 OF THE CIRCULAR PITCH.

RACK-TOOTH TEMPLET AND GEAR-TOOTH-SPACE TEMPLET GENERATED FROM IT. TO DETERMINE THE CLEARANCE ADD ½ THE AMOUNT OF ALLOWABLE BACKLASH TO THE THICKNESS OF THE RACK TOOTH AT THE PITCH LINE.

Machinery

Fig. 3. Rack Templets of Various Forms and Gear-tooth Outlines generated from them

Before going further with the description of the method of procedure, a description of the instrument will be given. The baseplate *A* supports the swinging arm *B*, and both the baseplate and arm have a slot machined in them in which a movable pin *C* is supported. The position of this pin may be varied in order to have the distance to the end of the arm equal to the required pitch radius of the gear for which the templet or forming tool is being made. When the pin *C* has been located in the required position it is secured against further movement. The cross-slide *D* at the end of the baseplate *A* is held and guided by means of the T-slot and tongue, which are clearly shown in the cross-sectional view, Fig. 1. Secured to the end of the swinging arm *B* there is a wooden block *E*, the outer surface of which conforms to a circle whose radius is equal to the pitch radius of the gear for which the templet is being made. It will be evident that a separate block *E* must be made for each gear of different pitch radius. It will be seen that a thin steel band *F*, the width of which is half the thickness of the wooden block *E*, is secured to each end of the block, and that the other ends of these bands are fastened to adjusting screws *G* at opposite ends of the cross-slide *D*. There is a center line *H* marked on the radial arm and a corresponding center line *I* on the cross-slide, and in setting up the instrument ready for use, these two lines are brought into alignment by means of the bands *F* and adjusting screws *G*, as shown in Fig. 1.

With the rack templet *J* and the blank *K* for the gear-tooth templet secured in the relative positions shown in Fig. 1, the cross-slide is moved over a little way at a time. When this is done, the steel bands *F* cause the block *E* and the blank *K* mounted on it to move a corresponding distance. It has already been mentioned that after each movement, the outline of the rack tooth is scribed on the gear-tooth templet or forming tool blank. The tool is machined to the outline produced in this way, the appearance of the work after it is laid out being shown in Fig. 3.

The plate on which the templet is to be laid out must be secured on a wooden block in a radially accurate position; and with the cross-slide in its central position, the center of the rack templet on the slide and the blank mounted on the swinging arm must be in perfect alignment. It may be claimed that the cost of this instrument would not be justified unless there was a great deal of work to be done on it. Where only a small amount of work is to be done, an instrument of the form shown in Fig. 4, which is made entirely of wood, will be found to give satisfactory results. The cost is relatively small.

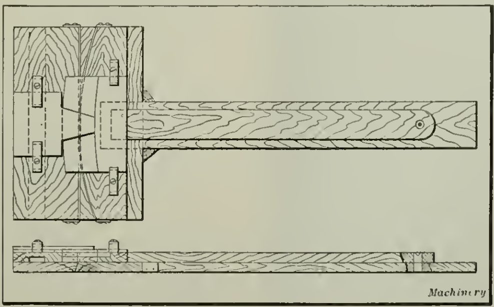


Fig. 4. A Simple Form of Involute Curve Drawing Instrument made entirely of Wood

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The Bureau of Labor Statistics of the United States Department of Labor has published as Bulletin 163 a report on wages and hours of labor in the building and repairing of steam railroad cars. The report is based on information obtained from the principal representative establishments in the industry. Figures are presented in this bulletin for rates of wages per hour and full-time hours of labor per week for the years 1907 to 1913 and for full-time weekly earnings for 1910 to 1913. Full-time weekly earnings of the employes in the principal occupations in this industry in 1913 were 5.5 per cent higher than in 1912, 6 per cent higher than in 1911, and 8.9 per cent higher than in 1910; average rates of wages per hour for 1913 were 6.3 per cent higher than in 1912, 6.4 per cent higher than in 1911, and 9.9 per cent higher than in 1910; the full-time working hours per week in 1913 were 0.7 per cent lower than in 1912, 0.4 per cent lower than in 1911, and 1.1 per cent lower than in 1910. The data for 1913 were obtained from 73 representative establishments and covered over 42,000 employes. The average full-time weekly earnings in 1913 in the principal occupations in these representative establishments were as follows: cabinetmakers, $19.03; carpenters and car builders, wood, $17.11; car repairers, $15.15; fitters, $15.99; laborers, $10.58; machine woodworkers, $16.26; machinists, $17.81; painters, $17.77; pipe fitters, $18.56; riveters and buckers, $19.41; tinners, $19.28; truck builders, $15.31; upholsterers, $19.50. In 1913 the full-time hours of labor per week were under 54 in quite a number of the establishments visited and over 60 in but very few. The average full-time hours per week were about 56.

FITTING CROWN BRASSES ON A DRAW-CUT SHAPER

A familiar machining operation in the railroad shop is the fitting of crown brasses to driving boxes. A typical driving box brass is shown in Fig. 1, and the fitting consists in machining the outside semicircular section and the side edges, so that it will just drive into its place in the box. There are several common ways of doing this fitting, one of which is to mount the semicircular brass casting on an arbor and turn off the outside.* This method requires an additional setting to machine the edges. Another way is to hold the casting on the circular table of a slotting machine and rotate the work while slotting, finishing the edges by slotting at the same setting. The illustrations show another method of machining crown brasses, using a Morton draw-cut shaper that has worked out satisfactorily at the shops of the Delaware & Hudson R. R., Watervliet, N. Y.

Referring to Fig. 2, which shows the operation as a whole, and Fig. 3, which shows the details of the job, it will be seen that the crown brass is held by a special mandrel chuck that grips the work by the ends. This chuck is mounted on a circular attachment on the table of the shaper. The crown brass casting is laid out for machining in the usual way, and after lightly pinching it in the chuck, it is lined up with an indicator that swings on the central shaft of the fixture. After tightening the clamping bolts of the mandrel chuck, the roughing cut is started.

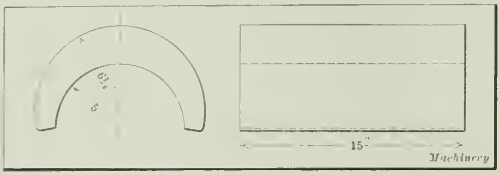

Fig. 1. Driving Box Crown Brass

Between each shaper stroke, the work is turned slightly by a simple worm and worm-wheel, operated from the cross-feed shaft of the shaper. The work is thus turned while the cutting is going on, and two cuts—one roughing and one finishing— are sufficient to finish the circular portion of the crown brass. One of the edges is next shaped off radially with the work, and by means of the circular gage the distance for the opposite end is marked. This is then finished at the same setting and the crown brass is ready to be put into its seat in the driving box. An apprentice can operate this machine and finish a crown brass complete, ready for fitting in its driving box, in twenty minutes. C. L. L.

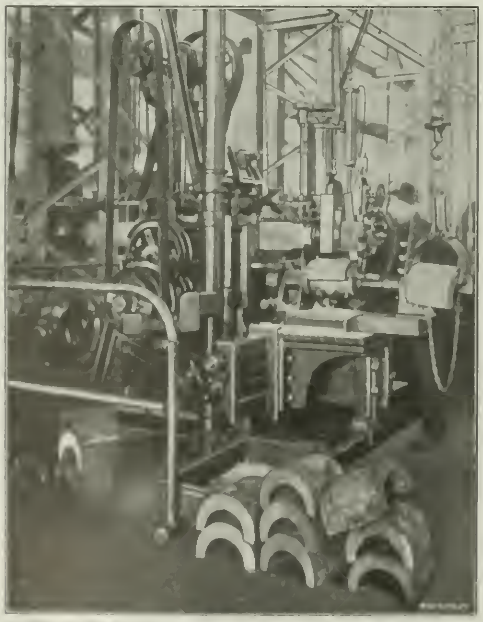

Fig. 2. Morton Draw-cut Shaper used on Crown Brass Fitting

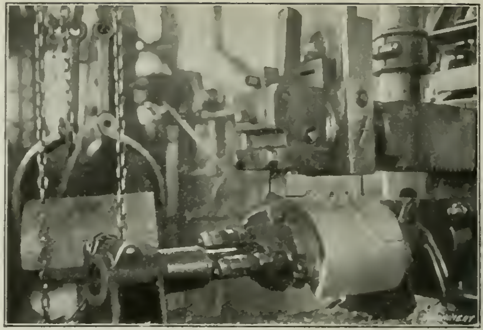

Fig. 3. Close-range View of Operation

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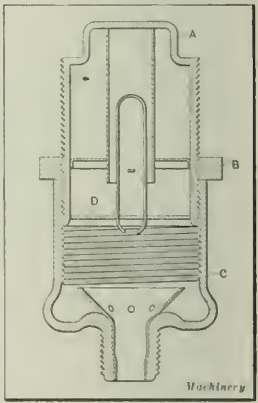
COMPRESSED AIR GREASE CUPS

The accompanying illustration shows a grease cup described in *Engineering*, the feed of which, instead of being effected by a spring in the usual manner, is worked by compressed air. These cups are made by Lubricators, Ltd., Leeds Place, Tollington Park, London. With spring-worked feeds, it is desirable to have a number of springs of varying capacity to provide a pressure suitable for different qualities of grease; or the grease cup may be provided with a strong spring and the feed may be regulated by an arrangement fitted in the body or neck of the cup for throttling the feed. This method, however, often leads to the clogging of the feed altogether. In the case of the compressed air cup, springs are unnecessary and there is no need of throttling, as the feed depends entirely upon the amount the top of the lubricator is screwed down, and the full bore of the outlet is always used. Another advantage claimed for the compressed air cup is that if the bearings should heat, the air in the grease cup would also be warmed and expanded, thus increasing the pressure and also the supply of lubricant delivered to the journal.



A Grease Cup where Flow of Lubricant is regulated by Air compressed within it

The lubricator, as will be seen from the illustration, consists of three main parts: a cup *C*, a cover or top *A*, and a lock-nut *B*. Parts *A* and *C* are pressed out of mild steel or brass. The top *A* contains a suspended disk *D*, the object of which is to keep the upper surface of the grease flat, and prevent the air from forcing a passage through the grease. When the cup is filled with grease, this should be packed down so as to prevent large air cavities in it. The suspended disk is pulled out to the end of top *A*, and the latter is screwed into the cup about ¼ or ⅜ inch, this being sufficient to compress the air the required amount, as all parts are hermetically sealed by the grease. The lock-nut is then tightened by hand. The small funnel at the bottom of the cup is made of thin sheet steel so that if the bearing becomes heated, the heat is quickly transferred to the grease, which melts and runs down.

THE MANUFACTURE OF CHAIN[*]—1

PRINCIPLES AND MACHINES EMPLOYED IN MAKING CHAINS OF VARIOUS TYPES

BY FRANK H. MAYOH[†]

Frank H. Mayoh[‡]

CHAINS are made in many forms, and with the exception of a few types of fancy chains used for jewelry and similar purposes, the links are flexibly connected with each other. The size of a chain is usually specified by the thickness of its links; for example, a $\frac{3}{8}$-inch chain is one made from bar metal $\frac{3}{8}$ inch in diameter. The metal used in the manufacture of chain must be very malleable and ductile to allow the bar or wire to be bent and twisted into the desired form of links. Chains are used for a variety of purposes, and their names are often derived from the purpose for which they are to be used, as anchor chain, surveyor's chain, etc.; or the name may be derived from the material from which the chain is made, as steel, iron, gold or silver chain. But the most common method of nomenclature is based on the shape of the links; and this has resulted in the development of such terms as ladder chain, rope chain, twisted link chain, flat link chain, etc. Possibly the most complete method of naming is a combination of the two latter systems, specifying the shape of the link and the material from which the chain is made. In this way a more complete description is afforded.

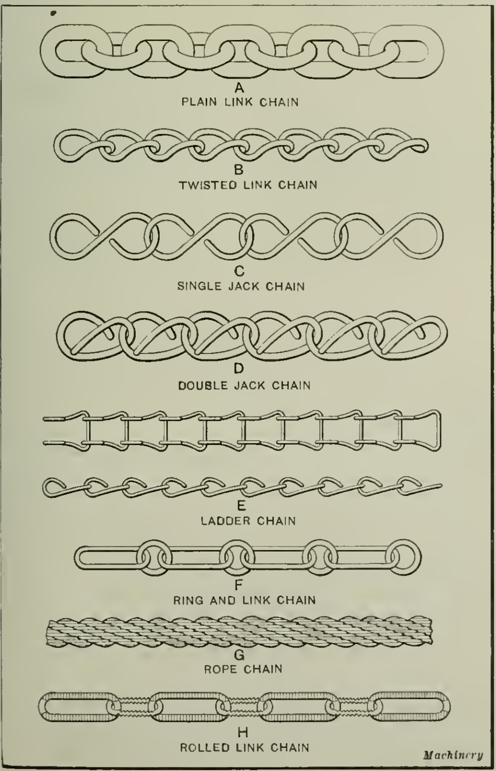


Fig. 1. A Few Typical Examples of the Different Types of Chain

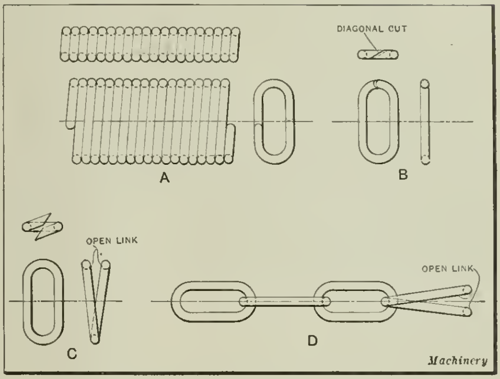


Fig. 2. Operations involved in making Plain Link Chain on the Coiling Machine and by Hand

It is the purpose of this article to describe some of the methods and machines used in chain manufacture, and in order to enable those who are not familiar with the principles employed in this industry to obtain a general working knowledge of the subject, some of the simpler principles are included. One very important point in chain making, as in all wire forming operations, is to have the wire free from kinks which would show in the finished product. Various forms of wire straighteners are employed for this purpose. In one common form there is a series of rolls that may be arranged in various ways according to the nature of the work. The wire is passed between these rolls as it is fed into the machine, and as a result all kinks are removed. The general practice is to draw the wire through the straightener, although in certain cases the straightener is drawn back and forth along the wire. In another form of wire straightener quite generally used, the wire is simply drawn between staggered pins to straighten out the kinks.

Fig. 1 illustrates some common types of chain; a plain link chain is shown at *A*, a twisted link chain at *B*, a single jack chain at *C*, a double jack chain at *D*, a ladder chain at *E*, a ring and link chain at *F*, a rope chain at *G* and a rolled link chain at *H*. In this connection it may be mentioned that the rolled link chain is a chain which has been passed through a set of rolls to flatten out the links. In addition to these common types of chain, other examples will be referred to in the later sections of this article.

A type of coiling machine often used in making chain from medium and heavy sizes of wire is shown in Fig. 3. This cannot be classed as a complete chain making machine because it does not make the links entirely but merely coils the wire into a spiral which is then cut up into individual rings from which the links are made. The successive operations in the manufacture of chain by this process are shown in Fig. 2, the coil of wire, as produced on the machine illustrated in Fig. 3, being shown at *A*. An individual link cut from this coil is shown at *B*, where it will be seen that the cut is made diagonally to provide for making a scarf weld, if so desired. The link is shown at *C* sprung open to enable it to be interlocked with the previous link of the chain. These individual links are then assembled to form the complete chain as shown at *D*. After the links are "sprung" together, the joints must be welded or brazed. In operating the coiling machine shown in Fig. 3, the wire passes through the straightening rolls *A* to the arbor *B* which is of the same shape and size as the links that it is desired to produce. The wire is clamped to the arbor and kept in close contact with it by means of guide rolls which are held by weights attached to the ends of suitable levers as shown at *D* and *E*. This is a simple method and one which produces very good links for hand welding.

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[*] For other articles on chain making and allied subjects published in MACHINERY, see "Chain Making by the Ton," October, 1911; "Making Diamond Auto Truck Chain," May, 1911; "Making Heavy Chain and Anchors for Uncle Sam," February, 1910; "Chain Making Extraordinary in a Scrapless Press Room," November, 1909; and "A New Process of Making Weldless Chains," July, 1907. For articles on wire forming, see also "Spring Winding and Coiling," October, 1914; "Fixtures and Machines for Wire Forming," September, 1914; and other articles there referred to.

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When it is necessary to make up various types of fancy chain and the demand for any one style is relatively small, it would not be practical to set up an elaborate machine. This is particularly true in cases where the links in a single chain are of various forms, *i.e.*, one long and one short, or where various fancy forms of links are used in the chain at specified intervals. In such cases a combination hand and machine method can be used to very good advantage, the set-up of the machine being shown in Fig. 4. Reference to this illustration will show that the method is nothing more nor less than the common method of spring winding on the lathe, adapted to the requirements of the chain making industry.

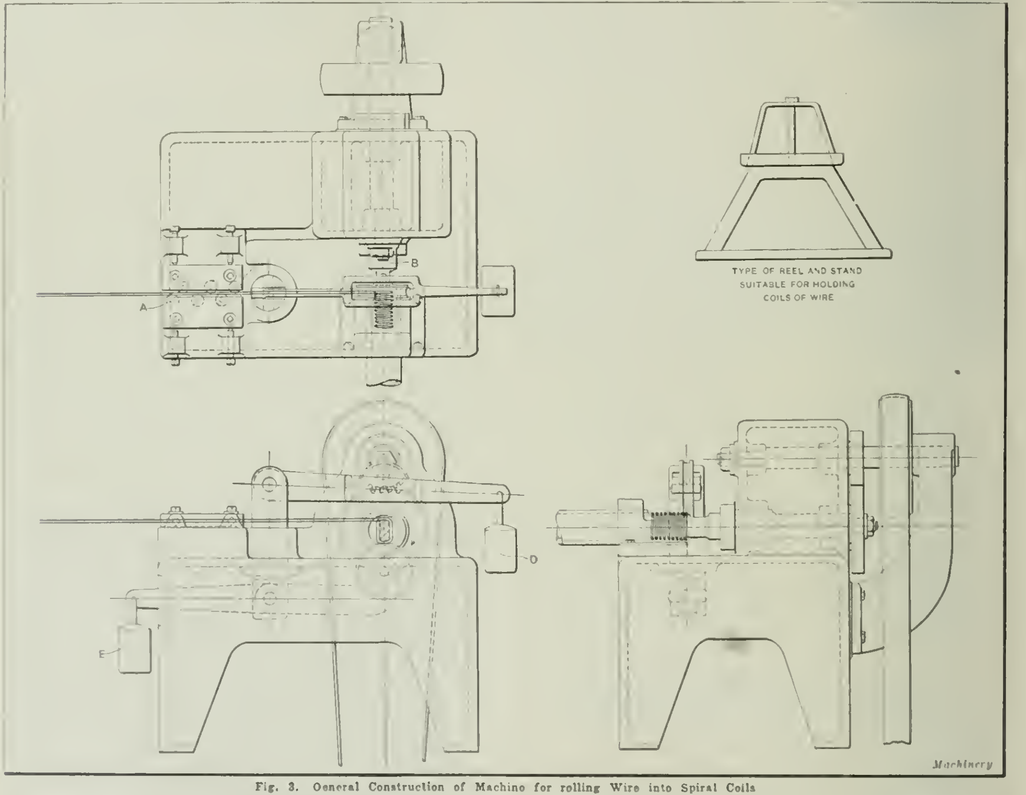

Fig. 3. General Construction of Machine for rolling Wire into Spiral Coils

The arbor *A* on which the wire is wound is made to correspond with the form of link that is to be produced. After the wire has been wound on the arbor, the coil is cut up into links by means of a fine-toothed saw, the arbor being provided with a groove in which the saw runs. In most cases links of this type are cut apart without attempting to make the diagonal or "scarf" cut, as such links are generally soldered or brazed together. Fig. 5 shows an end view of the arbor on which the wire is wound, and the saw in position to perform the cutting operation.

While by far the most common method used in the manufacture of chain is that which necessitates the cutting off of the wire and subsequent joining of the links by welding or some other means, some of the strongest chains are made by the production of the so-called "weldless" links. One style of chain produced in this way is illustrated in Fig. 6 where the principle of manufacture is clearly illustrated. The blanks are first stamped out from sheet metal in the form of washers, or holes are punched in round disks as shown at *A*. The ring produced in this way is next subjected to a swaging operation or some similar process by which it is brought to a round section, as shown at *B*. The next step consists of drawing out the links to an oblong form as shown at *C*, after which each link is bent double, bringing it to the condition shown at *D*. The finished chain *E* is then assembled by threading the individual links together. This makes a neat chain of uniform strength, the danger of weak links due to defective welds being avoided.

As in all industries of long standing, the original methods of chain making were quite primitive and some of these old methods are still employed in making certain classes of chain; but at the present time most of the chain is produced on automatic machines designed especially for the production of a certain class of chain. This is naturally the case, as the manufacture of small fancy chains is conducted along quite different lines from those followed in the making of commercial types of jack and ladder chains. Likewise, the machines employed in the production of large welded-link chains require welding apparatus to be incorporated in their design. In order that the movements involved in an automatic chain making machine may be thoroughly understood, the reader is referred to Fig. 7, which illustrates the form of machine employed in making plain link chain. This illustration shows the method of manufacture employed, and the individual steps are shown in detail in Fig. 8. Reference to the latter illustration will show that the wire is first cut off to the required length as shown at *A*; it is next bent around an arbor as shown at *B*; the ends of the link are then turned in as shown at *C*, where it will be seen that the link is practically closed; the finished link is shown at *D*; and the link is held as shown at *E* to have the wire for the next link threaded through it. The cycle of operations may be repeated indefinitely to produce chain of any required length.

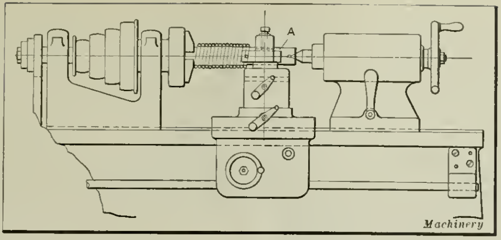

Fig. 4. Winding a Coil of Chain Link Blanks in the Lathe

In starting to make chain on the machine shown in Fig. 7, the wire, which is coiled on a reel mounted on a suitable stand, is fed through the straightening rolls and then passed into the feed slide *A*, from which it is carried on through the guide *B* until it engages the stop *C*. When the wire engages the stop, the feed slide remains stationary, while the jaws *D* are advanced by the action of cams *E* until they hold the wire against the arbor *F* to prevent the blank from dropping out of place when it is cut off. The cutting off of the blank is effected by the blade *G* which is operated by cam *H*, the motion being transmitted through the rocker arm *J* in the direction shown by the arrow. After the blade *G* has been returned to its original position by means of a spring, the jaws *D* are advanced by another rise on the cams *E*, thus causing the wire to be bent around the arbor *F* to partially form the link. The second step in the forming operation is obtained by closing the jaws *D* around the arbor *F*, this movement being effected by the side cams *K* which swing the jaws around the stud *L* on which they are carried, thus bending the link completely around the arbor. The arbor is next moved slightly in order to loosen the link on it, and the ends of the link are then turned in through the action of the swage *M* which is operated in the same manner as the cut-off blade *G*, the motion being effected by the cam *N* and transmitted to the swage through the rocker arm *P*.

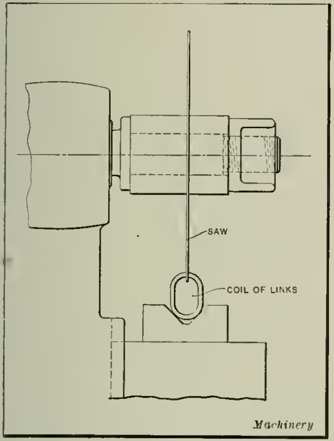

Fig. 5. Method of sawing apart the Links after coiling

While this cycle of operations is being performed, the feed slide *A* is drawn back against the stop screw *O* which is located at the end of the wire straightener. The position of the screw *O* may be adjusted to control the distance that the feed slide moves back, and in this way the length of the blank cut from the wire can be regulated. That this is the case will be readily understood when it is remembered that the cam which operates the feed slide always moves the slide forward to the same position. Owing to the fact that the feed slide must release its grip on the wire before returning, and that when its grip is released there is a tendency for the wire on the reel to slip back, some means must be provided to prevent such a movement of the wire. This is done by means of the pin *R* which is caused to grip the wire at the right moment by means of the cam *S* and rocker arm *T* which force the pin *R* firmly against the wire and hold it in a fixed position until the feed slide has secured a fresh hold.

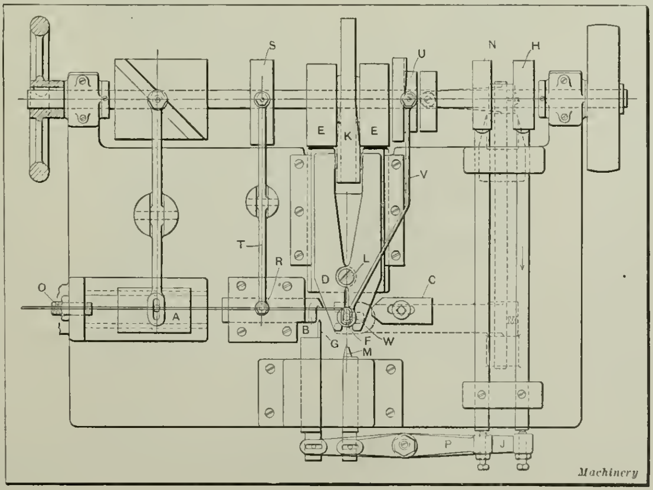

Fig. 7. General Arrangement of an Automatic Chain Making Machine

After completing the cycle of operations on a given link, means must be provided for making the connection between this link and the successive link of the chain. This is done by picking up the link from the arbor at the proper moment. For this purpose the cam *U* lifts the rocker arm *V* and causes the hook *W* to descend and catch under the link at the moment that the arbor *F* drops down. This leaves the link suspended on the hook *W* where it is in the proper position for the wire from which the next link is to be formed to be passed through it. After this has been done, the hook releases the link which is left suspended on the wire, after which the required cycle of operations is gone through to form the next link. This process is repeated over and over until the required length of chain has been produced. The finished chain passes through a hole in the machine and is received in a container which revolves in such a way as to prevent the chain from becoming tangled.

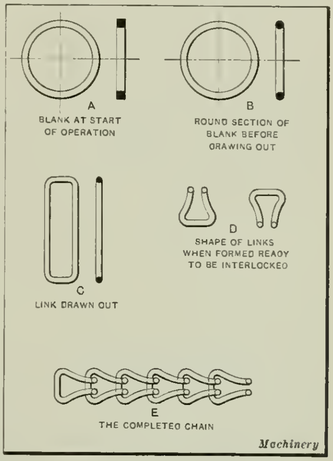
A
BLANK AT START OF OPERATION
B
ROUND SECTION OF BLANK BEFORE DRAWING OUT
C
LINK DRAWN OUT
D
SHAPE OF LINKS WHEN FORMED READY TO BE INTERLOCKED
E
THE COMPLETED CHAIN
Machinery

Fig. 6. Operations involved in the Manufacture of Weldless Chain

Referring to the bottom of Fig. 8, in which the chain is shown in the condition which it has reached after each successive operation, the process of manufacture may be briefly summed up as follows: First, the wire is fed through to the stop and the blank *F* is cut off; second, the jaws come forward and hold the wire blank in position against the arbor, and the jaws bend the wire around the arbor to the form shown at *G;* third, the jaws are closed in to complete the forming of the link, the arbor moves slightly to loosen the

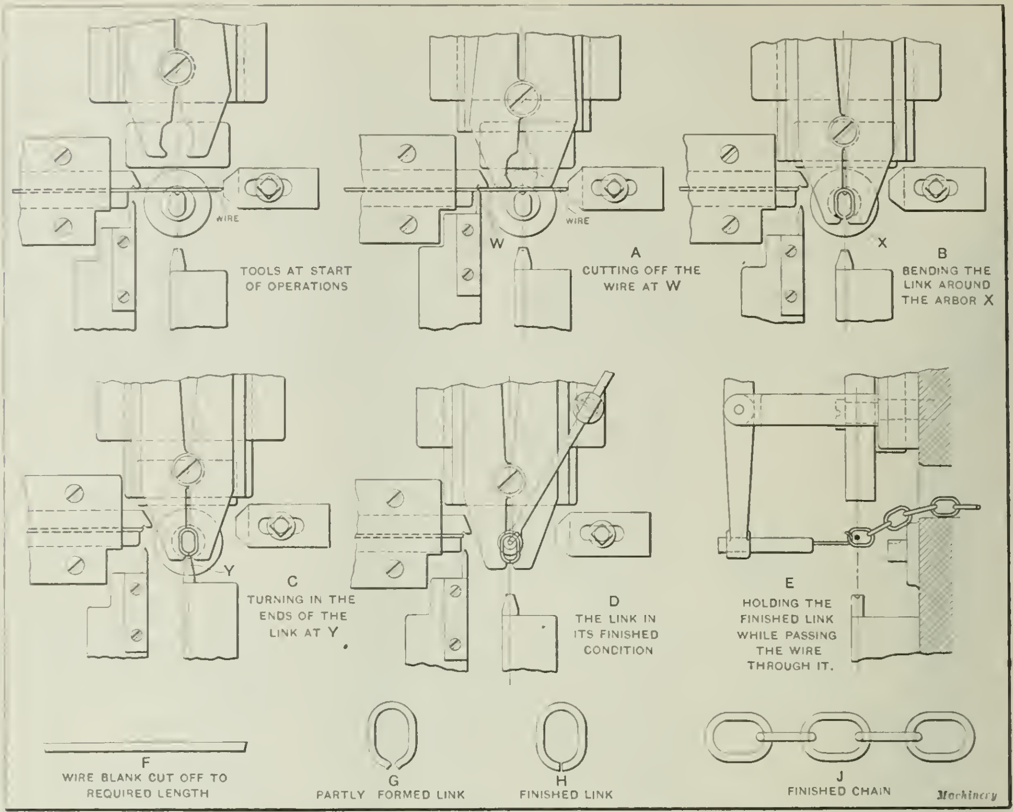
WIRE
TOOLS AT START OF OPERATIONS
W
WIRE
A
CUTTING OFF THE WIRE AT W
X
B
BENDING THE LINK AROUND THE ARBOR X
Y
C
TURNING IN THE ENDS OF THE LINK AT Y
D
THE LINK IN ITS FINISHED CONDITION
E
HOLDING THE FINISHED LINK WHILE PASSING THE WIRE THROUGH IT.
F
WIRE BLANK CUT OFF TO REQUIRED LENGTH
G
PARTLY FORMED LINK
H
FINISHED LINK
J
FINISHED CHAIN
Machinery

Fig. 8. Successive Operations performed on Machine shown in Fig. 7

link on it, the ends of the link are turned in as shown at *H*, and at the same time the binding pin secures its grip on the wire as the feed slide moves back to take a new grip; fourth, the arbor drops out of the link which is picked up by the hook and suspended on it, and the wire for the next link is fed through the finished link as shown at *J*, after which the cycle of operations is repeated. This method is best adapted for links 3/16 inch in length or larger, as the hook is likely to miss when it is required to pick out the links of very small chains. However, machines of this type are fitted with a stop motion which disengages the clutch in the event of the chain falling out of the machine through the failure of the hook to suspend the last link ready for its engagement by the following blank. This machine may also be used for making plain rings or individual links, for which purpose it is merely necessary to disengage the hook which picks the finished link off the arbor.

In most cases the fancy types of chain for decorative purposes have the links soldered or brazed together, making a seamless appearance. After this has been done the links are cleaned and tested in order to discover any weak links that may exist through defective joints. Commercial types of chain, where a good appearance is not necessary, and which are not required to do heavy work, are left with the ends of the links open, while cable chains have the links welded at the joints. Fig. 9 shows a collection of different forms of twisted link chains. Chains in which the links are twisted were originally made by holding one end of the link and twisting it at the opposite end with a pair of pliers. After this had been done the link was flattened by tapping it with a small mallet or by passing it through a pair of rolls. It is only natural to assume that modern methods of manufacture have largely done away with this crude method of making twisted chain; and as a matter of fact, it is now produced by automatic machinery. Referring to the variety of patterns of twisted chain shown in

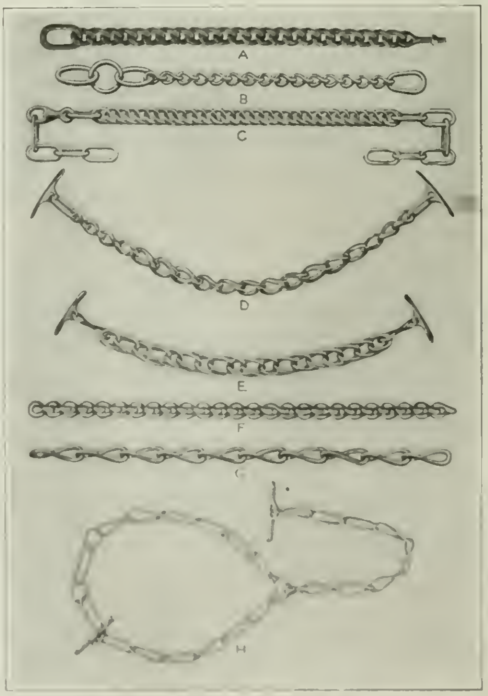

Fig. 9. Various Patterns of Twisted Link Chain

Fig. 9, *A* is a short twisted chain which may be wrapped snugly around a bar. A wagon-back chain is illustrated at *B* which has closely twisted links, in which the twist is a full quarter turn. A double cart-back chain is shown at *C*, while the chain illustrated at *D* is a type of single-tapered breast chain, and reference to this illustration will show that the links vary in size, growing smaller from the center toward one end. A double breast chain is shown at *E*, and *F* illustrates an example of a chain with very closely twisted links. The two remaining examples *G* and *H* are shown for the purpose of illustrating more open patterns of twisted chain.

* * *

THE SPACING OF MACHINES*

Many manufacturers handicap themselves by crowding the machines in their factories together and limiting the aisle spaces, in the belief that greater economy and production will be gained thereby. There is certainly no advantage, however, from a production standpoint, in placing machines so close that the workmen interfere with one another. If the workmen are paid by the day they are likely to stand idle while the operation of a near-by machine interferes with their work; and where the piecework system prevails, each employe, knowing that his wage will depend upon his production, is likely to continue his work in spite of difficulties and dangers to which he may be subjected. His movements are likely to interfere with his neighbors' work, just as their movements interfere with his own; and where the crowding is excessive the likelihood of accident is often very great. Serious results frequently follow from trifling causes, and a slight push may cause a workman to lose his balance, so that in recovering himself he may thrust his hand, arm, or foot into some moving part of the machinery, and be badly injured. To afford adequate protection to the workman, the machines should always be properly separated from one another, and they should also be set at safe distances from walls and posts and other fixed parts of the building.

Inadequate spacing is especially dangerous in connection with machines that turn out work of considerable length, or into which long pieces of raw material are fed. The operator of each machine must necessarily confine his attention closely to his own work, and so may be struck unexpectedly, and injured, by a bar or other object projecting from a machine near by. Under some circumstances one end of a bar of this kind may be caught in an unprotected gear or other moving part of the next machine, and suddenly transformed into an erratic, revolving flail, or twisted or broken into flying pieces. In either case the chance for injury to the employes in the immediate neighborhood is great.

The following conditions were observed during a recent inspection of a shop in which coal-mining drills are manufactured. On the same floor certain machines are used to sharpen one end of the drills, and others are used to square up the opposite end, to fit the crank. Most of the drills are not over three feet long, and the machines are spaced so that work on drills of this length can be carried on upon all the machines at once, without interference. Sometimes, however, drills from four to six feet long are made by the same machines, and operators are then obliged to work in a space which, although ample for making three-foot drills, becomes dangerously crowded when six-foot drills are substituted. The operator, intent on the work at one end of the drill, is likely to overlook the fact that the other end is dangerously close to his neighbor and his neighbor's machine, on the right, while the drill of the workmen on the left bears the same relation to him. Under these conditions there is an ever-present danger of cutting or otherwise injuring a fellow-worker at the next machine, or one walking along the aisle. The principle here noted in connection with work of one special kind applies also to many other industries, and should not be forgotten.

It is seldom that machines are crowded together when wide aisles are provided. Limited machine-space and limited aisle-space usually go together, and in such cases there is rarely sufficient space, near the operators, for the safe storage of material or finished product. Furthermore, the operators usually take little care to arrange the pieces in orderly fashion, but simply let the material lie wherever it falls. There is seldom room for trucks, or for a sufficient number of trucks to serve all the machines. One of two dangerous conditions will then prevail: either there will be excessive heaping or piling of material in the already crowded space, or there will be a constant procession of workers bringing in raw material and removing finished product.

When piles of small castings or of other finished or unfinished material lie on the floor of a shop, some few of the pieces almost invariably become separated from the others, and persons passing by often stumble over them. A simple fall upon the floor may cause a bad injury, and the likelihood of a serious result is greatly increased when a man who has tripped over one of these objects falls in the direction of a moving machine. This may happen at any moment in a shop where the machines are closely spaced, and where limited aisle-space is provided and piles of working material are allowed to remain on the floor. Any workman in going from one machine to another under such conditions must be extra vigilant to avoid colliding with other men or with materials they may be handling, and he must also be careful to avoid tripping over tools or material lying on the floor.

The men or boys who supply the machine operators with raw material, or remove the finished or partly finished product, are in danger of injury to themselves or of causing injury to others, in several ways. The truck will take up a large portion of the already limited space, and any person who wishes to use the passage is at a disadvantage. The man loading the truck is likely to have his hand or clothing caught in neighboring machinery, or he may accidentally move a belt-shifting rod or other machine-starting device. Any one of these actions is likely to cause an accident.

In pushing trucks about the shop it is often necessary for them to pass one another, and there is seldom any special place or space reserved for this purpose. The men in charge of the trucks usually take advantage of the first handy nook or recess, and try to get by one another. In doing this their hands often become bruised, lacerated, or crushed. If the men try to pass in the narrow aisle the trucks are likely to collide, thus knocking off some casting or other object that may have been insecurely placed. In the event of an injury of this kind, the crowded condition of the shop is not held accountable for it, as a rule—some other proximate cause being assigned. This is in accordance with the general principle that a *thing* or a *person* often bears blame that should rightfully be placed upon a *condition*.

The manufacturer who is seeking safety and efficiency will ascertain, beforehand, the dimensions of the machine he is to install, and he will also find out how much space should be allowed for the worker, and how much area his operations will cover. He will likewise ascertain the probable rate of production, and the rate at which the material can be supplied and the product passed on to other departments. With this information at hand it is easy to lay out the factory and locate the machines, so that efficiency, orderliness, and safety will all be assured. It is an excellent plan to have so-called "dead-lines" painted conspicuously on the floor to mark the limits of the aisles. Lines of this kind should be re-painted whenever they tend to become indistinct, and foremen should see that nothing is allowed to extend over them.

* * *

An interesting statement is made by a French publication to the effect that the number of deaths of aviators in the war service is very much smaller than the death records in time of peace, one of the explanations being that aerial navigation is quite safe when there is no indulgence in exhibition stunts that have brought so many disasters. When an aeroplane is handled by a skillful aviator for the legitimate purpose of plain flying, it is a very much safer means of transportation than is generally believed. Another matter of considerable interest is also mentioned in connection with aviation in Russia. That country has within the last two years trained a very large number of men in aviation, and as a result has more skilled aviators in its military service than any of the other warring nations.

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* Abstracted from "The Travelers Standard."

EMPIRICAL WORM-GEAR FORMULAS*

RUNNING PROPERTIES OF WORM-GEARS IMMERSED IN OIL

BY E. S. HEDSTROM†

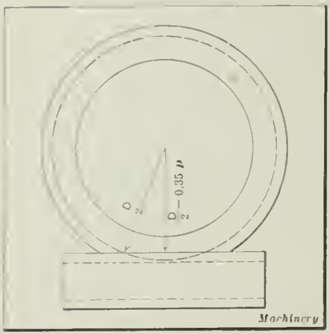

Fig. 1. Diagram showing Method of deriving Formula (2)

A GREAT deal of information has appeared in the technical press and elsewhere concerning the running properties of worm-gears, but very little has been published concerning their limit loads. This is largely due to the fact that so much depends upon the conditions under which the gears run and the quality of oil with which they are lubricated. To try to develop a strictly theoretical formula for the limit pressure on the teeth of worm-gears and in that way to obtain the safe working load, does not appear to be practical. A more feasible plan seems to be to derive a formula covering the main points which must be taken into consideration, and then apply a constant in connection with the formula, which has been determined by experiment. The cause of failure of a worm-gear may be due either to the fact that it lacks mechanical strength or to the breaking down of the oil film between the teeth of the worm and worm-wheel. The calculation of the strength of the teeth is made in the usual way; *i.e.*, a tooth is regarded as a cantilever on which the load is applied at a point near the center of the tooth at the pitch line.

Let l = length of worm thread per revolution;

β = angle of worm subtended by wheel = 70 degrees;

W = actual width of tooth $= l \times \frac{\beta}{360}$;

p = circular pitch;

T = thickness of tooth $= \frac{p}{2}$;

S = tensile strength of metal.

The length of the cantilever is approximately equal to the dedendum of the tooth = $0.3683p$. Then the breaking pressure P in a direction normal to the tooth surface is as follows:

$$P = \frac{1}{6} \times \frac{l\beta}{360} \times T^2 \times \frac{S}{0.3683p} = 0.000314 l\beta pS \text{ pounds.} \quad (1)$$

To determine the number of teeth N_c which are in contact simultaneously, referring to Fig. 1 we have:

$$N_c = \frac{2}{p}\sqrt{\frac{D^2}{4} - \frac{D^2}{4} + 0.35Dp - 0.12p^2} = \sqrt{\frac{1.4Dp}{p^2}} = 1.18\sqrt{\frac{D}{p}} \quad (2)$$

where D = pitch diameter of worm-wheel in inches.

Dropping the quantity $0.12p^2$ in deriving Formula (2) makes this a rather coarse approximation, but that it serves its purpose will be shown in the following discussion. Wilfred Lewis has shown (see MACHINERY'S HANDBOOK, page 594-596) that the permissible working stress in the material of gear wheels varies almost inversely as the square root of the peripheral speed. Applying this to the tensile strength factor S, and assuming a working stress of 20,000 pounds per square inch for a peripheral speed of 100 feet per minute, we have:

$$S = 20{,}000\sqrt{\frac{100 \times 12}{\pi D \times \omega}} = \frac{392{,}000}{\sqrt{D \times \omega}} \text{ pounds per square inch} \quad (3)$$

where ω = number of revolutions per minute of worm-wheel.

$$l = \frac{\pi d}{\cos a} \text{ inches} \quad (4)$$

where l = length of worm thread per revolution;

d = pitch diameter of worm in inches;

a = angle of lead of worm thread.

Multiplying Formula (1) by Formula (2) gives the total breaking pressure P_1 in pounds. Performing this operation we have:

$$P_1 = 0.000314 \times 1.18\, l\beta pS\sqrt{\frac{D}{p}}.$$

Inserting the values from Formulas (3) and (4) and assuming $\beta = 70$ degrees, we have:

$$P_1 = 0.000314 \times 1.18 \times 3.14 \times 70 \times 392{,}000 \times \frac{dp}{\cos a}\sqrt{\frac{D}{pD \times \omega}} = 32{,}200 \times \frac{d}{\cos a}\sqrt{\frac{p}{\omega}}$$

The preceding formula gives the value of the pressure acting in a direction normal to the surface of the teeth. Multiplying by $\cos a$ gives the tangential pressure P_2 at the pitch line which is required to break the teeth.

$$P_2 = 32{,}200d\sqrt{\frac{p}{\omega}} \text{ pounds.} \quad (5)$$

To determine the pressure P_3 which is required to break down the oil film between the worm-wheel and worm, the method of procedure is as follows: The length of the contact line l per tooth is $\frac{\pi d}{\cos a} \times \frac{\beta}{360}$, and from Formula (2) the number of teeth N_c which are in contact at the same time is $1.18\sqrt{\frac{D}{p}}$.

Then the total length of the contact line L is:

$$L = 1.18 \times \frac{\pi d}{\cos a}\sqrt{\frac{D}{p}} \times \frac{\beta}{360}. \quad (6)$$

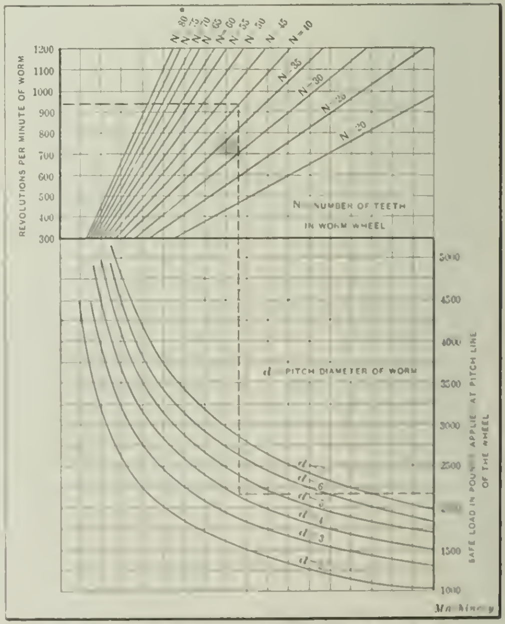

Fig. 2. Diagram for determining Safe Load for Steel Worm and Bronze Worm-wheel

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* For previous articles on worm-gears and worm-gear design see "Making High-efficiency Worm-gearing," January, 1914, and other articles there referred to.

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The pressure per inch of contact line necessary to break down the oil film between the teeth varies with the "rubbing" speed. With the experimental gears which were used in obtaining the data presented in this article, the load was increased to the "seizing point" for different rubbing speeds ranging from 200 to 1000 feet per minute, and curves were plotted with "seizing loads" as ordinates and speeds as abscissae. In each case it was found possible to replace these curves with one of the form $P = \dfrac{C}{\sqrt{V}}$, where C is a constant; and that by so doing the error did not exceed ± 5 per cent. This shows that within the speed range referred to, the pressure per inch of contact line may safely be regarded as inversely proportional to the square root of V.

Combining Formula (6) with the general formula for the pressure per inch of contact line we have:

$$P_3 = C_1 \times \frac{d}{\cos a \sqrt{V}} \sqrt{\frac{D}{p}}$$

where C_1 is a constant including all constants in Formula (6) and the constant C for the general formula for the pressure per inch of contact.

The value of the rubbing speed V is:

$$V = \frac{\pi d \omega_1}{12 \cos a}$$

$$\cos a = \frac{\pi d}{\sqrt{9.8d^2 + K^2p^2}}$$

Combining the preceding equations we have:

$$V = 12 \times \omega_1 \sqrt{9.8d^2 + K^2p^2} \qquad (7)$$

where ω_1 = revolutions per minute of the worm;

K = number of threads on worm.

Multiplying the value for the seizing pressure P_3 by $\cos a$ and inserting the value of the rubbing speed V from Formula (7), gives the tangential seizing pressure P_4.

$$P_4 = C_2 \times d \sqrt{\frac{N}{\omega_1 \times \sqrt{9.8d^2 + K^2p^2}}}$$

In deriving the preceding formula it must be remembered that $\dfrac{\pi D}{p} = N$ = total number of teeth in worm-wheel. For values of the constant K less than 3, we have the value of the seizing pressure P_4 as follows:

$$P_4 = C \sqrt{\frac{d \times N}{\omega_1}} \qquad (8)$$

where the value of the constant C is unknown.

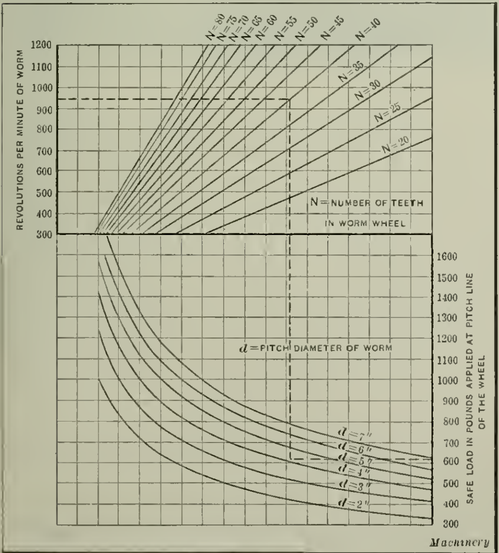


Fig. 3. Diagram for determining Safe Load for Steel Worm and Iron Worm-wheel

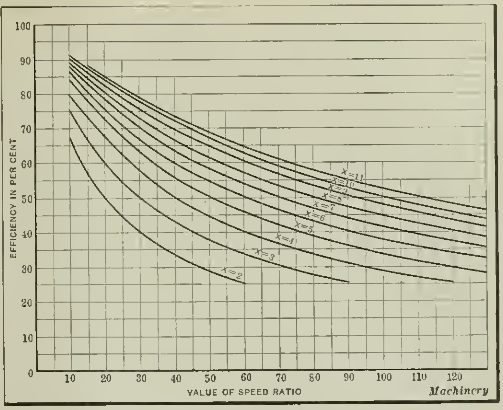


Fig. 4. Diagram for determining Efficiency of a Worm-gear Drive

For the purpose of determining the value of the constant C of Formula (8), tests were conducted with four worms having pitch diameters ranging from 2½ to 4½ inches and pitches ranging from 0.8 to 1.5 inch. These worms were first run in contact with bronze worm-wheels with pitch diameters ranging from 8 to 30 inches; and after these tests were completed, a second series of tests was conducted running the worms with iron worm-wheels of the same dimensions. A high grade of cylinder oil was used as a lubricant while using the bronze worm-wheels. For the tests in which the iron worm-wheels were used, a mixture of one pound of graphite in two gallons of cylinder oil was employed. The points at which the break-down of the oil film and consequent "seizing" of the gear teeth took place were apparent by the sudden drop of efficiency. In the tests where the iron worm-wheels were used, the seizing point was also readily distinguished by the sound. The worm-wheels were taken from a line of standard B. & S. elevator gears. The worms were neither ground nor tempered, but the worm-wheels were hobbed. The value of the constant C was found to average 15,600 for bronze worm-wheels, and 4350 for iron worm-wheels. These figures are based upon an oil temperature of 90 degrees F.; but where the temperature of the oil was 65 degrees F. the values of the constant C were found to be 15 per cent higher.

Now to find whether the value of the breaking pressure P_2 from Formula (5) or the seizing pressure P_4 from Formula (8) is the limiting pressure, we may consider them as equal. Thus for the bronze worm-wheels:

$$32{,}200d \sqrt{\frac{p}{\omega}} = 15{,}600 \sqrt{\frac{dN}{\omega_1}}.$$

Solving the preceding equation for the value of p we find:

$$p = 0.24 \frac{\omega d N}{\omega_1 d^2} = \frac{0.24N}{Rd} = \frac{0.24K}{d} \qquad (9)$$

where R = speed ratio $\dfrac{\omega_1}{\omega}$;

$K = \dfrac{N}{R}$ = number of threads on worm.

It will be evident from Formula (9) that when the pitch is less than one-quarter of the ratio $\dfrac{\text{number of threads}}{\text{pitch diameter of worm}}$ it is necessary to investigate the mechanical strength. Worm-gears of small pitch are often subjected to a severe strain in practice and the seizing pressure P_4, the value of which is expressed by Formula (8), is the limit load. The charts shown in Figs. 2 and 3 were developed to facilitate the application of Formula (8). The chart shown in Fig. 2 is made up with the data secured from tests with bronze worm-wheels, using a factor of safety of 3. Thus from Formula (8) $P_4 = 5200 \sqrt{\dfrac{dN}{\omega_1}}$. Similarly, the values for the chart for iron wheels, shown in Fig. 3, are calculated by substituting in the formula $P_s = 1450\sqrt{\frac{dN}{\omega_1}}$. Both charts will give values which are too high if the number of threads on the worm is greater than 2. Thus for $K = 4$, the maximum error will be about 5 per cent. To use either of the charts for a given gear, start at the ordinate in the upper section, which represents the proper number of revolutions per minute of the worm, and follow the horizontal line to the diagonal representing the proper number of teeth; then follow the vertical line down to the curve in the lower section of the chart representing the pitch diameter of the worm in question; and from this curve follow the horizontal line to the right-hand side of the chart where the safe load is found. The dotted lines are drawn for a 40-tooth worm-wheel running at 940 revolutions per minute, with a worm of 4 inches pitch diameter. Following this line in the two charts, it will be found that the safe load which can be applied to the pitch line of the bronze worm-wheel is 2150 pounds; and for the iron wheel, the safe load is 610 pounds. The writer has used these charts for a long while and has found them reliable for use in rating worm-gears for intermittent service. If the charts are used for rating worm-gears giving continuous service, it is necessary to ascertain that the temperature of the oil in which the gears run does not exceed the value specified on the chart.

In the efficiency test on the gears referred to, the writer found Prof. Barr's formula for the efficiency of worm-gears including the thrust collar on the worm to give results that were from 3 to 7 per cent lower than the maximum measured values; but the test curves give steadily increasing values of efficiency from no load up to the "seizing point." As the rated load is supposed to be only 33 per cent of the maximum load, the formula seems to be satisfactory for all practical purposes. The formula may be changed to a more convenient form as follows. The Barr formula for the value of the efficiency E is:

$$E = \frac{\tan\alpha\,(1 - f\tan\alpha)}{\tan\alpha + 2f}$$

where f = coefficient of friction = 0.05;
α = helix angle of worm thread.

Using the preceding notation:

$$\tan\alpha = \frac{pK}{\pi d}$$

$$E = \frac{\tan\alpha\,(1 - 0.05\tan\alpha)}{\tan\alpha + 0.1} = \frac{pK\left(1 - 0.05\dfrac{pK}{\pi d}\right)}{\pi d\left(\dfrac{pK}{\pi d} + 0.1\right)}$$

Multiplying the expression within both brackets by $\frac{\pi D}{pK}$ and bearing in mind that $\frac{\pi D}{pK}$ = the speed ratio $\frac{\omega_1}{\omega} = R$, while $\frac{D \text{ pitch diameter of wheel in inches}}{d \text{ pitch diameter of worm in inches}}$ is designated by X, we get:

$$E = \frac{pK}{\pi d}\left(\frac{R - 0.05X}{X + 0.1R}\right) = \frac{pK}{\pi D} \times \frac{\pi D}{\pi d}\left(\frac{R - 0.05X}{X + 0.1R}\right) = \frac{X}{R}\left(\frac{R - 0.05X}{X + 0.1R}\right) \qquad (10)$$

In practice, the quantity $0.05X$ is very small compared with the value of the speed ratio R and may usually be omitted from the formula without seriously impairing its accuracy. This reduces Formula (10) to the form:

$$E = \frac{X}{X + 0.1R} \qquad (11)$$

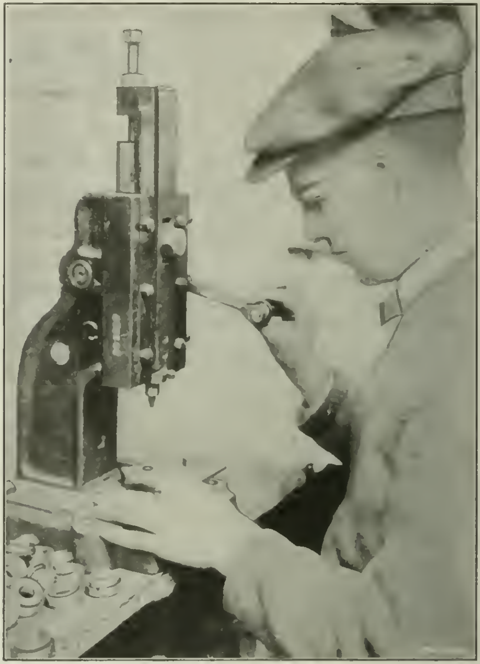
Formula (11) will be found convenient if it is desired to determine the efficiency of a gear from its dimensions.

The results of the tests referred to showed that the iron worm-wheels gave a slightly greater efficiency than the bronze wheels, but the mixture of oil and graphite which was used as a lubricant in testing the iron worm-wheels may have been partially responsible for this improved efficiency. The chart shown in Fig. 4 gives the efficiency for different values of the ratio X.

* * *

AN INSPECTOR'S STAMPING MACHINE

One of the inspectors at the Eclipse Machine Co.'s factory in Elmira, N. Y., has rigged up an inexpensive stamping machine for marking finished pieces with the lot number, etc. The illustration of the device, which is in reality a little bench press, shows that it is operated by a crank on the right-hand side of the machine; this crank turns a short shaft, the end of which may be seen at the left-hand side of the machine. On this shaft is a gear that engages a rack in the vertical slide of the fixture, and at the bottom of this slide is the stamp that makes the impression. The gear teeth on the pinion are cut away for three-quarters of the periphery, so that as the crank is turned the toothed section engages the rack and raises the ram until the last tooth on the gear lets go of the rack. Then as the rack runs into the open space the ram drops and stamps the work by gravity. As soon as the toothed section of the pinion comes around again, it picks the ram up and the operation is repeated. Adjustment is provided so that the letters may be stamped to any depth desired. A simple gage at the bottom serves to locate the work quickly, and the device may be operated continuously by simply turning the crank. The operator shown in the illustration has just finished stamping a lot of the small rings that may be seen in the foreground, and they were done at the rate of thirty pieces per minute, each one being evenly stamped and the impression uniformly located on the work.



Fixture for stamping Duplicate Parts

C. L. L.

* * *

Commercial rubber which is kept in perfectly dry air will not deteriorate, but in the presence of sufficient moisture it may be attacked by certain bacteria; some of these do not sensibly alter the properties of the rubber, but others are able to modify its properties so as to destroy its value. The importance of keeping rubber as dry as possible is, therefore, apparent.

BASE METAL PYROMETER COUPLES

Within the past decade the pyrometer has become an indispensable adjunct of the heat-treating plant, and fortunately it is no longer necessary to use the platinum-rhodium couple which alone costs about $60. The rare metal couple is costly, expensive to maintain and may be stolen because of the high intrinsic value of the metals used. During the past few years, in which the pyrometer has come into common use for testing the temperature of furnaces and molten metals up to 2000 degrees F., base metal couples have been successfully substituted for the rare couples formerly universally used. The base metal couples cost from one-seventh to one-tenth as much as the platinum-rhodium couples, and when the hot ends are burned off, they can be re-welded at a nominal cost and made as good as new. The construction of the common platinum-rhodium couple is such that it is practically non-repairable.

Another advantage of the base metal couple is its high electromotive strength. A base metal couple made by one well-known concern generates approximately 44 millivolts with temperatures of 77 degrees F. at the cold end, and 1950 degrees F. at the hot end, while the platinum-rhodium couple generates only about 10 millivolts with the same temperature difference. The base metal couple has an approximately straight-line electromotive force relation with the temperature, whereas the metal couple does not. This gives it the advantage of even scale divisions which obviously are more easily and correctly read by the average workman than uneven scale divisions. Because of the high millivoltage, it may be used with the rugged high-torque double-pivot type voltmeter that may be read without leveling, which is the only type suitable for shop use.

The base metal couple has an almost negligible temperature coefficient, whereas that of the rare metal couple is high. This feature of the base metal couple is also an advantage, as it eliminates what is known as the "immersion error." Hence the base metal couple pyrometer can be used bare in molten lead, aluminum and brass with good results. A noticeable portion of the couple is dissolved at each insertion, when used in molten brass, but though the welded end is soon eaten off, the couple can still be in use and give correct readings. One well-known make of base metal couple pyrometers has been used in molten brass for as many as two hundred readings, until the couple was too short to be handled.

* * *

The oxy-acetylene welding process has been used successfully for building up flat spots on locomotive driving wheel tires and restoring them to perfect condition. This means a substantial economy in the maintenance of locomotives and a saving of locomotive time in repair shops, which is of great importance during rush seasons. Instead of removing all the drivers of locomotives and turning them down to the common diameter made necessary by the depth of the flat spots, the flats are filled in with metal welded to the tire, and in a few hours the locomotive is ready for the road. The process saves tires, machining expenses and locomotive time.

INTERCHANGEABLE LOCATING AND CLAMPING ACCESSORIES

Everyone familiar with machine shops has noted the amazing number of bolts, straps, blocks, clamps, nuts and washers that accumulate around planers, milling machines, boring machines and other machines having a platen on which work is clamped for machining. Under some systems of shop management this mass of clamping accessories is relegated to the tool-room, from which it can be obtained on request as required for every job, but usually it will be found that there is a woeful lack of system in designing and dimensioning these very necessary parts of machine tool equipment.

Henry Lucas, of the Lucas Machine Tool Co., Cleveland, Ohio, has made a study of this vital subject for several years, and in cooperation with others in his organization has worked out a clamping outfit which seems to combine the maximum of efficiency with the minimum of parts. It is based on the unit principle, the idea being to get any height of block or any length of bolt required by using blocks or bolts of unit or multiple unit dimensions, building up to the required height or length.

The accompanying illustration, Fig. 1, shows a group of bolts, studs, washers, nuts, blocks, clamps, and stops which embody this principle and present a remarkable example of what can be accomplished in providing for all ordinary needs in clamping with a minimum number of parts. The clamping bolts ¾ inch diameter are threaded to the U. S. standard and have round heads, flattened, making two sides to engage the standard T-slot. The bolts have case-hardened threads, and the washers and nuts are also case-hardened. The nuts are rounded on both faces and the washers are cupped to fit. It will be noted that there are six lengths of bolts at the back and short lengths in front, connected with hexagon couplings. These cover all lengths from the minimum to 12 inches, the nearest length being selected and over-lengths being taken up by thick and thin washers in the usual manner.

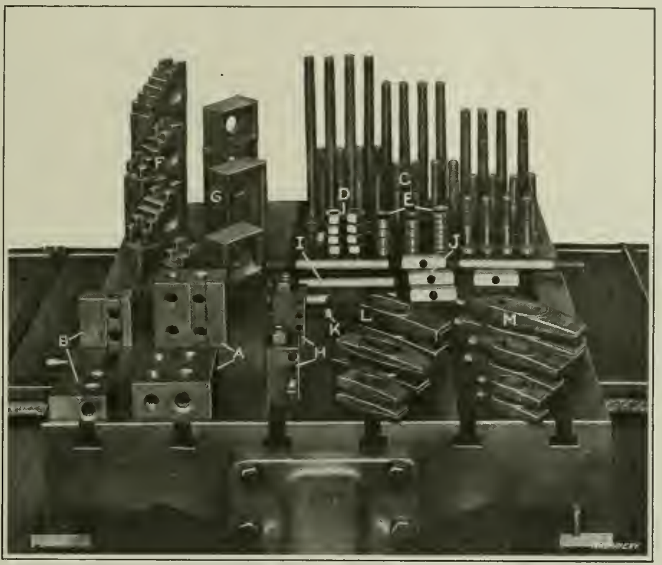


Fig. 1. Lucas Interchangeable Locating and Clamping Accessories for Machine Tools designed on Unit Principle

When a greater length is required than is provided for by the regular bolts, a regular bolt and a stud or studs are coupled together with the couplings to make up the length desired. The couplings are made of hexagon stock, drilled and tapped clear through. A lateral hole is drilled through the middle to show the machinist the position of the bolt ends so that he can engage the coupling threads equally on the two studs being connected.

The clamps are the regular drop-forged clamps made by one of the drop-forge concerns. These are provided in two styles, regular and pointed, the latter being used where a hole in the casting is to be engaged.

The blocking follows out the same general scheme of the clamp bolts. There are four blocks of each height, and the stepped blocks provide any small increment needed to accommodate a casting height, the height of the steps being one-half inch. A feature of these stepped blocks not common to stepped blocks in general is a slot in each side and base. The slot is provided to straddle a bolt in a narrow space. It often

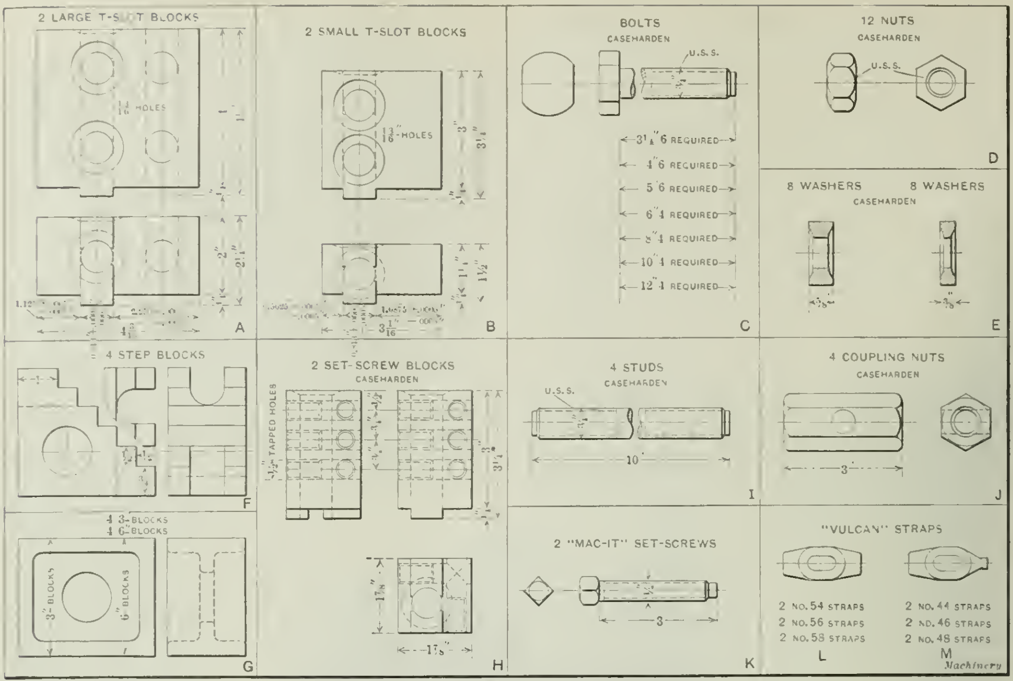


Fig. 2. Specifications of a Set of Lucas Locating and Clamping Accessories for Machine Tools

happens that a stepped block is needed in a space too narrow for the regular stepped block; this form will go into a narrow space because the legs straddle the bolt and reduce the space required by at least 1½ inch.

The system has been carried out to include stops, and two forms are provided. The block type is made of cast iron planed with a rib to fit the regular T-slot of the machine. These blocks are clamped, using regular clamping bolts and they may be used in a variety of ways as anchors for the clamp bolts where the latter cannot be used with the heads in the regular T-slots. The other form of stop is provided with set-screws facing in two directions. Three holes are tapped in both directions and set-screws are provided. An advantage of this type of stop, aside from its general convenience, is its secure attachment to the platen. It exerts no bursting or prying effect like that of the ordinary "jimmy" stop in common use.

A set of locating and clamping accessories as specified in Fig. 2 comprises the following parts:

A—2 large T-slot blocks, 4 inches by 4 3/16 inches by 2 inches;
B—2 small T-slot blocks, 3 inches by 3 1/16 inches by 1¼ inch;
C—6 ¾-inch bolts, 3¼ inches long under the head;
C—6 ¾-inch bolts, 4 inches long under the head;
C—6 ¾-inch bolts, 5 inches long under the head;
C—4 ¾-inch bolts, 6 inches long under the head;
C—4 ¾-inch bolts, 8 inches long under the head;
C—4 ¾-inch bolts, 10 inches long under the head;
C—4 ¾-inch bolts, 12 inches long under the head;
D—12 ¾-inch casehardened nuts;
E—8 casehardened washers, ¾ inch thick;
E—8 casehardened washers, ⅝ inch thick;
F—4 step blocks;
G—4 3-inch blocks;
G—4 6-inch blocks;
H—2 set-screw blocks, casehardened, 1⅞ by 1⅞ by 3 inches;
I—4 ¾-inch studs, 10 inches long;
J—4 coupling nuts, casehardened, 3 inches long;
K—2 "Mac-it" set-screws, 3 inches long under the head;
L—2 each Nos. 54, 56, and 58 "Vulcan" straps;
M—2 each Nos. 44, 46 and 48 "Vulcan" straps.

Suppose a casting to be clamped on a boring machine platen is 16¾ inches high, and is so shaped that clamping must be done at the top on one end, but at the other end a foot projects that is 2½ inches thick. Various combinations can be effected with the bolts, studs and coupling nuts to clamp at the height of 16¾ inches, but say that a 10-inch bolt coupled to a 10-inch stud *I*, using a coupling nut *J*, are selected. The available length under the head when the bolt end and stud meet in the coupling nut is 20 inches, which gives ample room for the "Vulcan" strap, nut and washer on top, and the length required below the table top to engage the T-slot. Two 6-inch blocks surmounted by a 3-inch block *G* and a step block *F* furnish the requisite height of blocking to support the other end of the clamp which should rest on the third step of the step block to be level. It will be noticed that the step blocks are so made that increments of ½ inch in height are afforded, the first step in one case being ¾ inch and 1 inch at the other end. Hence, any height within limits can be built up with no variation greater than ¼ inch. The projecting foot of the casting 2½ inches thick is clamped with a 4-inch bolt, using a clamp, washer and nut, and a step block supporting the outer end of the clamp on the third step; the side as shown in the illustration *F* is then the base.

F. E. R.

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Experiments have been undertaken in Germany with a view to determining whether boron would have a beneficial influence on iron and steel. The reason for this inquiry probably was that it had been discovered that boron has an extremely beneficial influence on copper; in fact, copper can be cast satisfactorily only by the addition of boron. It is also known that boron added to certain metals is valuable in preventing acid attacks, and a series of tests was made along this line also. In the tests on cast iron, it was found that the acid-resisting qualities were somewhat increased, but boron had a bad effect on the mechanical properties of the iron, so much so, in fact, as to outbalance any advantages. The hardness and brittleness of the cast iron increased in rising proportion as the percentage of boron increased. When added to steel, ingots with boron became brittle, piping became more pronounced, and the first blows with the hammer developed cracks. Bending tests were also impossible as cracks developed immediately. The results of the tests, hence, were that for practical purposes boron additions to steel and cast iron are of no value.

ESTABLISHING NUMBER OF OPERATIONS FOR DRAWING CYLINDRICAL SHELLS

DIRECT METHOD OF DETERMINING DRAWING DIE DIAMETERS AND NUMBER OF OPERATIONS BY THE USE OF CHARTS

BY FRITZ J. W. SPARKUHL*

When laying out or constructing dies for drawing cylindrical shells, the diemaker is confronted by the following questions: What should be the diameter of the first-operation die? Assuming that more than one operation is required, what should be the diameters of the redrawing dies? How many operations will be necessary for producing a shell of the required diameter and depth? If the diemaker is entirely in the dark regarding the properties of the metal to be drawn, he must depend principally upon his own experience or that of someone else, and the result is that the common and often very expensive way of determining die sizes by repeated trials is resorted to, the diameters of successive dies being increased or diminished as may be found necessary. This method, of course, results in a considerable waste of time and material and, in some cases, the die parts are spoiled. In order to avoid trouble of this kind, or at least decrease the amount of trouble and unnecessary expense, the writer uses two formulas for determining the die diameters for shells of soft steel and tinplate, which are simple and at the same time give correct results. One of these formulas is for determining the diameter of the first-operation die and is as follows:

$$d = \frac{X \times D}{100 - 0.635D}.$$

The diameters of the redrawing dies are determined by the formulas:

$$d_1 = \frac{X_1 \times d}{100 - 0.635d} \text{ and}$$

$$d_2 = \frac{X_1 \times d_1}{100 - 0.635d_1} \text{ etc.}$$

In these formulas

D = the calculated blank diameter;
d = diameter of the first-operation drawing die;
d_1 = diameter of redrawing die;
d_2 = diameter of following redrawing die;
X and X_1 = factors which depend upon the thickness of the metal to be drawn.

These factors X and X_1 for different thicknesses of stock are given in Table I. The numerical values of these factors were found by making several hundred trial draws, using different blank and die diameters and different thicknesses of stock. It should be mentioned that the results are correct only for dies used in double-action presses where the blank-holder pressure is constant and, in the case of redrawing dies, inside blank-holders having 45-degree drawing edges are employed. The method of determining these factors is indicated in Table II, which shows the results of a number of trial drawing operations. As will be seen, the blank diameter for a given die diameter was gradually increased, or, in other words, the ratio of $\frac{\text{die diameter}}{\text{blank diameter}}$ was decreased until the rupture of the shell occurred. For instance, when this ratio was equal to 61.5, the drawing was excellent, but when the blank had been increased until the ratio equalled 50, the shell was completely torn by the drawing operation. In this manner, several hundred tests were made on various thicknesses of stock with different die and blank diameters and the results carefully noted. These tests showed that the ratio of $\frac{\text{die diameter}}{\text{blank diameter}}$ for the same thickness of metal is not constant (assuming that the same quality of drawn work is obtained in each case), but that the increase of blank diameter means an increase in ratio; in other words, the diameter of the first drawing die should be proportionately larger as the diameter of the blank increases. For instance, by referring to Table II, it will be seen that a ratio of 53.5 represents the drawing limit when drawing a blank 3¾ inches diameter in a 2-inch die, some shells being good but most of them bad. Practically the same result was obtained when drawing a 1⅞-inch blank in a 31/32-inch die with a ratio of 51.5, which shows that a larger blank requires a comparatively larger die than a smaller blank.

TABLE I. MINIMUM AND MAXIMUM VALUES FOR DIE-DIAMETER FORMULAS

Metal Thickness, Inch	First-operation Die X Minimum	First-operation Die X Maximum	All Redrawing Dies X_1 Minimum	All Redrawing Dies X_1 Maximum
0.016 to 0.018	61	68	74	81
0.02	58	65	73	80
0.022 to 0.024	56	63	72	80
0.028	54	60	71	79
0.03	50	56	70.5	77
0.06	47	53	70	75
0.12	51		65	

Machinery

TABLE II. RESULTS OF TRIAL DRAWING OPERATIONS TO DETERMINE RATIO BETWEEN DIE AND BLANK DIAMETERS

	Blank Diameter D	Die Diameter d	Ratio d÷D, Per Cent	Remarks
Metal Thickness, 0.018 inch. Radius of Drawing Edge, ⅛ inch.	$1\frac{37}{64}$	$\frac{31}{32}$	61.5	Drawing excellent
	$1\frac{21}{32}$	$\frac{31}{32}$	58.5	Drawing good
	$1\frac{47}{64}$	$\frac{31}{32}$	55.8	Some good, some bad
	$1\frac{7}{8}$	$\frac{31}{32}$	51.5	Few good, mostly torn
	$1\frac{15}{16}$	$\frac{31}{32}$	50.0	Completely torn
	$2\frac{51}{64}$	2	68.0	Drawing excellent
	$3\frac{3}{16}$	2	63.0	Drawing good
	$3\frac{1}{2}$	2	57.0	Drawing limit
	$3\frac{3}{4}$	2	53.5	Some good, mostly bad
	$3\frac{7}{8}$	2	51.5	Torn
Metal Thickness, 0.02 inch. Double-action Press. Rad. Draw. Edge $\frac{3}{16}$ inch	$16\frac{3}{4}$	$10\frac{1}{2}$	62.75	Drawing excellent
	17	$10\frac{1}{2}$	62.0	Drawing excellent
	$17\frac{1}{4}$	$10\frac{1}{2}$	61.0	Drawing good
	18	$10\frac{1}{2}$	58.5	Drawing good
	$18\frac{1}{2}$	$10\frac{1}{2}$	57.0	Stretching
	19	$10\frac{1}{2}$	55.0	Some good, some bad
	$19\frac{1}{4}$	$10\frac{1}{2}$	52.5	Torn completely

Machinery

It will be noted that some of the blank diameters in the table are given to sixty-fourths of an inch. These exact dimensions are listed merely because they happened to be the diameters of the blanks which were cut out for these particular tests by the circle shear.

It is easy to calculate the diameters of the different dies by the formulas given, but as the factors X and X_1 have minimum and maximum values, it is rather difficult to determine the exact number of drawing operations that might be required in any case, and in order to facilitate this work the accompanying series of charts was laid out. After the required blank diameter has been determined, these charts show graphically what the diameters of the dies should be and the number of operations necessary to produce a given shell. Doubtless the best way to demonstrate the practical application of these charts is by means of an example. Suppose the dies for a cylindrical shell 4¼ inches in diameter and 5⅝ inches high are to be made and that the thickness of the metal is 0.02 inch. First it is necessary to determine the blank diameter. This may be done by means of the well-known formula $D = \sqrt{d^2 + 4dh}$. There is also the mensurative graphical method which is based on the rule of Guldinus, $D = \sqrt{8RL}$, and also the weighing method $D = 1.128\sqrt{\frac{W}{w}}$. In these formulas:

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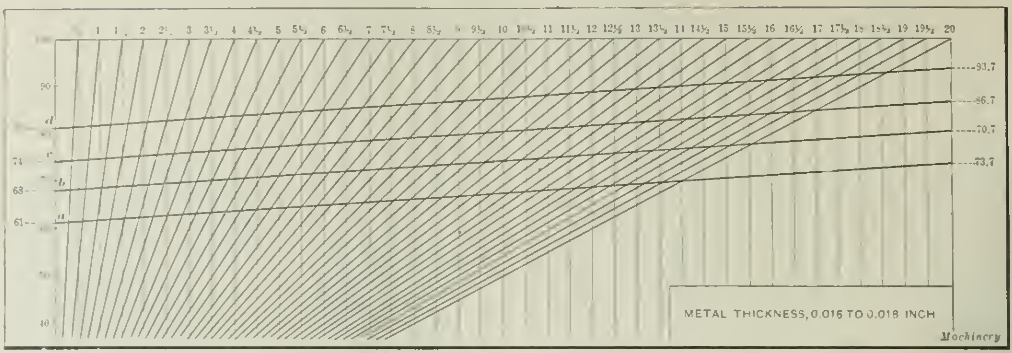

Fig. 1. Chart for determining Drawing Die Diameters for Given Blank Diameters

D = blank diameter;
d = shell diameter;
h = height of shell;
L = length of generating line;
R = distance from center of gravity of L to central axis;
W = weight of shell in pounds;
w = weight of metal per square inch.

All of these formulas are based on the supposition that the area of the blank diameter equals the area of the shell and that thin metal is used so that the thickness of the shell wall does not change to any appreciable extent.

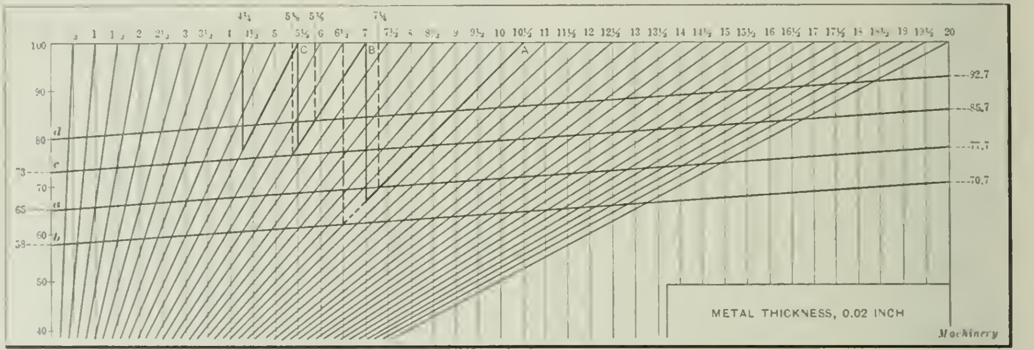

Fig. 2. Chart for determining Drawing Die Diameters for Given Blank Diameters

The blank diameter for a shell of the size given in the foregoing is found to be 10½ inches, allowing sufficient metal for trimming. This is, of course, a trial diameter and should not be used for the blanking die. The exact size of the blank must be established by trial after the drawing dies are made; ordinarily, it will be found that the calculated blank diameter is large on account of the stretch of the metal when drawing. As will be seen, the charts previously referred to are for different thicknesses of metal; for a thickness of 0.02 inch, the chart shown in Fig. 2 should be used. The blank diameters are given along the horizontal line at the top of the chart. As the diameter in this case is 10½ inches, this figure is located and then the diagonal line should be followed until the area between the cross lines a and b is reached. The intersection of the vertical lines (drawn from the horizontal diameter line at the top of the chart) and the diagonal line A within the area between lines a and b gives the minimum and maximum diameters for the first-operation die. In this case the minimum and maximum diameters are 6½ and 7¼ inches, respectively, as shown by the dotted vertical lines; thus, we have a minimum die diameter of 6½ inches, below which it is not advisable to go because of the danger of obtaining imperfect work. On the other hand, it would not be economical to use a die larger than 7¼ inches because it would be larger than necessary and an extra redrawing die might be required; hence, a diameter of 7 inches is selected for the first-operation die.

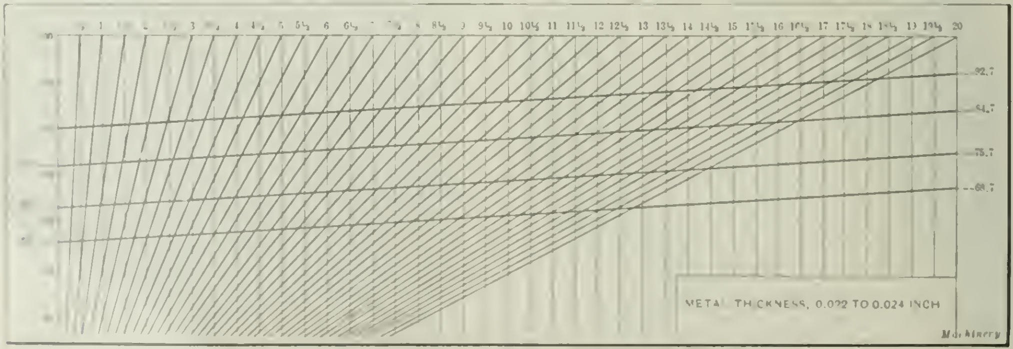

Fig. 3. Chart for determining Drawing Die Diameters for Given Blank Diameters

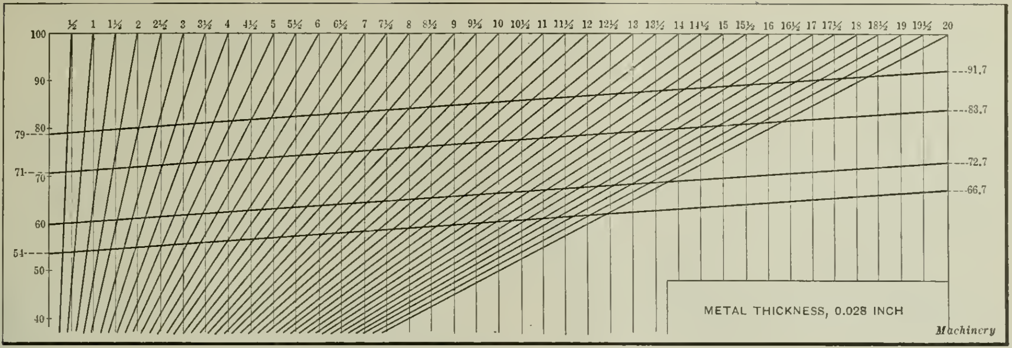

Fig. 4. Chart for determining Drawing Die Diameters for Given Blank Diameters

In order to find the diameter for the redrawing die, the diagonal line *B* from the 7-inch point is followed down to the space between the upper set of lines c and *d*. The intersection points with the vertical lines within this area give the minimum and maximum diameters of 5⅜ and 5⅞ inches, respectively, as indicated by the second set of dotted vertical lines. As the full line shows, 5½ inches is selected as the diameter for the first redrawing die. Now, if the diagonal line *C* leading from the 5½-inch point intersects with a vertical line leading to 4¼ inches (the required shell diameter) between the lines c and *d*, the diameters of the two preceding dies are correct. If the intersection point should be below line c, this indicates that the diameters of the first or cupping die and the first redrawing die should be decreased. On the other hand, if the diagonal line should intersect the 4¼-inch vertical line (or the one representing the finished size of the shell) at some point above line *d*, this would indicate that the first and second dies were smaller than they should be to obtain the best results. In some instances, one cannot always tell at first which diameter to choose within the minimum and maximum limits represented by the space between the lines *a–b* and *c–d*. This point is illustrated by the following example:

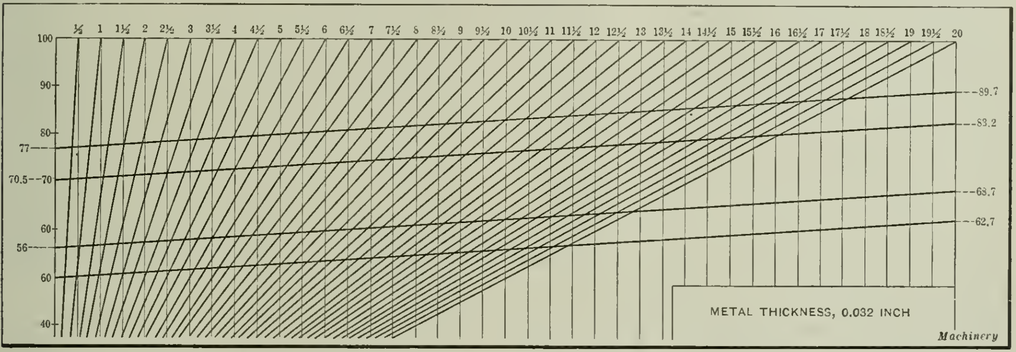

Fig. 5. Chart for determining Drawing Die Diameters for Given Blank Diameters

Suppose a shell is to have a diameter of 1½ inch, a height of 2⅞ inches and that metal 0.02 inch thick is to be used. In how many operations is it possible to produce this shell? The example is illustrated graphically by the special chart, Fig. 8, which represents the corner of the chart shown in Fig. 2, and is drawn on an enlarged scale. The points marked A_1, A_2, A_3 show that a shell can be drawn in three operations, the first die having a diameter of 2 11/16 inches, the first redrawing die a diameter of 2 inches and the finishing die a diameter of 1½ inch. Points *B* and the dotted lines, however, show that the shell should be drawn in four operations, the die diameters being 3 inches, 2⅜ inches, 1⅞ inch and 1½ inch, respectively. When three dies are used as indicated by the full lines on the chart, it will be noted that the points of intersection with the vertical lines are, in every case,

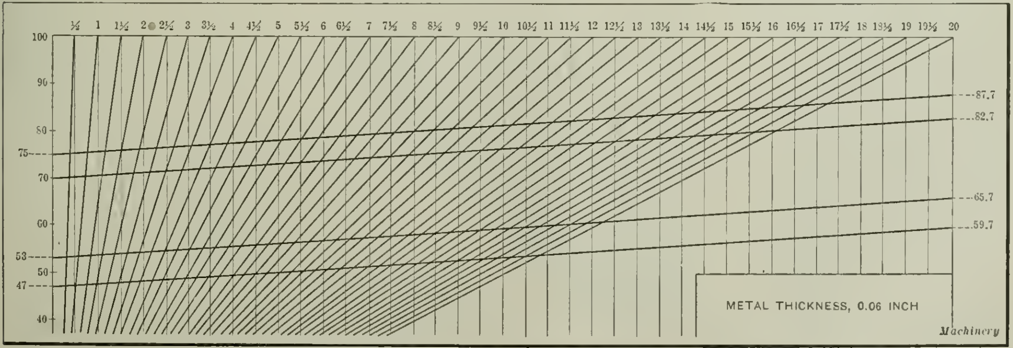

Fig. 6. Chart for determining Drawing Die Diameters for Given Blank Diameters

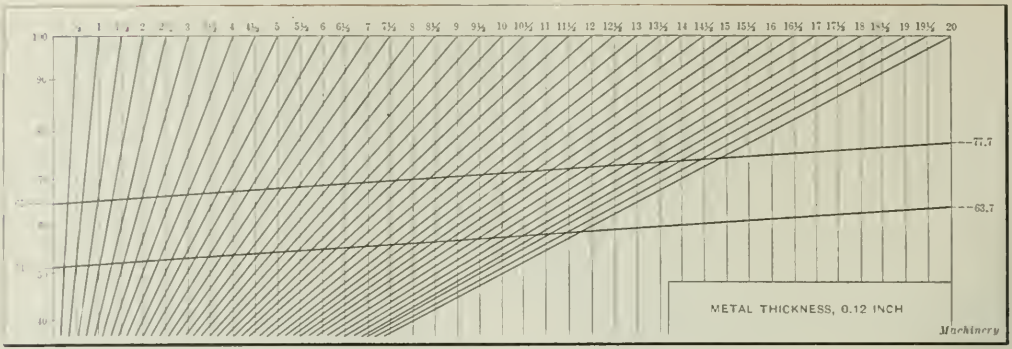

Fig. 7. Chart for determining Drawing Die Diameters for Given Blank Diameters

just above the cross line on the chart representing the maximum reduction. Therefore, if three dies are used, the metal must be of the very best quality, and it will doubtless be necessary to anneal the shell after each drawing operation, as otherwise the metal will not stand the strain. For this reason, it is advisable to use four dies instead of three. The extra die will soon pay for itself because less annealing will be necessary and the danger of breaking the shells is also avoided.

Perhaps the connection between the formulas previously given for determining the die diameters, and these charts, will be more apparent by applying the formulas to the example given in connection with the chart shown in Fig. 2. As previously explained, this chart shows that for a cylindrical shell 4¼ inches in diameter, 5⅜ inches high (requiring a 10½-inch blank), the dies should have diameters of 7, 5½ and 4¼ inches, respectively, with minimum and maximum values as represented by the dotted vertical lines. According to the formula, the diameter of the first die $d = \frac{X \times D}{100 - 0.635D}$. Taking the minimum value of X as 58 (as shown by Table I, for a metal thickness of 0.02 inch), $d = \frac{58 \times 10.5}{100 - 0.635 \times 10.5}$ = 6.5 inches minimum diameter, approximately. When using the maximum value X of 65, $d = \frac{65 \times 10.5}{100 - 0.635 \times 10.5} = 7\frac{1}{4}$ inches maximum diameter, approximately. As will be seen, these results conform to those indicated by the chart. The minimum and maximum values of 5⅜ and 5¾ inches, respectively, for the redrawing die also conform to formula

$$d_1 = \frac{X_1 \times d}{100 - 0.635d}$$

the minimum and maximum values of X_1 being 73 and 80, as given in Table I for this particular thickness of stock. It is evident that the use of these formulas or charts will eliminate much of the trouble connected with the designing and construction of drawing dies, especially when more than one operation is required. Incidentally, the drawing surfaces of the dies should be smooth and well lubricated. The blank-holder pressure should be constant and great enough to prevent the blank from wrinkling, a uniform metal should be used and it is very important that the press should be rigid enough to prevent any appreciable springing action during the drawing operation. The drawing velocity is another important factor although available data on this subject are unreliable and indefinite, as every tool designer and diemaker knows.

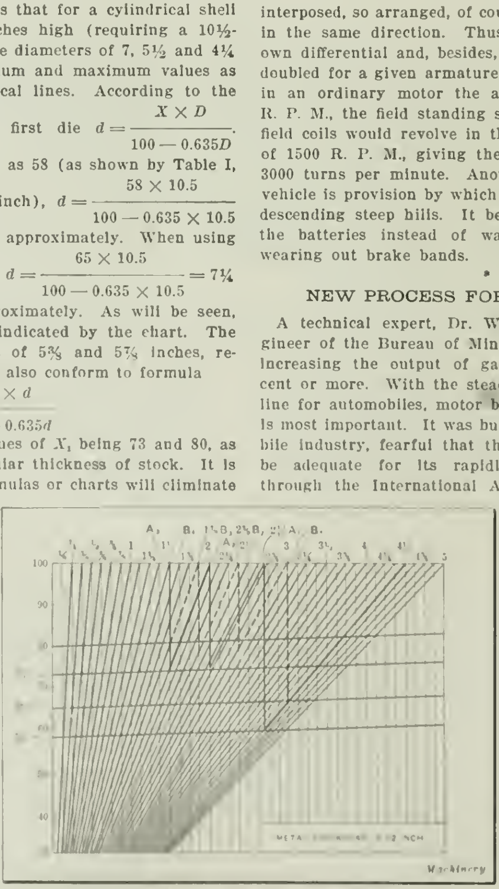

Fig. 8. Section of Chart shown in Fig. 2

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NOVEL ELECTRIC VEHICLE

Harry E. Dey, an electrical engineer of New York City, has invented a three-passenger runabout electric car weighing about 1200 pounds, that embodies a new idea in electric motor design. The entire driving mechanism is made a part of the rear axle, thus eliminating a considerable number of shafts, gears and other parts necessary in electric motor vehicles as now made. There is no separate motor suspended under the car and no differential. The field and the armature of the motor revolve in opposite directions, reducing gears being interposed, so arranged, of course, that both wheels are driven in the same direction. Thus the electric motor acts as its own differential and, besides, its power per unit of weight is doubled for a given armature revolution speed. For example, in an ordinary motor the armature might revolve at 1500 R. P. M., the field standing still. In this case, however, the field coils would revolve in the opposite direction at the rate of 1500 R. P. M., giving the equivalent revolution speed of 3000 turns per minute. Another feature of the new electric vehicle is provision by which the motor acts as a brake when descending steep hills. It becomes a generator and charges the batteries instead of wasting the potential energy in wearing out brake bands.

* * *

NEW PROCESS FOR MAKING GASOLINE

A technical expert, Dr. Walter F. Rittman, chemical engineer of the Bureau of Mines, has discovered a process for increasing the output of gasoline from petroleum 200 per cent or more. With the steady increase in demand for gasoline for automobiles, motor boats and engines, this discovery is most important. It was but two years ago that the automobile industry, fearful that the supply of gasoline might not be adequate for its rapidly expanding business, offered through the International Association of Recognized Automobile Clubs, a prize of $100,000 for a substitute for gasoline that would cost less than gasoline. Happily, the urgency of this situation has passed, and at the present time there is a plentiful supply of motor fuel to meet immediate demand, but this new process adds to the hope that in spite of the wonderful growth in the use of gasoline, there may not be any shortage in the future. It indicates an increased production of gasoline from the present production of petroleum an output of 50,000,000 barrels instead of 25,000,000 yielded by present methods.

RECENT LEGAL DECISIONS INVOLVING MACHINERY

Infringement of Machine Patent

(U. S. Supreme.) The United States Supreme Court in the case of Dowagiac Mfg. Co. v. Minnesota Plow Co. has held that in an action for the infringement of a machine patent, no damages can be recovered by the original patentee for lost sales, where, although the number of machines sold by the defendant was shown, there was no proof that the patentee thereby lost the sale of a like number of machines, or of any definite or even approximate number, and where, during the period of infringement, several other manufacturers were selling machines in large numbers in the same localities in direct competition with the plaintiff's machine and under the evidence it could not be said that, if the sales in question had not been made, the defendant's customers would have bought from the plaintiff rather than from the other manufacturers, and where it did not satisfactorily appear that the plaintiff possessed the means and facilities requisite for supplying the demands of its own customers and of those who purchased the infringing machine. *(Dowagiac Mfg. Co. v. Minnesota Plow Co., 35 Sup. Ct. 221.)*

Recovery of Property Sold

(Federal.) When a buyer being insolvent induces a seller to sell him machinery on credit, which he does not intend to pay for, the seller may rescind and recover the property. The United States Circuit Court of Appeals has so held in the case of In re Marks & Co. The court in commenting on the case said:

> The law is well settled that when a party, being insolvent, induces another to sell him goods on credit which he does not intend to pay for, the court may order the contract disaffirmed and restore the property. Three propositions must be established by the claimant before he can rescind the contract and recover the goods: First, the insolvency of the bankrupts at the time the purchase was made. Second, the concealment from the claimant of the fact of insolvency. Third, intention on the part of the bankrupts, at the time of the sale, not to pay for the goods. *(In re Marks & Co., 218 Fed. 453.)*

Duty to Warn and Instruct in Use of Machinery

(Federal.) When a servant is taken by the master from his ordinary employment and put at work at a machine which he has never used before, there rests upon the master the duty of instructing the servant with respect to the methods and the dangers of the machine, and such duty is an absolute one, for the performance of which the master is personally responsible.

Plaintiff, who was employed as an unskilled workman in defendant's works, was set to operate planer fixed in a table for planing boards. He had never done such work, and at the very beginning his hand was caught by the machine and injured. There was a guard fixed above the machine for the protection of the operator, but plaintiff was not instructed as to its purpose or mode of adjustment. While the foreman showed him how the machine was operated and gave him certain instructions, there was a conflict of testimony as to their nature and extent, and as to whether the guard was properly placed. Held: The duty of the master to instruct the servant as to the operation of the machine is an absolute one.

Under the Pennsylvania factory law requiring the use of safety appliances on dangerous machines, the avowed purpose of which is "to provide for the safety of all employes in industrial establishments," a "proper guard" on a dangerous machine means, not merely the presence of a proper guard on a machine, but that it shall be so used and adjusted as to be effective, and the failure of the master to comply with both of such requirements constitutes actionable negligence. *(Freedom Casket Co. v. McManus, 218 Fed. 325.)*

Warranty by Manufacturer of Fitness of Machine for Purpose Intended

(Federal.) Plaintiff contracted to furnish and install for defendant at its laundry a water-softening machine; the understanding of the parties being that it was to be used for treating water from a well which had been sunk by defendant. A sample of the water was furnished to and analyzed by plaintiff, and its hardness found to be what is technically called 35 degrees. Plaintiff then wrote into the contract a guaranty that the water, as per its analysis, "when properly treated in this softener, will be satisfactory for laundry purposes." Water taken from the well some months afterward, on analysis, showed a hardness of 79 degrees, and, while the machine would soften it, so much chemical was required as to render it unsatisfactory for laundry purposes. Held, that the warranty applied only to water of substantially the same degree of hardness as that previously analyzed, and not to any water which might come from the same well, and that the failure of the machine to satisfactorily soften water of 79 degrees of hardness was not a breach thereof. *(Wendell & Evans Co. v. Kennicott Co., 218 Fed. 622.)*

Duty to Guard Premises

(Federal.) Where defendant railroad company maintained a machine shop on a lot six feet back from a much-traveled street in the city, and the moving machinery was visible from the sidewalk through a wide double door, which was kept open in summer, and such machinery was attractive to children passing the shop, defendant was under a common law duty to guard the premises that children should not approach the machinery and be injured.

Where plaintiff, a boy of six, wandered from the street through an open door and into defendant's machine shop, and was there accidentally injured, he was too young to be a trespasser, and the company maintaining the shop is responsible for an injury which the boy suffered. *(Chesko v. Delaware & Hudson Co., 218 Fed. 803.)*

Delivery Within Reasonable Time Implied

(Federal.) Where written agreements by a manufacturer of brick-making machinery, whereby it sold certain machinery to a brick concern, and agreed to furnish complete working drawings for the construction of a patented kiln, and to license defendant to use such kiln, specified no time for delivery of the machinery, drawings, license, delivery within a reasonable time was implied, and what was a "reasonable time" depended on the circumstances of the particular case. The United Circuit Court of Appeals so held in C. W. Raymond Co. v. Allegheny Valley Brick Co.

The facts were that in March, 1911, the Allegheny Valley Brick Co. entered into a written contract with the C. W. Raymond Co. for brick machinery, kiln drawings, etc. The consideration was $2500. The machinery was shipped and drawing and specifications sent in the latter part of May. The Allegheny Valley Brick Co. refused to pay the full amount of $2500, claiming that the machinery concern had not performed the contract; that the delay in furnishing the plans, specifications, drawings and machinery was unreasonable. In the trial court, judgment was entered for the machinery concern in the amount of $3250.50, this amount representing the contract price, freight, court costs and damages. The United States Circuit Court as the court of review affirmed the decision. The court said that the contract as entered into by the parties implied performance within a reasonable time, and that since diligence was used in filling the order as soon as it was received, the machinery being constructed after the order was taken, two months was a reasonable time within which to perform the contract. *(Allegheny Valley Brick Co. v. C. W. Raymond Co., 219 Fed. 77.)*

Sale of Future Inventions

(New York.) A corporation which, at the time it employed an inventor, who was a large stockholder therein, as its manager, at a fixed salary and a percentage of the net profits, also purchased from him for an additional consideration the patents which had been granted to him for inventions, all applications pending, and inventions now made or to be made in the future, was entitled to assignments of the patents for inventions by the manager made thereafter, though they were not in contemplation at the time the contract was made, especially where the manager had made use of those inventions for the benefit of the corporation, without making any additional claim for them. *(Klauder-Weldon Dyeing Machine Co. v. Weldon, 151 N. Y. S. 1068.)*

Return of Imperfect Machinery

(New York.) Where a manufacturer of machinery, to be delivered to defendant and erected upon his land, delivered imperfect machinery, the defendant could return the property, or could notify the manufacturer to remove it at his own cost, and could hold the manufacturer for the expense of restoring his property after removal, or he could take the machinery out and store it at the manufacturer's expense. *(Smith v. Hedges, 152 N. Y. S. 95.)*

Lease of Machinery

(New York.) Where a machine was delivered to the lessee under a 99-year oral lease and one month's rent thereon paid, but thereafter the lessee surrendered possession for the purpose of allowing repairs to be made, and the lessor refused to redeliver, there was not such part performance as would take the contract out of the statute of frauds requiring a lease for a longer period than one year to be in writing, and permit the lessee to recover damages for its breach. *(Siegel v. Reece Buttonhole Machine Co., 152 N. Y. S. 192.)*

Logging Company Responsible for Injury

(Arkansas.) A contract for the sale of a machine to a logging company provided that the price should include the services of a man to superintend and assist in the erection of the machine, and to instruct the buyer's employes in its operation. The seller sent one of its regular employes to do that work, and the logging company directed some of its employes, including the plaintiff, to assist him. While the operator was demonstrating the operation of the machine under the general orders of the logging company's manager and in his presence, it was overturned through the negligence of the operator, and plaintiff was injured. Held, that since the work which was being done was the logging company's work, and under its control, all engaged therein, even the operator, were its servants for that purpose, and the company was liable as master for the injuries to plaintiff. *(Arkansas Logging Co. v. Martin, 173 S. W. 185.)*

Warranty in Sale of Machinery

(Virginia.) Where machinery did not work to the satisfaction of the buyer, as warranted by the seller, who failed to make good his warranty, the buyer could rely on breach of warranty, though he could not arbitrarily or capriciously discard the machinery for breach of warranty.

Where a buyer of saw mill machinery, when sued for the price, set up only a claim for damages for breach of warranty and proved that the machinery was worthless, while the warranty was that it could do satisfactory work, and if not, that the seller would make it do it, and that the seller, though frequently called on, failed to make good his warranty, the seller could not as a matter of law limit the buyer's offset to the extent an expert witness said the cost would have been in making repairs necessary to put the machinery in satisfactory working condition. *(Ney et al. v. Wrenn et al., 8[illegible] S. E. 1.)*

Forging Six-throw Motor Crankshafts at One Operation in the Buick Motor Car Co.'s Plant

FORGING SIX-THROW MOTOR CRANKSHAFTS

The illustration shows an 18,000-pound steel frame drop-hammer built by the Alliance Machine Co., Alliance, Ohio, for the Buick Motor Car Co., plant of the General Motors Co., and installed in the Flint, Mich., forge shop at a cost of approximately $18,000. It is used for forging six-throw crankshafts at one operation, the dies being so constructed that the bending, breaking down and forming of the three pairs of crankshaft throws 120 degrees apart are accomplished in one set of dies and at one heat. The advantage of forging the cranks at 120 degrees, over the usual process of forging them in one plane and then twisting to the desired required angular position, is that the cranks have little or no tendency to change position; while those forged in one plane and afterward twisted are likely to shift position in use, because of the internal stresses set up and not relieved by annealing.

* * *

AN EARLY SUBMARINE

In view of the important part now played in naval warfare by submarines, it is interesting to note that fifty-six years ago (January 14, 1859) the *Journal of the Royal Society of Arts*, to use its present title, contained an account of an invention for which it was claimed that "it would make such a change in the mode of carrying on a naval war as would put steamers out of the question, and render of no avail the tremendous forts of Krönstadt and Cherbourg. It is nothing less than a submarine boat, made only for working under water, in form much resembling the shape of a porpoise, but capable of being made large enough to contain eight, ten, or even fifteen men, if necessary, with a proportionate quantity of explosives." The patentee stated that he, with others, had submerged the boat in Lake Michigan, and remained under water for four hours, without any air tubes or other communications, and propelled the boat in and near the bottom of the lake for several miles at the rate of about three miles an hour. He claimed that he could convey powder torpedoes of 100 pounds weight in his boat, and when under an enemy ship pass them out of the side of his boat through his patent hatch, fasten them to the ship's bottom, and fire them. One of the most remarkable points about the description is that he appears to have used a periscope. "He can enter an enemy's harbor under water and make surveys, only showing above the surface a sight tube, not more than one-half inch in diameter, and retire still under water; he can then proceed out to sea and make his report to the commander of a fleet or ship."

* * *

The circular saw is said to have been invented by James Murray, of Mansfield, Nottinghamshire, England. The original saw was about six inches in diameter and is still in existence.

SPECIAL ELECTRIC BUTT-WELDING MACHINES*

APPLICATION OF ELECTRIC WELDING MACHINES TO THE WELDING OF TAP AND DRILL SHANKS, HOOPS PIPE, CHAIN LINKS, WHEEL HUBS, ETC.

BY DOUGLAS T. HAMILTON†

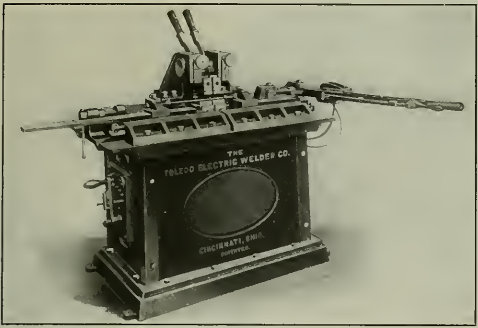

Fig. 1. Special "Toledo" Electric Butt-welding Machine designed particularly for welding such Work as Extension Taps, Twist Drills, etc.

As has been mentioned in previous articles on electric welding, many classes of work can be most satisfactorily handled in machines designed especially for that purpose. To meet this demand, a large number of special electric welding machines have been put on the market, and in the following some of the most important of these will be illustrated and described.

Electric Welding Machine for Taps, Twist Drills, etc.

In making extension drills, taps, etc., use is made of the electric welding machine, and for this purpose special types of machines are usually built. Fig. 1 shows a machine designed for this work by the Toledo Electric Welder Co., Cincinnati, Ohio. In this machine, work which has been finished can be electrically welded so that the two finished parts will come together in perfect alignment. The machine has V sliding ways similar to those on a planer bed, which are scraped to a bearing and are provided with screw-adjusted long taper gibs, insuring accuracy in taking up wear of the moving parts. Stops with screw adjustments to back up and hold the work in perfect alignment are also provided. Each clamping lever is mounted on an eccentric that can be quickly adjusted for varying sizes of stock. The current is turned on by touching the thumb-switch mounted on the compression handle, and the clamping jaws are accessible and can be quickly changed for varying sizes of stock. The current regulator is mounted on the side of the machine and by means of this device the amount of current is under the complete control of the operator.

In welding extensions on taps or drills, the extension is usually made of low-carbon steel and the cutting part of the tool from high-carbon tool steel. To accomplish a satisfactory weld, it is therefore necessary to have the two materials protrude the proper distance from the faces of the clamping jaws. The amount that the work should project from the clamping jaws is governed by several conditions, and in this case would be governed largely by the diameter and carbon content of the parts being welded. Low-carbon steel, of course, does not offer as much resistance to the flow of electric current as does high-carbon steel, and consequently should project farther from the clamping jaws. For example, in welding a 15-point carbon shank to a 50-point carbon tap, the low-carbon extension should project about 1.8 times its diameter from the face of the clamping jaws, and the high-carbon part 0.625 times its diameter from the clamping jaws. The welding of shanks on taps and drills should be done very rapidly; that is, a large amount of current should be supplied, and the heating done quickly. A flash weld is also preferable to an upset weld.

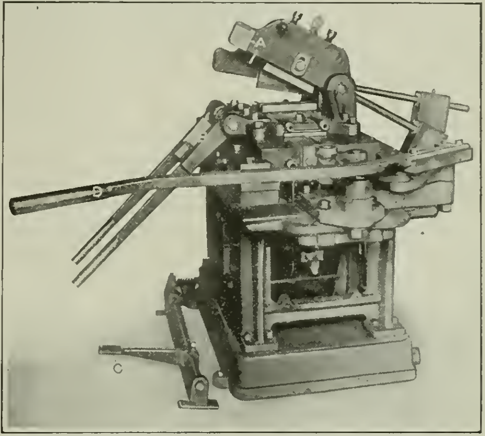

Fig. 2. Special Type of Electric Welding Machine built by the Thomson Electric Welding Co. for welding Automobile Rims and Similar Work

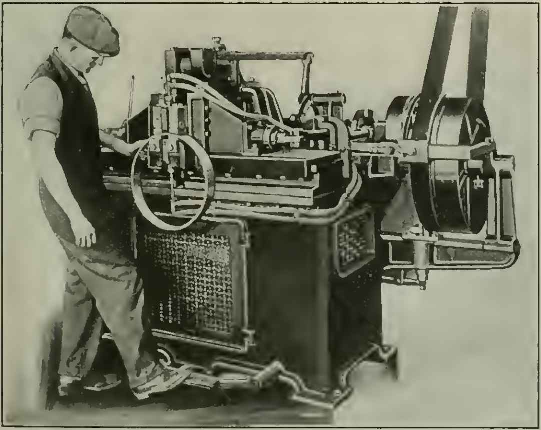

Fig. 3. Power-driven "Toledo" Automatic Butt-welding Machine especially designed for welding Hoops, having a Maximum Capacity of 2 by 3/8 Inch and a Minimum Capacity of 1 by 1/4 Inch Flat Stock

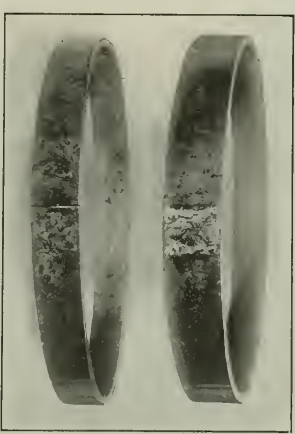

Fig. 4. Example of Hoop-welding performed on Butt-welding Machine shown in Fig. 3—Toledo Electric Welder Co.

Hoop and Tire Welding Machines

In changing over from cemented to clincher tires for automobile wheels, steel

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* For further information on welding, see "Electric Butt-welding Practice" in the March and April, 1915, numbers of MACHINERY and article referred to in connection with the first installment.

† Associate Editor of MACHINERY.

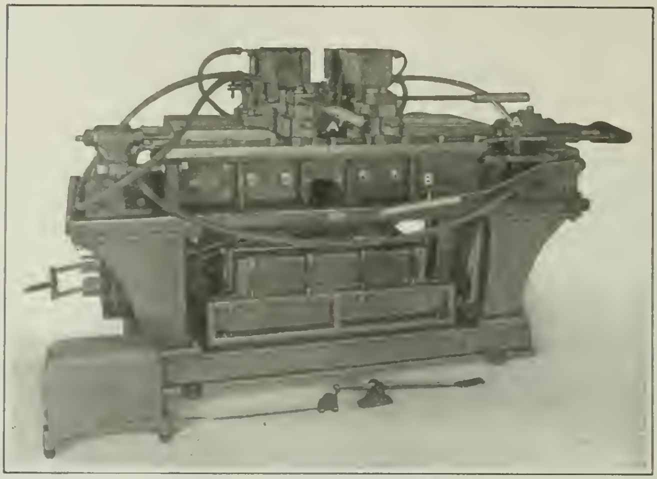


Fig. 5. 60-kilowatt Thomson Electric Welding Machine particularly adapted to the welding of Pipe and Tubing

instead of wooden rims were used. As a means of making steel rims cheaply, welded strip stock was adopted, and for handling this work special electric welding machines were devised. Fig. 2 shows an electric welding machine designed and built by the Thomson Electric Welding Co. for welding automobile rims. This machine will weld flat stock up to 7 inches wide by 5/32 inch thick, and has a capacity of 30 kilowatts for 15 seconds, or 125 kilowatt hours for 1000 welds. It is known as a 30-kilowatt electric welder and is shown in the illustration with the clamps thrown open. In operating this machine, the hoop or rim is slipped in between the upper and lower clamping jaws with the ends of the rims abutting.

The two upper clamping arms *A* are then brought down in contact with the work, and the handles or clamps *B* swung up so as to hold them in position. The current is then turned on by depressing the foot treadle *C* and handle *D* is operated. This moves the platen and brings together the abutting ends of the rim which are now highly heated, forming a weld. The machine is supplied with adjustable replaceable self-hardening steel jaws in the upper arms, which are also provided with balancing weights so that as soon as the clamping levers are removed the upper jaws fly up. The platen is provided with ball bearings to facilitate its operation, and water is circulated through the secondary terminals and clamping jaws or electrodes to keep them cool.

Automatic Electric Tire Welding Machine

Electric butt-welding machines for welding automobile rims, hoops, etc., are made to be hand-operated or are of the semi-automatic type. A rim-welding machine of the semi-automatic type, built by the Toledo Electric Welder Co., is shown in Fig. 3. The stock is rolled into hoop shape and placed in the clamping jaws of the machine. The operator then depresses the foot-treadle shown at the front of the machine, whereupon the jaws instantly close and firmly grip the stock, bringing the ends of the hoop closely together. At the instant that the foot-treadle is operated, the current is automatically turned on and the stock begins to heat. In a few seconds it reaches the welding temperature, whereupon the operator again depresses the foot-treadle. This starts the machine, and the movable slide which is operated by a cam through connecting links and additional mechanism moves forward, bringing the semi-molten ends of the metal together, and as these come together the current is shut off. For flattening the burr formed at the joint, a pair of steel forming dies is located between the clamping jaws and operated from the lower and upper surfaces of the work. After flattening the flash, the forming dies then withdraw, the right-hand clamping die backs away, and the machine resets itself ready for the next cycle of operations. The operator then throws out the finished rim and places another in the machine, whereupon the cycle of operations is repeated. The entire working mechanism of the machine is controlled automatically with the exception of the foot-treadle. The members of the machine that have to be varied for different classes of work are made adjustable, and when these have once been set in their correct position the operation is comparatively simple. An example of work handled in the semi-automatic rim-welding machine shown in Fig. 3 is illustrated in Fig. 4. To the left of this illustration is shown a rim previous to welding and to the right is shown a rim successfully welded. By looking closely at this illustration it will be noticed that the joint has been flattened out so that the thickness of the rim at the weld is very little greater than anywhere else along the circumference of the rim.

Machine for Welding Tubes and Pipes

Fig. 5 shows a pipe-welding machine built by the Thomson Electric Welding Co., which is capable of welding pipe up to 4 inches in diameter or boiler flues up to 5½ inches in diameter, and has a capacity of 60 kilowatts for 50 seconds, producing 100 welds with 83 kilowatt hours. This machine has water-cooled removable gun-metal clamps, into which the pipe is dropped. The movable slide is operated by a twelve-ton double-acting oil jack mounted at the right-hand end of the machine, and the break-switch for throwing the current off and on is controlled by a foot-treadle. In operation, the tubing is either dropped into the clamping jaws or pushed through them until the two ends of the pipe meet midway between the jaws. Levers *A* are then drawn together, tightening the clamping jaws on the work. The foot-treadle is then depressed, turning on the current, and the ends of the pipe immediately begin to heat up. The jack lever *B*, operating the oil jack, is then moved up and down two or three times to force the molten ends of the pipe to-

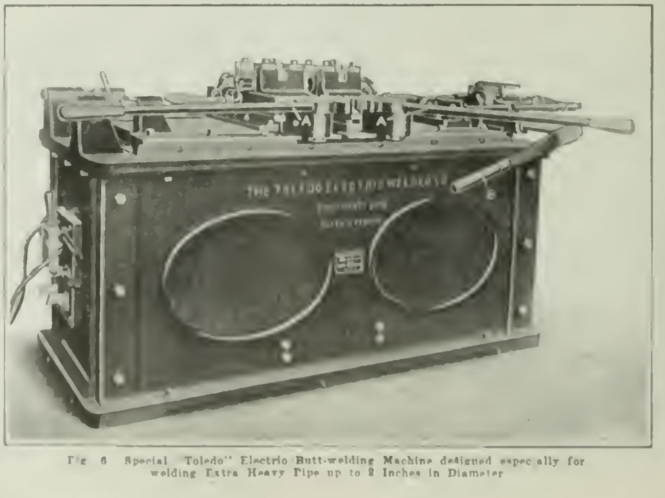


Fig. 6. Special "Toledo" Electric Butt-welding Machine designed especially for welding Extra Heavy Pipe up to 2 Inches in Diameter

gether. The foot-treadle is now released, shutting off the current; the clamping levers are thrown back and the tubing removed, leaving the machine ready for the next weld.

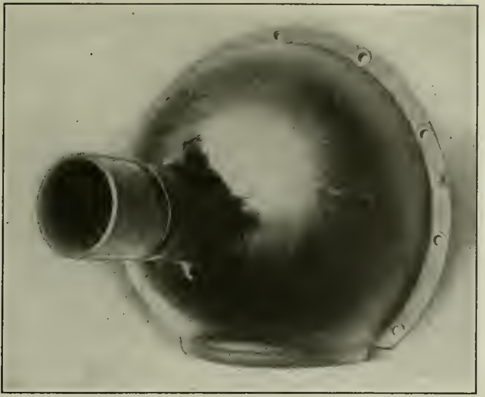


Fig. 7. Tubing welded to a Stamping; Weldings of this Character can easily be handled on Butt-welding Machines especially designed for this Work—Toledo Electric Welder Co.

Another Pipe Welding Machine

Another type of pipe-welding machine which is designed and built by the Toledo Electric Welder Co. is shown in Fig. 6. This machine has a capacity for welding extra heavy pipe up to 2 inches in diameter, or round bar stock 1¼ inch in diameter. The maximum power required is 35 kilowatts. The machine is provided with vertical clamping jaws, which particularly adapt it for handling tubing. The work to be welded is clamped between the copper jaws by levers *A*. These levers operate similarly to a quick-acting eccentric vise. The work is placed in the two clamping jaws with its ends abutting. The current is then turned on by operating a foot-switch, not shown, and the stock quickly reaches a welding temperature. Two or three strokes of the pump handle *B* connected to the five-ton hydraulic ram then force the molten ends of the metal together to make a perfect weld. The clamping levers operate in a horizontal direction and do not interfere in any way with the pipe clamped in the jaws. These levers are long and are designed to clamp the stock so firmly that backing-up stops are not necessary when ordinary pipe is to be welded. The distance between the clamping dies can be regulated by means of adjusting screws located at the left-hand end of the machine. This allows the operator to set his machine for a certain amount of upset on the stock.

An example of welded work that can be handled on a tube-welding machine is shown in Fig. 7. This shows a piece of tubing welded to a stamping that is used for an automobile rear axle housing. In welding tubing to forgings, or tubing to tubing, a flash weld, as previously mentioned, is generally made, except in the welding of hydraulic or ammonia piping, where particular care must be taken to get a good weld without flash, as will be explained later.

Preparing Tubing for Welding

Tubing or piping that is to be welded should be cut square on the ends so as to abut evenly. To avoid having the upset decrease the inside diameter of the pipe, the abutting ends should first be flanged outward to a slight extent so that the ends when under pressure will force the upset to the outside. Instead of flanging the inside edges, one or both tubes can be chamfered slightly so that there will be a recess in which the upset metal can go. If tubing is rusty or scaly it should be brightened at those spots where it contacts with the clamping jaws and where it abuts. This can be done quickly on a grinding wheel. It is possible to weld tubing or ordinary pipe, and especially pipe with thick walls, by clamping the work in a V-shaped jaw, where but four points are in contact; or one flat and one V-jaw giving a three-point contact. By using the latter type of jaw, one set can be used for several different sizes of pipe.

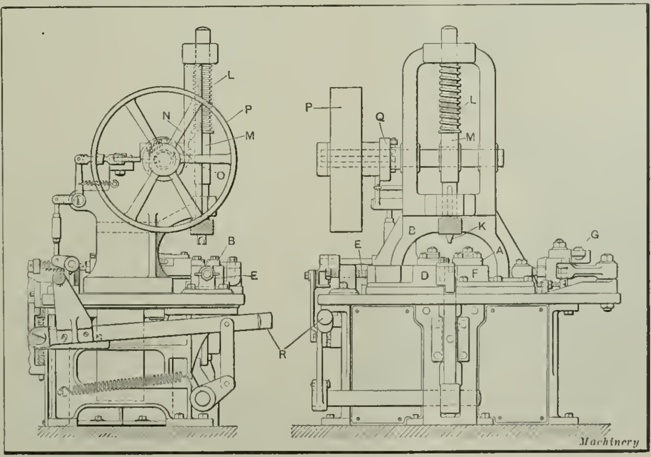


Fig. 8. Chain-welding Machine designed and built by the Thomson Electric Welding Co.

In the welding of hydraulic or ammonia piping, special care must be taken to eliminate the flash on the inside of the pipe, as mentioned. In addition to the methods previously described, another way of doing this is as follows: The ends of the pipe are not chamfered, but an upset weld instead of a flash weld is made. The pipe is clamped in the jaws of the welder, heated and compressed to make a slight upset. Then while the metal is still hot, the outside diameter of the pipe is rolled down with a pair of special piping tongs to bring it to uniform size. By taking care, the inside of the pipe will show very little, if any, upset, and by inserting a mandrel inside the pipe at the time that it is being compressed with the tongs it can be made perfectly smooth.

Electric Welding Machine for Welding Chain Links

Another interesting application of the electric welding machine for manufacturing purposes is that employed in the welding of chain links. Fig. 8 shows a chain-link welding machine built by the Thomson Electric Welding Co. In this machine the work-holders are so constructed that they do not require manipulation prior to the operation of the machine. A mechanism is also provided for hammering the chain links after heating in order to reduce the burr or upset produced in the electric butt-welding operation.

Referring to Fig. 8, the chain links which are to be welded are clamped longitudinally and in a horizontal plane between the left- and right-hand clamping dies *A* and *B* with the open side of the links facing the rear of the machine and in line with the contact electrodes *C*, Fig. 9. The work-holders are firmly bolted in a suitable recess in the die slides, which can be adjusted to slide horizontally in a right and left-hand direction from each other. The left-hand slide *D*, which is normally held stationary, is mounted between guides formed on the table and is adjusted longitudinally by stop-screw *E*. The right-hand horizontal die slide *F* is actuated by a double toggle through a long hand lever *G*. The clamping dies *H* and *I*, Fig. 9, are provided with shallow link clamping recesses cut in their upper surfaces, and each of these recesses conforms substantially with the plane or outline of the links that are to be welded. The electrodes *C* can be moved sideways to contact with the work so as to draw the open end of the link together. The electrodes are actuated by a foot-treadle (not shown) through an equalizing yoke; this foot-treadle projects from the front of the machine near the floor. The double-ended lower hammer die or anvil *J*, which acts in conjunction with hammer *K* to flatten the flash formed at the welded joint, is a flat oblong

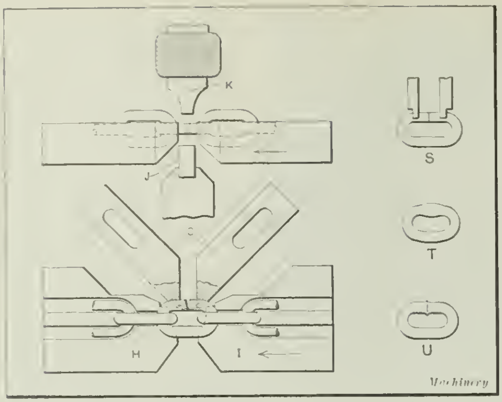


Fig. 9. Diagram showing Operation of Chain-welding Clamping Dies and Electrodes; also Results of Finished Work—Thomson Electric Welding Co.

piece of hardened steel mounted with its working end beneath the clamping position of the chain link. This anvil is made with interchangeable ends so that when one working end becomes worn or softened by contact with the heated chain link, it can be reversed and a new end brought into position. The hammer *K* is mounted directly above the anvil. A tripping device lifts the hammer against spring *L* and then releases it, the spring giving the required compression. The upper hammer *K* is held in the lower end of a vertically reciprocating die shaft *M* provided with a projection *N* that engages one or more actuating cams or dogs *O* mounted on the cam-shaft; these dogs lift shaft *M* against the tension of the spring *L*. Power is received from a flywheel *P* driven by a belt in the usual manner, which runs free until the clutch *Q* is engaged. The burr-reducing or link-finishing mechanism for both the anvil and hammer is controlled by hand-operated lever *R* extending across the left-hand side of the machine.

In operation, the link is centered and clamped between the holding dies, with its abutting ends just out of contact. These ends are then brought into contact by slightly increasing the pressure on clamping lever *G*. The contact electrodes *C* are then brought forward by pressure on the foot-treadle until they make contact with the side of the link which is to be welded. The primary circuit is then closed, thus producing a current in the seondary circuit or loop carrying the current to the electrodes. Meanwhile, the operator maintains an end pressure on the holding dies by means of the clamping lever. Since the contact of the open ends of the link is the greatest resistance in the circuit, the link rapidly heats up at this point and soon becomes plastic, spreading under the longitudinal pressure to which the abutting surfaces are subjected. As the ends of the link gradually upset, the operator quickly brings the holding dies closer together, thus completing the welding of the link. As clamping lever *G* reaches the position corresponding to the completion of the weld, the automatic current-controlling switch causes the circuit breaker to operate and shuts off the flow of the electric current. The manner in which the electrodes force the open ends of the link together is clearly illustrated in Fig. 9.

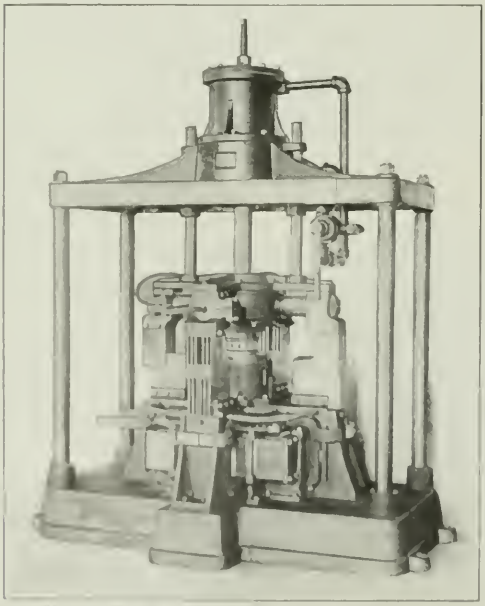


Fig. 10. Hub and Spoke Welding Machine designed by the Thomson Electric Welding Co.

After the weld has been completed, the end pressure of the holding dies is maintained by the operator and the foot pressure on the treadle is released, permitting the contact electrodes to back away from the work. Lever *R* for operating the burr-removing mechanism is then pressed downward, raising the anvil *J* into engagement with the upset portion of the link, and at the same time operating the upper hammer *K* that strikes one or more blows upon the still heated blank. Meanwhile the pressure on the holding dies is gradually released to permit the chain link to lengthen. After welding and drawing the links, lever *R* is returned to the upper position, thus depressing the anvil and raising the hammer, when the link is removed and the same operation repeated until the entire length of chain has been welded.

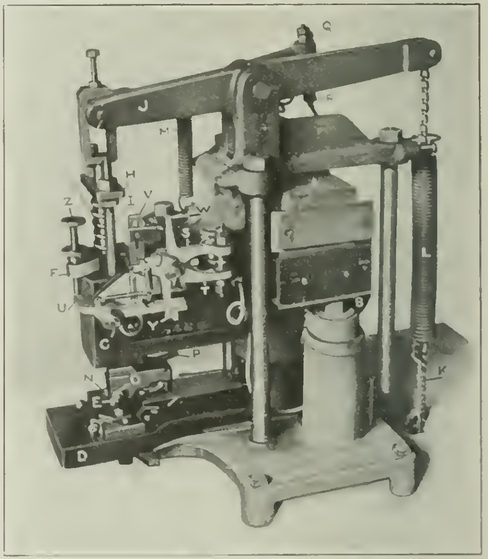


Fig. 11. Special "Thomson" Electric Welding Machine built for welding Platinum Tips to Screws, etc.

At *S* in Fig. 9 is shown another method of welding chain links. In this case, the welded portion of the chain link is reinforced by forcing a large amount of metal into the weld and surrounding parts. This is an upset weld as shown at *T* rather than a flash weld as shown at *U*. The cross-sectional area of the link is increased at the welded joint, making the link as strong at the joint as anywhere else along its section.

Hub and Spoke Welding Machine

Another electric welding machine of a special type, particularly adapted to the welding of hubs and spokes for agricultural wheels, is shown in Fig. 10. In this machine two wrought-iron hubs with the spokes inserted before being brought to the machine are welded together. This machine possesses some interesting points in its construction, especially as regards the relation of the terminals or contact points, which are secured through copper leaves that interlace or lock when the press is in operation. Power for operating this machine is secured through a hydraulic cylinder located at the top of the press, which is operated by the lever shown in front of the machine.

In operation, the upper contact part of the machine is raised, leaving sufficient space so that the assembled hubs and spokes can be placed in the lower contact die. Then the lever at the front of the machine is operated and the hydraulic pressure forces the upper die down in contact with the work, and at the same time brings the copper leaves into contact with each other. The circuit is then closed and the hubs and spokes that are in contact immediately commence to heat up. In about thirty seconds they reach a welding heat, when the pressure cylinder is again operated and the spokes and hubs are mashed together in one homogeneous mass. The wheel is then taken out and the outer rim placed on it. The hub shown in this illustration is about 4 inches outside diameter and 1¼ inch thick, and the spokes are about ⅝ inch oval shaped.

Special Vertical Butt-Welding Machine

A special bench butt-welding machine of the vertical type for welding platinum tips to screws, etc., is shown in Fig. 11. In this machine, which is built by the Thomson Electric Welding Co., the welding electrodes or clamping dies are disposed vertically instead of horizontally as is the usual construction in butt-welding machines. This machine comprises a core *A* and secondary casting *B*. *C* and *D*, respectively, are the upper and lower terminals of the secondary casting. The lower terminal carries the anvil-like electrode *E* on which the disk of platinum is placed, this being retained in a holder which is adjusted by the screws shown.

The upper terminal of the secondary casting carries a slide *F*, kept down by spring *G* working against plate *H*, through which the slide-operating rod *I* passes. Rod *I* is raised by rocker lever *J* which is actuated by chain *K* attached to a foot-treadle on the floor. This is so arranged that when it is pressed down the chain is pulled down, causing the forward end of the rocker lever to rise and lift slide *F*. Spring *L* is interposed to take care of the weight of the chain and treadle so that they will have no effect on lever *J*, whereas spring *M* is intended to keep the forward end of lever *J* down.

Attached to the lower end of slide *F* is a clamp *N* consisting of a horizontal rocking lever, to the forward end of which one of the clamping jaws is attached. Facing this jaw is another that is attached to the extreme bottom of the slide by a nut *O*. These jaws are bored out to suit the diameter of the screw to which the platinum disk is to be welded. The horizontal moving lever is clamped by a cam on which *P* is the operating handle.

The switch-operating mechanism comprises upper contact arm *Q* pivoted on the same pin as lever *J*, but operated independently. *R* is the lower contact of the switch and is attached to lever *J*, whereas *S* and *T* are, respectively, the upper and lower contact levers of the break-switch. This break-switch is operated through the lever mechanism shown by the screw in slide *F* that comes in contact with lever *U* to trip the mechanism.

In operation, slide *F* is raised slightly to allow the screw to be inserted, which is clamped by operating lever *P*. The platinum disk is then laid in a slight depression in electrode *E*. Slide *F* is now lifted far enough to cause the block on arm *V* to strike block *W*, depressing contact lever *S* sufficiently to bring the contacts on the ends of levers *S* and *T* together, and at the same time causing the plate on projecting arm *Y* to catch on the plate on the end of lever *U*. The slide is now lowered by raising the foot from the treadle; this brings the screw in the clamping jaws in contact with the platinum disk. Upon further raising of the treadle, the forward end of lever *J* tips down under the pull of spring *M*. The closing switch attached to lever *J* is thus raised, closing the circuit, when fusion between the screw and disk immediately takes place. As fusion progresses there is a slight upsetting of the material due to the pressure of the spring, so that slide *F* moves downward an amount equal to the upset. Tripping screw *Z* now strikes lever *U*, causing it to be disengaged from the plate on arm *Y* of lever *S*. This allows lever *S* to fly up and thus break the circuit. The weld is now complete, and cam lever *P* is pushed back to release the screw, whereupon another screw and disk is inserted and the operations are repeated.

The preceding gives some idea of the many types of electric-welding machines built, and shows some of the possibilities of electric welding. Some machines are built to operate semi-automatically, whereas others are built so that it is only necessary to place the work in the machine. Various arrangements are also used for operating the movable head and other movable members of the machine, depending on the requirements. On the smaller sizes the movable head is operated by a lever, by hand or power, and on the larger machines hydraulic pressure is used. The construction and operation of the machine depends largely, of course, upon the shape and nature of the work to be welded. Space will not permit of an extended treatment of these machines, but the underlying principles in all are practically the same.

* * *

CONVENTION OF NATIONAL ASSOCIATION SCHOOLS

The third annual convention of the National Association of Corporation Schools will be held at the Hotel Bancroft, Worcester, Mass., June 7 to 11 inclusive. The convention is held in Worcester this year as the result of an invitation tendered at last year's convention by three of Worcester's leading industrial concerns—the Norton Co., the Norton Grinding Co. and the American Steel & Wire Co. George I. Alden, president of the Norton companies, will open the convention with an address of welcome, following which Mayor George M. Wright will extend the freedom of the city to the visitors.

No business will be transacted on Monday, and the first session will be on Tuesday beginning at 9 o'clock and continuing throughout the day, with a round-table talk at night. On Wednesday morning the second session will be held in the ball-room of the Bancroft Hotel, opening at 9 o'clock, and at 4:30 the delegates will leave by special cars for the plant of the Norton Co. for the remainder of the afternoon session. A supper will be served at 6 and the night session concluded in the assembly hall of the Norton plant. An all-day session will be held on Thursday at the Bancroft, and the day will wind up with a big annual banquet in the Bancroft ball-room. The closing session of the convention will be held on Friday morning and will conclude with the annual business meeting and election of officers. Howard W. Dunbar of the Norton Grinding Co., who was appointed general chairman by the executive committee of the association, has selected a number of committees to assist him in preparing for the delegates.

The National Association of Corporation Schools was founded January 24, 1913, and its first meeting was held in the New York University, New York City. The functions of the association were designated as follows: to develop the efficiency of the individual employe; to increase efficiency in industry; and to influence courses of established educational institutions more favorably toward industry. The first annual convention of the association was held at Dayton, Ohio, September 16, 1913, and the second annual convention at the home of the Curtis Publishing Co. in Philadelphia, Pa. Every effort is being put forth to make the third convention profitable to all the delegates attending it, and to give the impetus needed to make its work effective. It has been asserted that if the workers of American industry would increase their efficiency to an average of 10 per cent, in one year the United States would be the leading industrial nation of the world. Prominent men generally realize the crying need of industrial and vocational training, as is evidenced by the statement of President Wilson who in one of his speeches said: "We need trained and disciplined men who know and who can think, men whose judgments are steadied by knowledge."

DOING LATHE WORK ON ALL-GEARED GANG DRILLS

STANDARD DRILLING MACHINES EQUIPPED WITH SPECIAL TOOLS AND FIXTURES FOR HANDLING UNUSUAL WORK

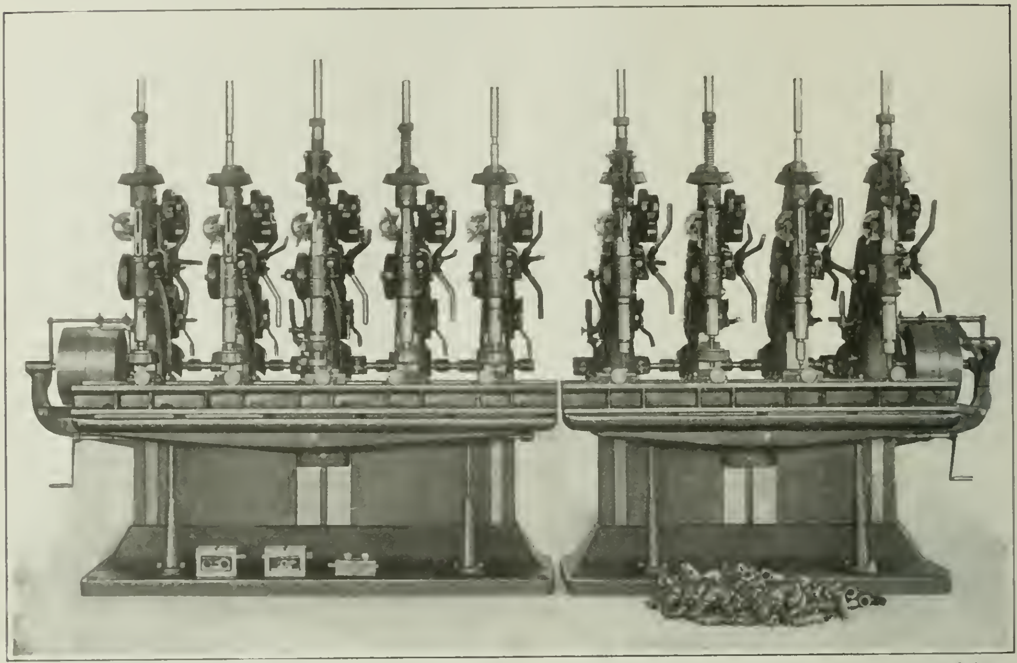


Fig. 1. Barnes Drill Co.'s Five-spindle and Four-spindle 20-inch All-geared Drills set up as a Battery and equipped for machining Brass U-fittings

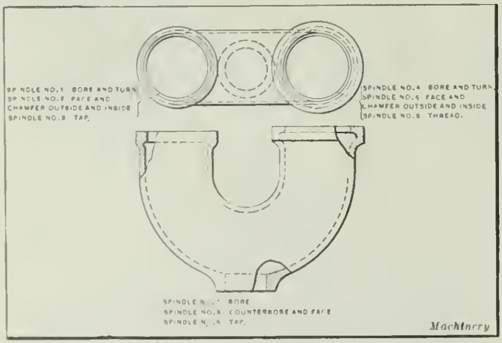

SPINDLE NO. 1 BORE AND TURN
SPINDLE NO. 2 FACE AND CHAMFER OUTSIDE AND INSIDE
SPINDLE NO. 3 TAP.
SPINDLE NO. 4 BORE AND TURN
SPINDLE NO. 5 FACE AND CHAMFER OUTSIDE AND INSIDE
SPINDLE NO. 6 THREAD.
SPINDLE NO. 7 BORE
SPINDLE NO. 8 COUNTERBORE AND FACE
SPINDLE NO. 9 TAP.
Machinery

Fig. 2. Operations performed on Brass U-fittings to be machined

THE factory superintendent who is responsible for the maintenance of rates of production is sometimes likely to adhere too closely to traditional methods of machining. This is particularly true in cases where the superintendent has been employed in the same shop for a number of years and has failed to keep abreast of the times. It goes without saying that there are certain operations which can be handled most advantageously on milling machines, others which naturally come within the province of lathe work, etc.; but there are many classes of work that lie on the border line, and that at first sight may appear to come under a given classification, although a careful study of the subject would show that machining the work by some other method would enable a far more satisfactory rate of production to be attained. It is the purpose of this article to describe the way in which the Barnes Drill Co., 814 Chestnut St., Rockford, Ill., has equipped the all-geared multiple spindle drills of its manufacture for handling several classes of work that would, at first sight, appear to be typical lathe operations. By equipping multiple spindle drills with suitable fixtures, however, it was found that the work could be handled more expeditiously than would have been possible on a lathe.

Fig. 1 shows a five-spindle and a four-spindle drill set up to form a nine-spindle battery for machining brass sanitary U-fittings. The four-spindle machine is built with left-hand drive, in order that its table may come up close to the table of the five-spindle machine. It will be seen that a track is provided on each of the drilling machine tables, and the fixture in which the work is held runs on this track, traveling from spindle to spindle. There are nine operations to be performed on these fittings. In the first six operations, the two

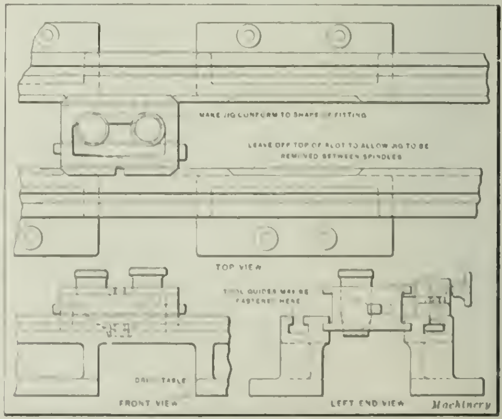

MAKE JIG CONFORM TO SHAPE OF FITTING
LEAVE OFF TOP OF SLOT TO ALLOW JIG TO BE REMOVED BETWEEN SPINDLES
TOP VIEW
TOOL GUIDES MAY BE FASTENED HERE
DRILL TABLE
FRONT VIEW
LEFT END VIEW
Machinery

Fig. 3. Section of Fixture used on Machines shown in Fig. 1

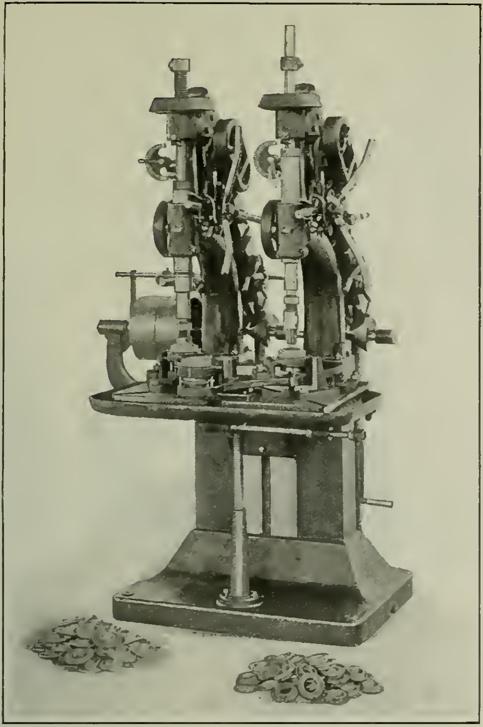


Fig. 4. Barnes Drill Co.'s Two-spindle 20-inch All-geared Drill equipped with Rotary Fixture

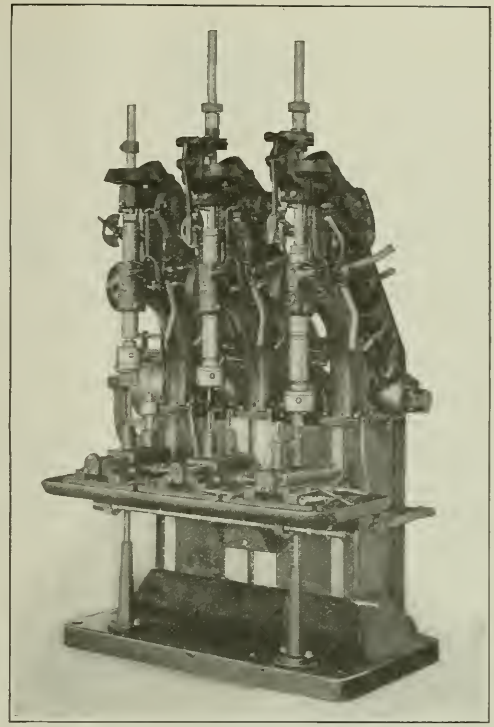


Fig. 5. Barnes Drill Co.'s Three-spindle All-geared Drill equipped for drilling, facing and tapping Steel Plugs

openings in the top of the fitting are machined; and after this, the fixture is turned over on the track to bring the bottom of the fitting into position to be machined. The fixture is then moved along under the remaining three spindles, which machine the bottom of the fitting. This will readily be understood by referring to Fig. 1, where three of the fixtures are shown lying at the base of the machine. Fig. 3 shows a detailed view of a section of the fixture, and Fig. 6 shows the tools used for the turning, boring, chamfering and facing operations which are performed on these fittings.

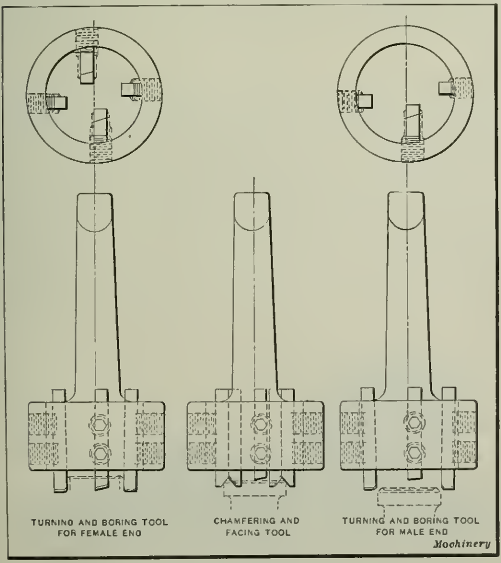

TURNING AND BORING TOOL FOR FEMALE END
CHAMFERING AND FACING TOOL
TURNING AND BORING TOOL FOR MALE END
Machinery

Fig. 6. Tools used for turning, boring, chamfering and facing U-fittings

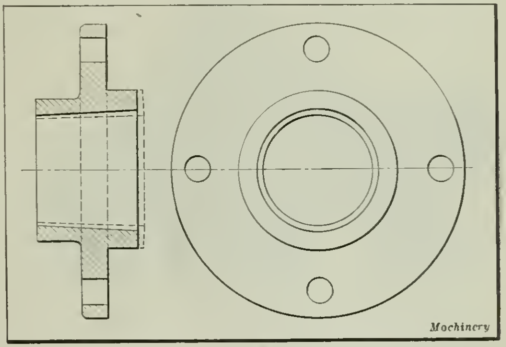


Fig. 7. Work handled on Machine shown in Fig. 4

Spindle 1 bores and turns the top of the left leg of the fitting; spindle 2 faces and chamfers the outside and inside of the fitting; and spindle 3 performs the tapping operation. Spindle 4 bores and turns the top of the right leg; spindle 5 faces and chamfers the outside and inside of the fitting; and spindle 6 performs the threading operation. After the sixth spindle has finished its work, the fixture is turned over to bring the bottom of the fitting into position to be machined. After this has been done, the fixture is again moved along to the seventh spindle, which bores the opening; spindle 8 counterbores the opening and faces off the bottom of the fitting; and spindle 9 performs the tapping operation. The tapping spindles are provided with positive leaders to insure obtaining perfect threads. One of the threads in the fitting is 27 pitch, which is so fine that without the leader it would be impossible to prevent stripping the threads. By means of this outfit, three men can turn out one finished piece a minute, and the operators need not be skilled mechanics, deftness and agility being the chief requirements.

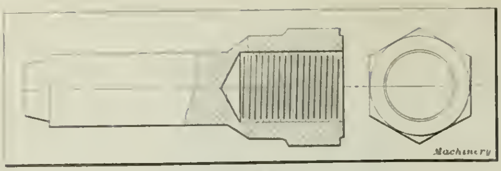


Fig. 8. Work handled on Machine shown in Fig. 5

Fig. 4 shows a Barnes Drill Co.'s two-spindle drill equipped with a rotating fixture and tools for performing the boring, reaming and facing operations on small castings of the form shown in Fig. 7. It will be seen that the work has a tapered hole which must be reamed, and the right-hand edge of the hub has to be faced. The fixture for handling this work revolves on a trunnion fastened to the table of the drilling machine, and consists of a three-armed spider, made with a distance of fifteen inches between work-holders to conform with the standard distance between the spindle centers. The operator unloads the finished work and replaces it with fresh blanks at the front position, during which time the first spindle is performing the rough-boring and facing operation. The fixture is then rotated to bring the partially finished work under the second spindle, where the taper hole is reamed and the edge of the hub faced to exactly the required dimensions, a stop collar being provided at the top of the spindle for this purpose. It will be seen that the first spindle is provided with a spring which automatically returns the spindle as soon as the feed is tripped. With this equipment, a practically continuous operation is secured and the work can be done by an unskilled operator.

Fig. 5 shows a Barnes Drill Co.'s three-spindle, all-geared drill equipped with fixtures and tools for drilling, facing and tapping steel parts of the form shown in Fig. 8. The work is held in a chuck in the drill spindle and the first operation consists of drilling the hole with the work held in the left-hand spindle of the machine. After this has been done, the fixture on which the tools are carried is moved forward to bring the facing tool into position to face off the end of the work. The spindle is equipped with a stop collar to provide for drilling and facing the work to the required depth. After these operations have been completed, the work is transferred to the second or third spindle, where it is rough-tapped by the first tap carried on the fixture, after which the fixture is moved forward to bring the finishing tap into position to have the work fed down onto it. The two tapping spindles are provided with positive leaders to insure obtaining perfect threads, and the taps have holes through the center to provide for delivering oil into the work. The drilling and facing operations can be performed more rapidly than the tapping operations; hence, the provision of two tapping spindles to handle work that is drilled and faced by a single spindle. These are typical examples of a great many jobs formerly done on the lathe for which the Barnes Drill Co. has fitted up gang drills. In these cases a very satisfactory rate of production has been obtained. E. K. H.

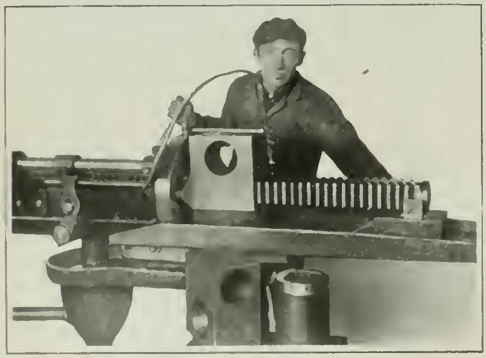


Fig. 1. Broaching a 4-inch Square Hole

BROACHING A LARGE SQUARE HOLE

An interesting broaching operation on a gun carriage part is illustrated in Fig. 1. This piece is a hard steel block and the broached hole is 9 inches long and 4 inches square, finished as indicated by the view to the left in Fig. 2. The rough-bored hole is squared by the use of five broaches which follow one another in the usual manner; that is, the corners are partially cut away by the first broach and the neck of the second broach is made to enter the hole left by the preceding one, and so on, until the hole is finished to the required shape. Owing to the length of the hole, the broach teeth were spaced 1¼ inch apart in order to provide sufficient chip room.

Each broach removes over 1½ pound of chips and the total weight of the chips from each hole is about 7½ or 8 pounds.

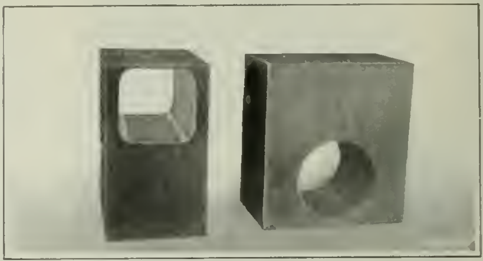


Fig. 2. Gun Carriage Part broached as illustrated in Fig. 1

Fig. 3 shows a pile of chips removed from one of these holes and also one of the pieces used for testing the broaches. The last broach removes about 1/32 inch of metal all around, and very accurate work is obtained notwithstanding its size. The walls at the side of the hole are only ½ inch thick, and at one end the thickness is only ¼ inch. The time required for this operation is approximately twenty minutes, although the rate of production naturally depends somewhat upon the activity of the operator.

As Fig. 1 shows, the machine is equipped with a long supporting table and the outer end of the broach rests upon a sliding carriage. Each broach weighs 235 pounds. This machine and the broaches used for the operation referred to were made by the J. N. Lapointe Co., New London, Conn. According to the experience of this company, built-up broaches for such large and heavy work are not sufficiently strong and only solid broaches are used. These are said to be capable of broaching from 4000 to 5000 pieces without being worn enough to cause any appreciable change in the size of the hole.

* * *

The laws of science are being recognized and applied in the daily lives of the people today as never before. Rapid strides are being made in the manufacturing, transportation, communication, structural, commercial, agricultural and industrial interests of the world. To keep pace with this advancement the world workers must be trained. No longer is the finger of scorn pointed at the theorist, the scientist and the applied scientist in the world's workshop. Science goes hand in hand with practice.—*R. B. Dale in "The Iowa Engineer."*

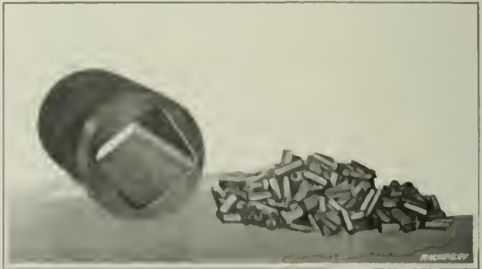


Fig. 3. Chips removed by Each Broach and Piece used for Testing Broaches

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

THE SETTING OF ANGLE GAGES

In the December number of MACHINERY, John Mahon describes a useful form of gage for measuring tapered plugs, but a brief consideration makes it evident that his setting gage is only designed for very small tapers. This, of course, is due to having the center distance between the holes in which the setting disks are held fixed, this distance being only 3 inches. Doubtless Mr. Mahon's gage was designed for work with very small tapers, but if it is to be in any sense universal, it would be much better to have the setting gage provided with means for adjusting the center distance between the disks.

The rule for determining the center distance between the setting disks of an angle gage is as follows: The distance between centers must be equal to the difference in the radii of the disks divided by the sine of one-half the taper angle. Calling the distance between centers L, the difference in the radii of the setting disks $R - r$ and the whole taper angle α, we have:

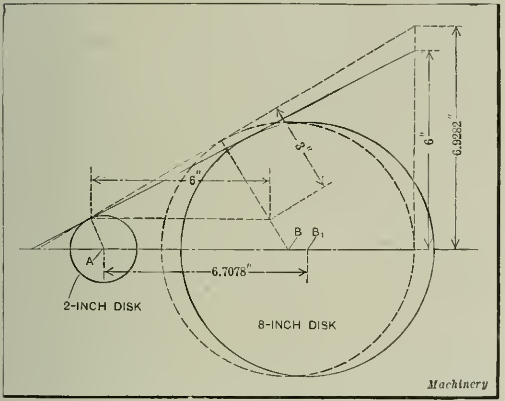


Diagram illustrating Desirability of having Center Distance between Disks Adjustable

$$L = \frac{R - r}{\sin \frac{1}{2} \alpha}$$

The following discussion of the method of setting angle gages may prove of interest and value, and it applies with equal force to the universal angle gage which I described on page 315 of the December number of MACHINERY, as well as to Mr. Mahon's gage previously referred to. In all calculations of this kind we deal with one-half the taper angle, dividing it on the center line. Suppose it is attempted to make a setting for the taper shown by the full line for one-half the taper angle, using setting disks 2 and 8 inches in diameter, respectively. Here the difference in radii $R - r$ is 3 inches. Referring to the accompanying illustration, it will be seen that the 8-inch disk cannot be used in this case as it is too large to enable the required angle to be obtained with a center distance of 6 inches. The center of the 8-inch disk would have to be at B_1, making the distance between the centers of the disks 6.7078 inches. Using the disks with 6 inches between centers would produce the taper of 3 inches in 6 inches for one-half the taper angle, as shown by dotted lines.

To illustrate the use of the rule for determining the distance L between the centers of the setting disks, the following examples are given: Suppose it is required to set for an included taper angle of 60 degrees, using disks 1 inch and 5 inches in diameter, respectively. One-half the taper angle is 30 degrees and the sine of 30 degrees is 0.5. The difference in the radii of the disks is 2 inches.

$$L = \frac{R - r}{\sin \frac{1}{2} \alpha} = \frac{2}{0.5} = 4 \text{ inches.}$$

As a further example, suppose it is required to set for a taper of ¾ inch per foot, using disks 1 inch and 1½ inch in diameter, respectively. One-half the taper angle will obviously be 0.375 inch per foot and

$$\frac{0.375}{12} = \tan \tfrac{1}{2} \alpha = 0.03125.$$

$$\tfrac{1}{2} \alpha = 1 \text{ degree } 47 \text{ minutes}$$

$$\sin \tfrac{1}{2} \alpha = 0.03112.$$

$$L = \frac{R - r}{\sin \frac{1}{2} \alpha} = \frac{0.25}{0.03112} = 8.0334 \text{ inches.}$$

A good way to set the disks at the required distance between centers is to measure over their outside with a micrometer set to the required center distance, plus the sum of the disk radii. With a holder that permits of adjusting the center distance between the disks, it will rarely be necessary to make new disks in order to obtain any required setting.

Turtle Creek, Pa. WILLIAM S. ROWELL

HOLLOW STEEL BEARING BALLS

The writer, who is much interested in the design of ball bearings for machinery, has been struck with the evident waste of high-grade material in large steel balls when the diameters are, say, one inch and over. Not only is an amount of valuable steel wasted, but it is worse than wasted. Large bearing balls weigh pounds when they should weigh ounces, and the heavy, useless weight is a serious disadvantage at high speeds, the inertia of the balls causing them to hammer the races and ruin them when speeds become excessive.

Being somewhat familiar with the possibilities of electrical welding, I suggest that the manufacturers of steel balls consider the feasibility of making hollow steel balls for all the larger sizes. This, I believe, could be readily accomplished by forging the balls in hollow hemispherical parts and joining them by electric welding. After being electrically welded, the hollow steel ball would be heated, hardened, tempered, rough-ground, finish-ground, polished, inspected and, in short, treated the same as a high-grade ball made from a solid forging. The advantages of the hollow ball would be a saving of material, greater elasticity, more uniform hardness, freedom from internal stresses and reduced weight.

I recommend that all steel balls one-half inch diameter and larger be made hollow, the thickness of the wall relative to the diameter decreasing progressively with increase of diameter. To illustrate, the thickness of shell of a hollow one-inch diameter ball might be, say, one-eighth inch, while the thickness of a three-inch ball shell would be, say, only one-quarter inch. The weight of a hollow one-inch ball with a one-eighth inch shell is about 0.084 pound, and that of a three-inch hollow ball with one-quarter-inch shell is about 1.654 pound, while the weights of solid one-inch and three-inch balls are 0.145 pound and 3.927 pounds, respectively.

M. E. CANEK

The foregoing contribution was submitted to L. J. Hoover, vice-president and general manager of the Hoover Steel Ball Co., Ann Arbor, Mich., who comments as follows:

A few years ago the writer spent several thousand dollars for a concern with whom he was connected in making hollow steel billiard balls. The principal reasons why a hollow steel ball would not be satisfactory are as follows:

1. You cannot get a high-grade material that will draw into a half sphere without cracking. If it is annealed soft enough so that it will not crack, the steel has been so decarbonized that it will not harden properly.
2. The expense of the dies alone would be tremendous, as you would have to have three sizes of dies for every size of ball, and would have to anneal the metal for every time you draw the half sphere, as the bending of the metal would crystallize it considerably, which can only be relieved by an-

nealing. This could only be bent a small distance each time; therefore it would be absolutely necessary to have three separate sizes of dies.

3. With electrical welding you would throw up a fin on the inside of the ball which you could not remove, as by putting the two parts together to make the complete sphere you have to press the metal when it is red-hot, which throws inward a little fin that will not allow the ball to balance. Of course the outside fin could be removed by grinding, but the inside would gradually rattle off and you would have a rattle box which would be very nice for some child to play with.

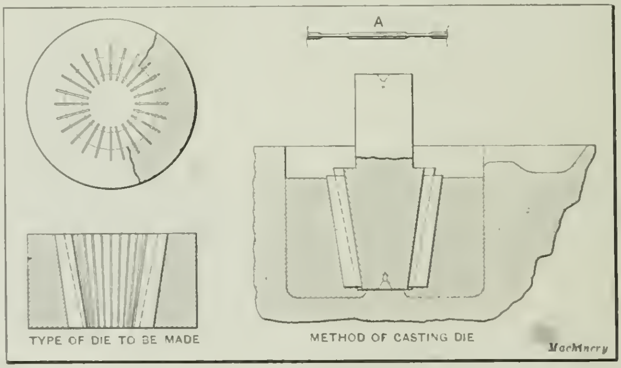
4. Any metal that is electrically welded cannot be hardened where it has been welded; therefore you would have a soft streak all the way around the ball when it is tempered, as the electric welding process takes out all the carbon where the electric juice is turned on and the steel brought up to the welding point.

5. After you had completed the ball, you would have nothing left but an egg-shell, which would be hard on two sides with a soft streak around where the electric welding process took effect, as it would have to be made from very cheap material to be drawn cold and you would have a very hard shell just the same as an egg-shell; but just as soon as you put any weight on the ball it would crush into so many pieces that you could not put them together. In drawing these half circles, you could not draw them evenly and the ball would be thicker in some places than in others; therefore the expansion and contraction would not be the same and you could not grind these to a perfect sphere.

The cost of the manufacturing of these hollow balls would be several times in advance of the cost of manufacturing the solid steel balls. There would be no resistance in the hollow ball whatever, as on a large sized ball it is the soft metal in the heart of the ball which gives it the resistance, as a three-inch ball will only harden about one-quarter inch deep, being backed up with the soft metal of the heart.

MAKING A RIBBED DIE

To produce the type of die shown in the accompanying illustration in an economical way, is a problem that might puzzle many mechanics; but the method of casting this piece of work, as described and illustrated herewith, is inexpensive and will prove very successful, provided a few important points are observed. A brass cone is turned and used as a core, with the angle the same as the inside of the brass die to be made. Slots are milled around the cone surface, the depth and angle being made the same as the required position of the ribs in the die. These slots are made just wide enough to permit the ribs to be set in close without driving. Before inserting the ribs, however, the outside of the core is coated with a solution of lamp black and turpentine, applied with a small brush for the purpose of preventing the molten brass from sticking to the core. The slots are cleaned by drawing a piece of flat thin steel through them, which removes any fine chips that may be lying in the bottom. Care must be taken when inserting the ribs, to have both ends down in the bottom of the slots. If the ribs, by being loose, are likely to move or shift in the slots, the sides of the slots should be peened just sufficiently to hold the ribs in place, as shown in an exaggerated manner at A.



Punch and Die, and Method of casting the Die

The core is then ready to be set in the mold, and the die is cast. It will be seen that by making the mold as shown, both centers of the core are available for use. The die is taken directly from the sand mold and placed in the lathe, using the core as a mandrel. After finishing the outside, the core is driven out and the inside finished by filing. It must be remembered that the core should be well coated with the lamp black and turpentine solution, and that the brass should not be poured at too intense a heat, which would cause the surface of the core to melt in spots, making it almost impossible to drive out. But it is not necessary to have the core heated when pouring. This type of die was used in forming flexible material, and extreme accuracy of the product was not required.

Moore, Pa. **John Leafstrom**

EQUIPMENT FOR TRADE SCHOOLS

Every little while, and especially when general business is a little dull, some one brings out a new machine adapted, in his mind, to some educational use. Manual training and technical schools, and more recently trade schools, are a Mecca to the man who wants to get business, for they are seldom if ever affected by hard times, their accounts are always good, and occasionally the purchasing agent is not keenly onto his job. On page 333 of the December number of Machinery there is illustrated a contraption that is stated to be "particularly intended for use in trade schools where students may become familiar with these types of equipment before starting work on high-class machine tools which might be readily damaged." While I realize, of course, that such a statement is not an editorial endorsement of the device, it is a statement that appearing in conjunction with so many things that are good may make a wrong impression on men whose duties as buyers for trade schools are not based on a knowledge of the machine tool business.

For nearly six years I have had charge of the machine shop section of as large a school as there is in the country, which is strictly a trade school. During that time there has not been over $100 damage done to the machine tools in the shop, and we have over $30,000 worth of as good machinery as money can buy. This is less than would have occurred with an equal number of journeymen machinists. The boys come in, off the street or from grammar school or high school, without any previous notions of machine work; and they are put at work on a lathe or a miller the first hour they are in the place. At first it was our idea that the machines should be protected by automatic stops and that they should be completely set up before the boys came to work, and that an older boy should really be responsible for the job. Now we find that there is little danger the first part of the time that a boy is in the shop. Later on, after he has become familiar with the place and the machinery, there is more danger that he will become careless and will take unnecessary chances.

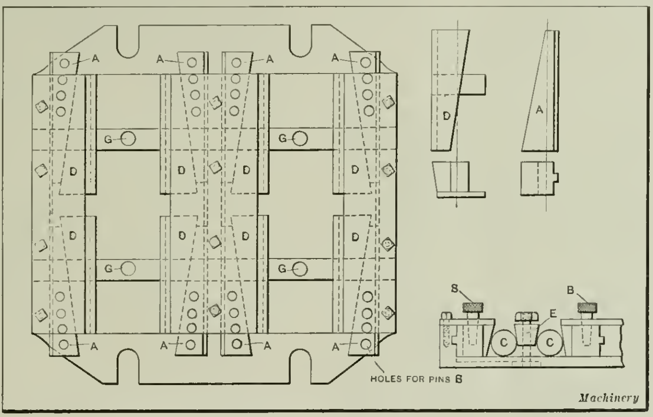
There is no reason why a boy should not be trained in this way from the very start, on machinery which is life size and on which he can do work that is a credit to the school, except the fact that such equipment costs heavily. It seems a pity to tie up $500 or $600 worth of machinery to try out a boy, when you know beforehand that at least half of those that you try out are not fitted for the machinist's trade but must later be switched to some other industry. It seems as if some one ought to be able to bring out a lathe with every essential part for the production of plain work, that would enable a school to teach a boy the two most essential principles of the machinist trade—to cut metal and to measure. Such a machine need not be back-geared, nor does it need a power cross-feed, a compound rest, nor a large faceplate, and half of them need not be equipped for screw cutting. They need not be heavy, though they should have large cones for wide driving belts. They will seldom be used for turning or boring work over 2 inches in diameter, but they should swing 14 or 16 inches. Such a machine will, of course, cost much more than the combination machine referred to, but it will do real work in quantities, and within its range it will be the equal of the higher priced wider ranged tool.

Worcester, Mass. JOHN P. CASEY

ORDERING TOOLS AND SUPPLIES IN THE FACTORY

Practically every factory has a different method of handling requisitions for tools and supplies for the various departments. In many factories there is too much red tape in the ordering of small tools and supplies generally. In fact, there is more red tape in the ordering of the less expensive materials and tools than in the case of the more expensive machines. The reason for this is probably that in a large factory small tools and supplies are ordered by a great number of individuals holding subordinate positions in the organization, while the orders for the larger and more expensive equipment generally come from men of greater responsibility; therefore, it is assumed that a more careful supervision is necessary over the orders for minor tools and supplies than in the case of the orders for larger machines.

Few concerns carry in their tool-room an adequate supply of tools for the needs of their shop force, but depend to a large extent on the fact that many skilled mechanics have a considerable kit of tools of their own. New men added to the force are therefore often handicapped by the lack of suitable tools for the work they are expected to do. Niggardliness in respect to small tools does not pay, however. These should be considered just as vital a part of a modern shop equipment as any of the machine tools.



Keyseat Milling Fixture with Adjustment to provide for holding Various Sizes of Shafting

The difficulty which arises in the ordering of small tools and supplies is to formulate a system by means of which it can easily be determined what should and what should not be ordered. If every requisition is too closely questioned and the system is too rigid, a foreman will hesitate about asking for necessary tools and supplies, because he feels that his judgment is questioned. Hence, many necessary supplies may be neglected. On the other hand, if every request coming from the foreman was passed without comment, abuse of the privilege would in many cases become a source of unnecessary expense.

The best way to take care of this matter is to let all the requisitions pass through the hands of a properly trained man capable of exercising judgment in the matter of standard supplies and small tools, and who should keep records which would indicate whether the consumption at any one time exceeded the regular consumption of similar supplies, in which case he would investigate the matter and take steps to correct the trouble. When requests are made for articles which are not regularly purchased, then the facts relating to the matter should be ascertained by the person in charge of the purchasing, and he should place these before the chief executive for his decision. In this way, the executive can be relieved of the routine of approving a needless number of regular orders, and yet feel that when any department calls for something that is not part of the regular equipment he will have an opportunity to decide whether or not the expense is warranted.

Sarnia, Ontario, Canada. P. W. BLAIR

UNIVERSAL KEYSEAT MILLING FIXTURE

The purpose of this fixture is to provide a means of cutting keyways in various sizes of shafts, provision being made for holding four pieces of shafting at one time without the necessity of changing the spacing collars between the cutters. To enable this to be done the shafts must be brought central with the cutters, which is provided for by means of the adjusting gibs *A*. These gibs are located by pins *B* fitting into several tapered holes, each hole providing for setting the fixture for a given size of shafting. Reference to the illustration will make it evident that the gibs *A* act in conjunction with gibs *D* which grip the work. It will be seen that the gibs *D* are provided with tongues on their under side, which fit in transverse grooves to provide the necessary adjustment.

After the shafts *C* are placed in the fixture, they are secured in place by the clamps *E* which are held down by bolts entering holes *G* provided at the center of the fixture, as shown in the plan view. This fixture was designed for splining shafts from 4 to 7 feet in length, one of these fixtures being used on each end of the milling machine table. It will be evident that the time consumed in setting the jigs is much less than it would be for changing the spacing collars between the cutters, as the necessity of truing up the cutters after changing the spacing collars is eliminated.

Readville, Mass. O. A. WEBSTER

SENDING ANNOUNCEMENTS OF CATALOGUES

A few months ago I made a suggestion to my firm that has produced very good results. At that time I was checking up a list of about 10,000 names of firms and individuals to whom we intended to send catalogues. These catalogues were then in course of preparation and would not be off the press for about another month. It occurred to me that it might be a good plan to send "preparatory letters" or announcements in advance of the catalogue, to every name on the list, stating that their name had been suggested to us as that of a possible customer, that we were getting out a catalogue which would undoubtedly prove of interest, and that a copy of the catalogue would be mailed as soon as it was off the press.

The firm adopted my suggestion and sent a letter of this character in advance of each catalogue, the letter incorporating a brief outline of what the catalogue would contain. We believe that the use of these letters caused our catalogues to be considered of more value, so that they were not thrown into the wastebasket. People knew that the catalogues were coming and had become slightly interested in them before they arrived. In undertaking a campaign of this character, it pays to spend plenty of time in working up a list. Don't make the mistake of sending catalogues to "dead timber"; also, it certainly ought to pay to spend a little extra money in interesting those to whom you intend to send a catalogue, so that they will give it due consideration when it arrives.

N. G. NEAR

DRAWING A DEEP CUP

The accompanying illustration shows successive steps in the drawing of a deep cup or shell that was used for an automobile rear axle housing. We have made about 150,000 of

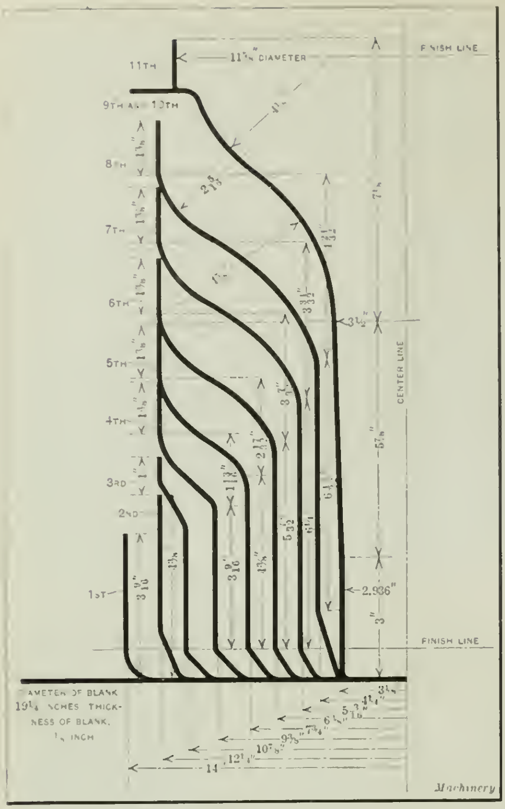


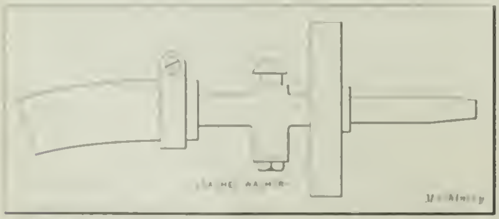
Diagram showing Dimensions at Successive Steps in drawing a Deep Cup

these cups and have obtained very satisfactory results, an average of only three or four cups out of each hundred being broken by pulling out the bottom. It is found necessary to anneal the work three times—after the third, sixth and ninth operations. The punches and dies were made of steel castings which were carbonized and hardened. No blank holders were used on this job. In the ninth operation, the flange was drawn at right angles to the shell, this being done so that the shell could be held for the tenth operation (not shown in the illustration), in which eight pockets are drawn and bolt holes pierced in them. The eleventh operation consisted of turning the flange straight with the body of the shell, and no trouble was experienced in doing this.

Vredenburgh, Ala. WILLIAM BUTZLAFF

SAFETY COLLAR TO PROTECT AIR VALVES

In a manufacturing plant making extensive use of compressed air, the complaint was made that the self-closing valves with which all hose ends were equipped frequently gave trouble due to leakage and breakage. A study of the conditions under which the valves were used revealed the fact that when the workers were through using the air they would drop the hose onto the floor near their work so that it would be convenient when needed. As the floors are of cement construction, this resulted in the valve receiving a hard blow many times a day.



Built-up Leather Washer used as a Safety Collar to protect Air Valve

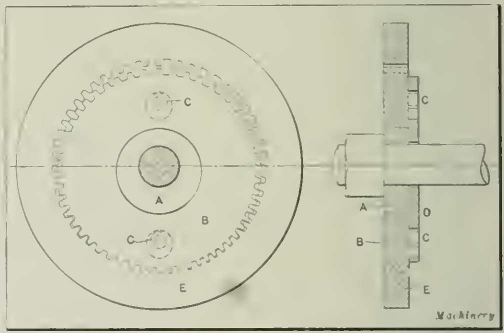
It seemed to be impossible to break the men of this habit of rough handling, partly due to the fact that the noise of the machinery made it impossible for them to realize what a severe blow the valve really received, and also because the piece work system under which these men were working does not tend to encourage workers to expend any thought on matters that do not immediately increase the "upholstering" of their pay envelopes. These valves are made of soft metal and are not very rugged, so it was decided to change the design to meet these severe conditions; and the whole trouble was eliminated by the addition of a safety collar as shown in the illustration.

This collar is simply a leather washer about three inches in diameter, built up to a thickness of a half inch and provided with a hole of the proper size to permit it to be slipped onto the nozzle of the valve just in front of the push button. This leather collar is held securely in place by the addition of a metal band that is soldered to the nozzle, and the arrangement leaves the valve easy of manipulation and does not prevent getting the air just where it is needed. It is now impossible for the valve body to touch the floor when the hose is thrown down, so the valve, instead of receiving a dull destructive thud, bounces about like a Halloween apple in a tub of water.

Madison, Wis. FRANK S. CULVER

SOLUTION OF SPEED REDUCTION

A speed reducing mechanism of an unusual form has been brought to the attention of the writer, and it is thought that perhaps it may be of interest to others. It is of the planetary type, making use of but two gears, as shown in the accompanying illustration, and is used on one make of electric starting motor for automobile engines where a great speed reduction between the starting motor and the engine is desired. An eccentric *A*, carried by the driving shaft of the motor, imparts motion to a gear wheel *B* which is prevented from turning by two rollers *C* that slide in slots in a fixed plate *D*. The oscillatory motion that is transmitted to the gear *B* imparts a much reduced rotary motion to the driven gear *E*, the teeth of which mesh with those on *B*. On the starting motor referred to, the gear *B* has 54 teeth and the gear *E* has 56 teeth. The speed reduction is in the ratio of 28 to 1, and this result may be arrived at as follows: Suppose, first, that the three members *A*, *B* and *E* are locked together and turned in a clockwise direction through one revolution. Then, in order to verify the fact that the gear *B* does not rotate, but has an oscillatory motion, imagine the eccentric *A* to be held stationary and the gear *B* turned in a counter-clockwise direction through a revolution, bringing it back to its original position. During this operation, gear *E* will turn $\frac{54}{56}$ of a revolution in a counter-clockwise direction



Speed Reduction Mechanism used on an Automobile Motor Self Starter

Since it was first turned one revolution in a clockwise direction, it is now $1 - \frac{54}{56} = \frac{2}{56}$ or $\frac{1}{28}$ of a revolution from its original position. In other words, for the one revolution that the eccentric *A* has been turned, the gear *E* has moved ahead $\frac{1}{28}$ of a revolution, and the gear reduction is 1 to $\frac{1}{28}$ or 28 to 1.

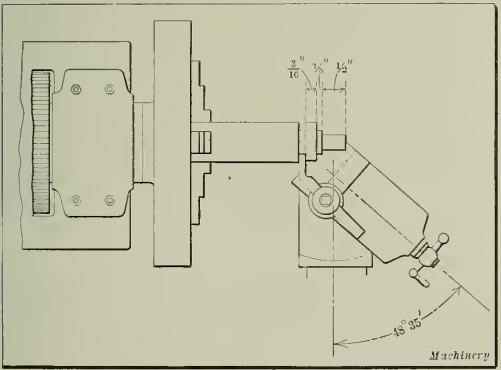
Tabulated, the result is as follows:

	A	B	E
Gears and eccentric locked....	+1	+1	+1
Eccentric *A* stationary........	0	−1	$-\frac{54}{56}$
	+1	0	$+\frac{2}{56}$ or $+\frac{1}{28}$

That is, speed of *A* : speed of *E* :: 1 : $\frac{1}{28}$, or as 28 : 1. Therefore in order to move gear *E* through one revolution, it is necessary to give the eccentric *A* 28 turns. S. H. Y.

COMPOUND REST KINKS

The writer recently saw a lathe operator using his compound rest in an ingenious way. The lathe was a very old machine which did not have a graduated collar on the compound rest screw. The slide was kept set 30 degrees off center for convenience in thread cutting, and when facing operations were being performed it was fed up twice as far as the depth of the facing cut it was desired to take. A brief consideration will make the reason for this evident when it is borne in mind that the sine of 30 degrees is 0.5000. The same workman, when using a lathe with a compound rest screw having six threads per inch, makes a practice of setting the slide at 48 degrees 35 minutes off center when he has to make a number of small pieces with lengths given in common fractions of an inch, as shown in the illustration. With the slide set in this way, a whole turn of the screw corresponds to ⅛ inch, a half turn to 1/16 inch, and a quarter turn to 1/32 inch travel of the tool in a line parallel with the axis of the work. The sine of 48 degrees 35 minutes is 0.7499, and as previously stated the pitch of the compound rest screw is 1/6 inch. Then for one complete turn of the handle, the tool is advanced parallel to the axis of the work a distance equal to 0.7499 × 1/6 equals ⅛ inch; and movements of 1/16 and 1/32 inch are obtained by half and quarter turns of the handle, respectively.



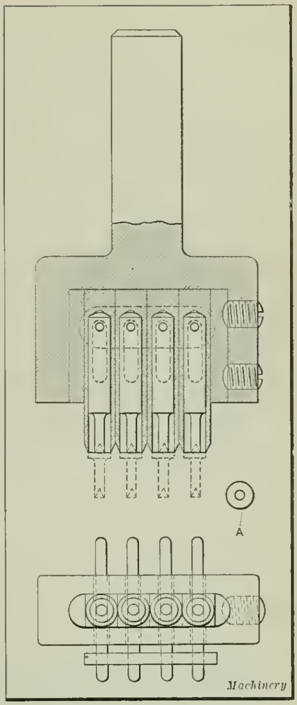
Setting of Compound Rest with 6-pitch Screw, to facilitate machining Work dimensioned with Common Fractions

The writer believes that compound rest screws with six threads per inch are an abomination, as it complicates machining work where common fractions are used to specify the dimensions. By having the pitch of the screw equal to a common fraction, as ⅛ inch, the movement of the tool is much more easily regulated. Of course a graduated collar on the compound rest screw would save all this trouble.

Turtle Creek, Pa. WILLIAM S. ROWELL

MULTIPLE HAND PUNCH

The multiple hand punch illustrated and described herewith has given very satisfactory results in producing small leather washers of the form shown at *A*. These washers are cut from 1/32-inch stock, and it will be noted that the design of the punch provides for cutting the washer from the stock and punching the hole at the same time. The punches which cut out the washer are made square on the outside and held tightly in place by an arrangement of clamping strips and setscrews, which is clearly illustrated. These punches are bored on the inside to the required diameter of the washer which is to be made and the outside is taper-turned to form the cutting edge.



Multiple Hand Punch for stamping Leather Washers

The piercing punches are made a sliding fit in the outside punches and the working section of the punches is made long enough to allow a considerable number of washers to accumulate before it is necessary to remove them. It will be seen that each of the piercing punches is fitted with a cross pin, these pins, in turn, being connected by a small bar. By connecting the pins in this way, the punches may be shifted out together—as shown by the dotted lines—to provide for removing the finished washers. About fifteen washers can be run up onto each of the punches so that a total of sixty washers can be made before requiring the piercing punches to be run down to strip the washers from them.

As originally made, the piercing punches had a 60-degree included angle. This caused considerable trouble, because of the fact that the punching from the hole in the washer wedged into the center of the punch, making it impossible to stamp out a second washer until this waste had been removed. However, when new inside punches with a 45-degree included angle were made, as shown in the illustration, the difficulty was entirely overcome, as the punchings remained in the end grain of the hard maplewood slab which was used as a stamping block. The inside punches only were hardened.

Moore, Pa. JOHN LEAFSTROM

SIMULTANEOUS INTERNAL AND EXTERNAL FORMING ON SCREW MACHINE

The accompanying illustrations show the method of procedure in manufacturing ball bearing races, in which the in-

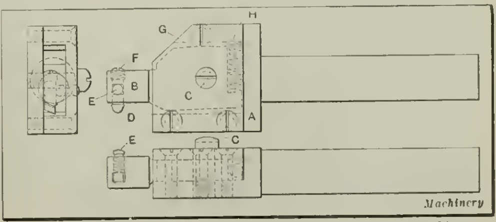


Fig. 1. Internal Forming Tool carried in Turret of Screw Machine

ternal and external forming operations are performed simultaneously. The requirement of accuracy on this work is 0.002 inch either way from the specified size, and it is required to finish the ball grooves smooth enough so that grinding will not be necessary after the casehardening operation has been performed. The material is carbon steel containing 0.20 per cent of carbon.

The usual method of centering, drilling and reaming with turret tools is employed, after which the internal grooving tool shown in Fig. 1 is brought into position and entered into the hole previously drilled in the race. This tool consists of the body *A* with a shank to fit the turret hole. The swinging arm *B* is carried by the body of the tool, this arm being pivoted on the screw *C*. A high-speed steel internal forming tool *D* is carried in the swinging arm and held in place by the screw *E*, the tool *D* being backed up by the headless setscrew *F*. The arm *B* is normally held in contact with the surface *G* by means of a coil spring *H*.

The external forming tool *J*, shown in Fig. 2, is carried in the rear toolpost or angle-block *K*, in which the screw *L* is inserted. The position of the screw *L* is fixed by a checknut. When the internal forming tool is in place, the cross-slide of the machine is brought forward and the screw *L* engages with and forces the internal forming tool forward, thus cutting the ball race simultaneously with the external forming operation. Owing to the length of the internal tool, a support is provided from the rear toolpost to steady this tool and prevent chatter and vibration. In doing this work, a hand-operated screw machine with power feed of the turret slide was employed; and the results obtained were very satisfactory for producing these pieces in relatively small quantities.

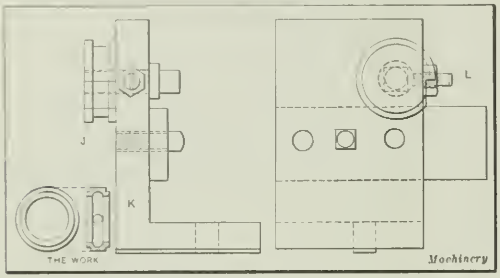


Fig. 2. Work and External Forming Tool carried in Rear Toolpost

Aurora, Ill. CORWIN LAMOREAUX

OLD PISTON USED FOR A CORE BOX

After reboring the cylinder of a gasoline engine, the mechanic is often required to make a pattern and core box for use in casting a new over-size piston to fit the enlarged cylinder. An inexpensive core box for use in this connection may be quickly made by splitting the old piston through the center, at right angles to the axis of the wrist-pin bosses, as shown in Fig. 1. These two halves of the old piston are held together by a wooden block, as shown in Fig. 2, and the inside of the old piston is then employed in molding a core for use in casting a new piston. The block of wood in which the halves of the old piston are held should be thick enough to allow sufficient length for the core print to extend beyond the piston, as shown in Fig. 2, and if desired the block may be cylindrical in shape.

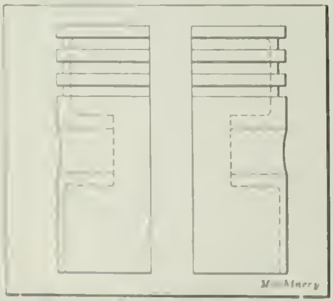


Fig. 1. Old Piston split ready for Use as a Core Box in casting New Piston

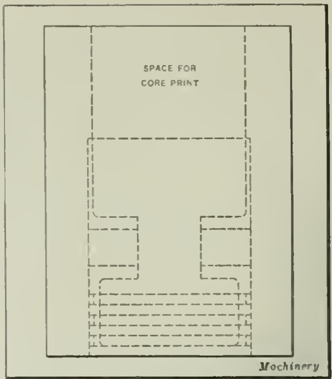


Fig. 2. Split Piston held in a Wooden Block ready for making the Core

Fig. 3 shows this block in detail, and this illustration is to be referred to in connection with the following description of the making of the block. The large hole is bored to such a size that the old piston fits tightly in it before being split, and the smaller hole is bored to the same size as the inside diameter of the open end of the piston. It will be evident to the reader that this smaller hole forms the core print, and so it should be slightly tapered so that the block may be easily withdrawn after the core has been rammed up in the box. The block is first withdrawn and then the two halves of the old piston are separated and removed from the core which is now ready for any finishing touches that it may require; for instance, the necessary correction to allow sufficient metal for machining on the inside faces of the wrist-pin bosses. This adjustment of the core should be made before it is baked. In some cases it may be desired to cast solid wrist-pin bosses in the new piston, and if this is the case the holes in the bosses of the old piston should be plugged up so that the core will provide for casting solid bosses.

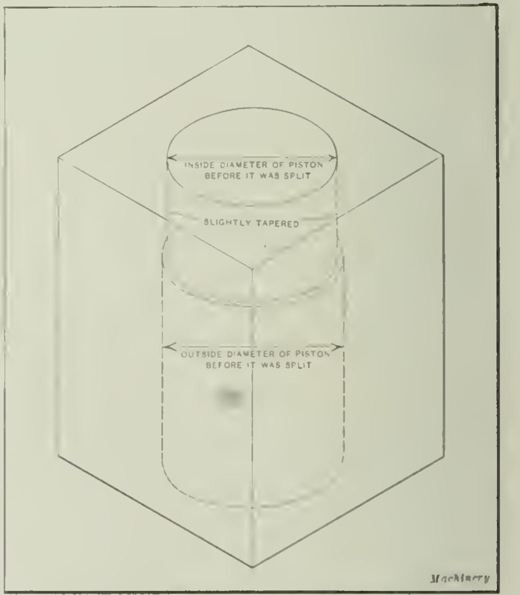
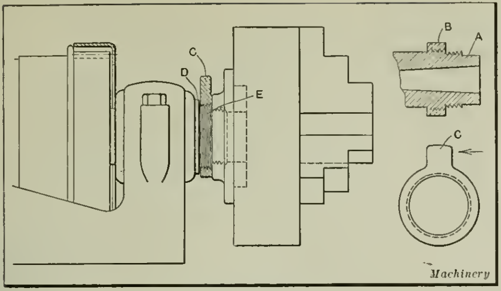

INSIDE DIAMETER OF PISTON BEFORE IT WAS SPLIT
SLIGHTLY TAPERED
OUTSIDE DIAMETER OF PISTON BEFORE IT WAS SPLIT
Machinery

Fig. 3. Detail of Wooden Block in which Split Piston is held

Washington, D. C. ARTHUR F. ALBFAT

PREVENTING LATHE CHUCKS FROM STICKING

We experienced so much trouble with our lathe chucks sticking fast on the nose of the spindle, making it practically impossible to remove them without injury, that it became necessary to find some way of overcoming this difficulty. The trouble, of course, was largely due to ignorance or carelessness on the part of the men who put the chucks onto the



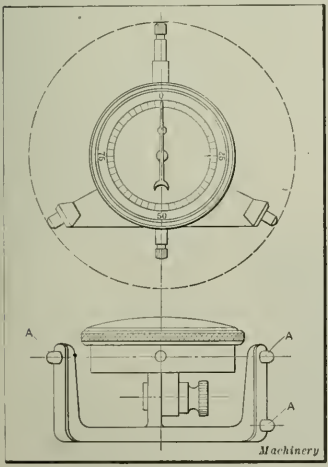
Locking Collar provided on Lathe Spindle Nose to prevent Chuck from sticking

spindle, but these men were employed on a piece-work basis and as a result were likely to grow careless about cleaning the threads on the spindle nose and in the chuck, and also about screwing the chuck up slowly against the shoulder on the spindle. It is impossible to watch everyone in the shop at the same time, and although you may have instructed them in the proper way of doing the work, they will forget such instructions when they are intent upon making a piece-work rate.

The solution of the difficulty which we finally hit upon is shown in the accompanying illustration, which will need little explanation to make it clear to any mechanic. Referring first to the partial cross-section of the spindle nose shown at *A*, the full lines show the spindle in its original condition, while the dotted lines at *B* show how the collar on the spindle was turned down and threaded to receive the collar provided with a tail *C*. The thread on this collar is made left-hand to fit the thread just cut on the spindle nose. In assembling this device, the collar is first placed on the spindle and screwed up against the shoulder *D*, after which the chuck is screwed onto the regular thread on the spindle nose in the usual way, care being taken not to screw the chuck quite up to the shoulder *E*. The collar *C* is then screwed back against the chuck to lock it in place. When it is required to remove the chuck from the spindle, it is merely necessary to screw back the collar *C* to loosen the chuck, and if difficulty is experienced in doing this the tail on the collar *C* may be hit with a lead hammer to drive it in the direction of the arrow.

G. E. P.

CYLINDER TESTING GAGE



Inexpensive and Accurate Gage for testing Accuracy of Cylinders

There are nearly as many cylinder testing gages in the gas engine factories of the country as there are factories. The writer has experimented with a considerable number, and believes that the one shown in the accompanying illustration is the cheapest and gives the most accurate results of any he has seen. The indicating mechanism of the instrument shown is simply a dial gage having a plunger with a hardened anvil, the gage being graduated to read to 0.001 inch. This is attached to a two-legged casting by means of a compression thumb-nut. In this casting are set three hardened buttons *A* arranged two on one side and one on the other, giving a three-point bearing. The bearing points are set with an included angle of about 120 degrees from the center line of the cylinder. Two opposite points and the plunger of the dial gage are set in a horizontal plane, the third point being about one-third of the cylinder diameter down one post of the casting. The dial gage is provided with a slip ring so that the pointer may be set to zero no matter what its position may be.

In using the instrument, it is pushed into the cylinder, dial first, from the head or compression end, supposing, of course, that the cylinder head is detachable. By the time the rear point engages with the cylinder bore, the front points and the dial gage anvil are approximately at the point of furthermost travel of the piston. With the aid of an electric flashlight the operator or inspector may easily watch the variations in cylinder diameter. The instrument should be shoved through the cylinder slowly, care being taken to have all three points bearing on the cylinder bore. If it is desired to use the instrument as a micrometer, this can be done by setting the pointer at zero in a ring gage of the standard size desired. The indicator itself is not an especially expensive instrument, and ordinary tool-room care in machining the small casting and setting the hardened buttons gives an extremely accurate and comparatively inexpensive cylinder gage.

Charles City, Iowa. H. E. McCray

DRAWING PAPER CUTTER

The cutter here described was designed for cutting blueprint paper, and the cabinet in the table just behind the cutter holds two 100-yard rolls. The paper passes through two slots in the top of the table and then under the knife. The top of the table is marked off for various standard sizes of sheets, and thus the cutting of the paper is facilitated.

Bench and Cutter arranged for cutting Drawing and Blueprint Paper

The same cutter is used for cutting tracing cloth and drawing paper into sheets of standard size, the rolls of cloth and paper being hung on the wall just back of the cutter. This cutter has been in use for about twelve years and has paid for itself many times by the saving of material. Where there are a number of small sheets to be cut, the work can be facilitated by handling from three to eight large sheets at a time, depending upon the weight of the paper.

Salem, Ohio. H. W. Weisgerber

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

ON OILING TAPS WHEN TAPPING CAST IRON

H. A.—Some of the men in our shop use oil when tapping soft gray iron, and some do not; the latter say that it is of no special benefit and, in fact, claim that it is detrimental to the tap. Please advise me as to what is the best practice in regard to lubricating the tools when tapping, reaming or drilling soft gray iron.

A.—We advise the use of a few drops of machine oil on the tap at each tapping and the same on a reamer for each hole reamed, but no oil for drilling. A few drops of oil when tapping or reaming lubricate the teeth slightly without making an abrasive mixture with the cuttings. A flood of oil is detrimental either for tapping or reaming, and should never be used.

METRIC DRAWINGS

C. M. C.—I am about to make drawings for a number of machines to be built in Europe under the metric system. What is the practice in making metric drawings as regards scales, dimensions, etc?

A.—The custom when making drawings to metric measurements is to express all measurements in millimeters. The reason for not expressing the dimensions in decimeters or meters is the possibility of mistakes due to misplacing decimal points. No matter what the dimension is on a drawing showing machinery or machinery parts, the dimension is expressed in millimeters. This often means numbers of five figures but the rule is invariable. The practice as regards scales is to use full, 1/5 and 1/10 scales; if necessary, 1/20, 1/50 and 1/100 scales may be used, but ½, ¼, ⅛ and other binary division scales are not recommended.

TRUING FILES WITH ACID

J. A. J.—The slide valve of the air brake triple valve operates in a brass bushing on a flat seat about four inches long. The bearing becomes worn in service, and being in a circular cavity, it is usually trued with files. A bastard file is used first, following with a smooth mill file to finish. The files used range from ⅝ to 1 inch square, and are provided with safe edges. Occasionally a new file is found that will not file true, owing to irregularities of the teeth. I have heard that the air brake manufacturers have a process of truing their files with acid, which is kept a trade secret. The process removes the tops of the high teeth, making the cutting faces of the file flat and uniform. Can you give me any information on the method employed for truing files by the acid process?

Any reader having knowledge of a practicable method of correcting the irregularities of files so as to make them suitable for work of this sort will confer a favor by communicating with the editor.

MAKING WOVEN BED-SPRINGS

F. O.—Can you tell me how the so-called woven wire bed-springs are made?

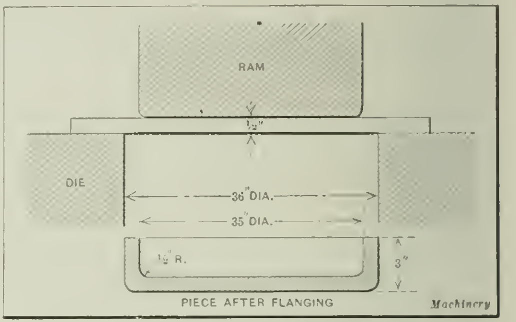
A.—The bed-springs composed of interlaced helical springs are "woven" with a small wire-coiling machine of the projection or extrusion type. The helical coil is formed by shooting the wire through a spiral die at the rate of 800 feet per minute, the wire being driven by a pair of rolls which are started by the operator but which stop driving automatically when the requisite length of coil is formed. The operator cuts off the coil with a pair of wire nippers, and then sets the coil just formed so that the next one projected will interlace with it as it is formed. The operation is a very pretty one, the coil being formed and projected so rapidly that the eye can hardly follow it as it interlaces with the coil previously made. When weaving the edges of the bed-spring, a number of coils are formed in parallel without interlacing. When doing this, the operator does not shift the position of the coil previously formed but allows the next one to run in with it and so on until the required number to form the edge have been "woven" in parallel.

POWER REQUIRED TO CUP A 36-INCH TANK HEAD

E. P. H.—What pressure is required to flange a ½-inch steel plate forming a cup 36 inches outside diameter and 3 inches deep, the interior radius at the corner being ½ inch?

Answered by Otto S. Beyer, Toledo, Ohio.

A pressure of from 1250 to 1500 tons must be exerted by the press when performing the work cold, provided the yield point of the material is within 40,000 pounds per square inch, but if the plates are heated, the work may be performed at considerably less pressure. If the plates are heated to a temperature of 1375 degrees F.—a temperature at which scale does not form—the pressure required will be only 20 per cent of the pressure required when the plate is cold, or 250 to 300 tons; it will be only 7½ to 10 per cent of that required for forming the cup cold if the plates are heated to a white heat—a temperature in the neighborhood of 2000 degrees F. A mechanical press for doing the work cold should be a twin-gear drive double-crank press with a shaft diameter of, say, 17 inches. I would estimate the weight of the press to be between 275,000 and 300,000 pounds. In this connection, would say that up to within a few years ago, tank heads of the kind and size described were generally formed by hydraulic presses, the work being done hot. In later years, however, the mechanical press with its positively controlled punch and greater production capacity and minimum maintenance cost of machine and dies has supplanted hydraulic machinery generally.



Flanged Tank Head 36 inches Diameter

* * *

TEN SAFETY COMMANDMENTS*

1. Thou shalt have no thoughts other than those of thy work.
2. Thou shalt take no unnecessary risks, nor try to show off, nor play practical jokes, for by thy carelessness thou mayest do injury which will have effect unto the third or fourth generation.
3. Thou shalt not swear nor lose thy temper when things do not come just right.
4. Thou shalt not clean machinery while it is in motion.
5. Remember that thou art not the only one on the job, and that other lives are just as important as thine own.
6. Honor thy job as thyself, that thy days may be long in employment.
7. Thou shalt not watch thy neighbor's work, but attend to thine own.
8. Thou shalt not let the sleeves of thy shirt hang loose nor leave the flaps of thine coat unbuttoned, as they may get caught in the machinery.
9. Thou shalt not throw matches or greasy waste on the floor, nor scatter oil around bearings, as a dirty worker is a clumsy worker, and a clumsy worker is a menace to his fellows.
10. Thou shalt not interfere with the switches, nor the engines, nor anything else that thou art told is dangerous.

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* From "The American Drop Forger."

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

NEW BRITAIN SIX-SPINDLE AUTOMATIC SCREW MACHINE

The single-spindle automatic screw machine was developed to secure a greater production of screws and relatively small turned parts than could be obtained with the engine lathe; and in order to increase the output of such products over that obtained from the single-spindle automatic screw machine, multiple-spindle "automatics" were designed with four and five spindles. The result was that the production of one machine was increased, as four or five operations could be done in the time formerly required for one. The New Britain Machine Co., 64 Bigelow St., New Britain, Conn., has now perfected a six-spindle machine that permits nine operations (including the cross-slide tools) to be simultaneously performed on six pieces; and it is believed that this is the first six-spindle automatic screw machine ever placed on the market. A front view of this machine is illustrated in Fig. 1; Fig. 2 shows a rear view of the same machine equipped with motor drive; and in Fig. 3 the machine is shown from the spindle end. Before going into a detailed description of the machine, an outline of its principal features may be of interest. Of course, the chief distinguishing feature is the provision of six working spindles. It is obvious that with six spindles and the cross-slides, pieces may be produced that require as many as nine operations; and long drilling or turning operations may be freely sub-divided.

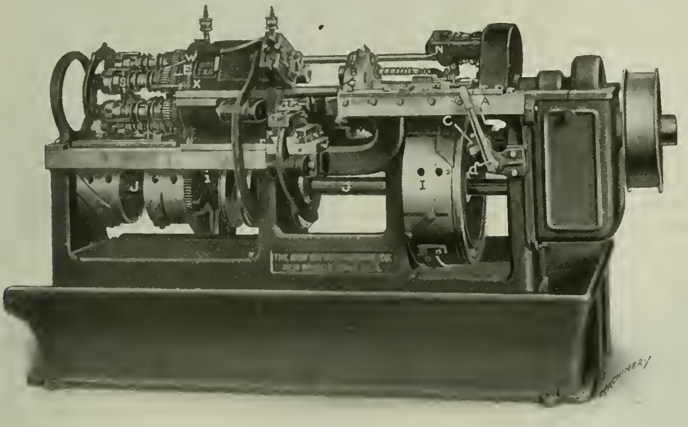


Fig. 1. Front View of New Britain Six-spindle Automatic Screw Machine

In designing this machine particular attention was paid to the development of a heavy base and frame that would be of sufficient rigidity to allow heavy cuts and coarse feeds to be taken. Another important feature is that a ball thrust bearing is fitted on each spindle, which greatly reduces the amount of power required for driving the spindles under the action of the end-working tools. It is claimed that the provision of these ball thrust bearings reduces the power required to drive the spindles fully 30 per cent. The direction of spindle rotation is counter-clockwise, thus permitting the employment of standard tools, no left-hand cutting tools being required. Irrespective of the spindle speed, the spindle carrier is indexed at a constant speed in every case. Another important feature is the method of driving the threading spindle independently of the other spindles. By means of change-gears the speed of the threading spindle can be varied to suit the particular part that is being threaded, and left-hand threads may be cut. The threading mechanism operates independently of the tool-slide, and the die is run on and off the work at the same time that the turning tools are in operation.

The Drive

Fig. 4 shows a layout of the different drives which transmit power to the main shaft, cam-shaft, indexing shaft, threading shaft, and spindles. In order that these drives may be readily understood, reference letters are used, corresponding letters denoting the same parts. The driving shaft is shown at the extreme right in Fig. 5, and this shaft runs at constant speed. In Fig. 4 the driving shaft is shown with the gear covers removed. At the left-hand end of the driving shaft there is a helical gear *A* that transmits motion to the main shaft *B* through a helical gear *C*. The main shaft passes through the tool-slide and spindle carrier, and at its extreme left-hand end carries a gear *D* whose function it is to rotate the six spindles through gears *E*. (See also Fig. 6.) The drive is carried from the main shaft to the cam-shaft through a small pinion *F* on the main shaft, that meshes with gear *G* on the feed-shaft. (See also Fig. 4.) This feed-shaft carries a pinion *H* that meshes with an internal gear on the feed-cam *I*. Rotation is carried to the cam-shaft *J* through change-gears from the end of the feed-shaft, and these gears may be changed to secure any required speed for the cam-shaft. The drive to the indexing shaft is taken direct from the drive-shaft to the index drive-shaft *K* through spur gearing. The index shaft is in two sections, the forward section being marked *L* and the rear section *M* in Fig. 5. (See also Figs. 2 and 3.) The forward half rotates continuously, but at the time of indexing a clutch connects it with the rear section *M* and the indexing is done through spur gearing and a Geneva motion that will be described later. Power is carried to the threading shaft *N* (see Figs. 2, 3 and 5) through spur gearing direct from the main shaft. At the left-hand end of the threading shaft is a spur gear that is thrown into mesh with

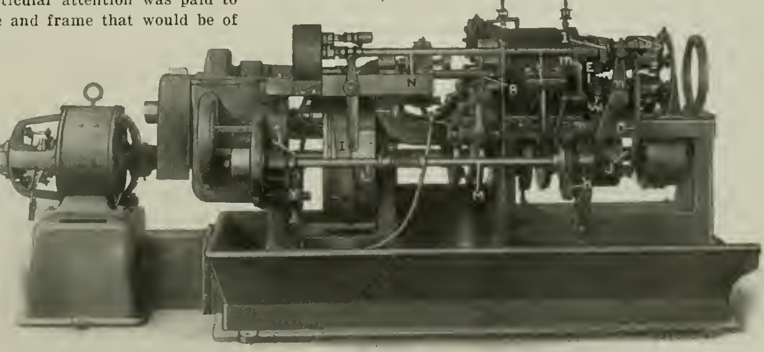


Fig. 2. Rear View of Machine equipped with Individual Electric Motor Drive

the driving gear on the threading spindle for performing the threading operation.

Spindle Construction

Fig. 7 shows a cross-section through one of the six spindles and its bearings. Referring to this illustration, one of the long taper bronze bearings in which the spindles are mounted is shown at *O*. These bearings are ground and may be adjusted for wear by drawing them into their sleeves with the threaded nuts *P*. All the spindle thrust is taken upon the ball thrust bearings *Q* that are set into the frame of the spindle carrier, and receive the thrust of the rotating spindles. The collet chucks, one of which is shown at *R*, are closed on the "push-in" principle, being forced into sleeves on the noses of the spindles. The usual mechanism for closing the chucks is present in the form of fingers *S* that are oscillated and throw the chucks forward into the sleeves. These fingers are operated by clutches; and the manner of operation will be described later. The stock tubes *T* are also of the usual type, and the work is seized by the spring jaws on the chuck-end of the stock tubes. The stock tubes are advanced by the cam mechanism, which will also be described later, this mechanism acting through the sleeve that may be seen on the extreme left-hand end of the stock tube.

The spindles themselves are of liberal diameter and are hammer-forged from chrome-nickel steel, after which they are heat-treated and ground. Lubricant is carried to the spindle bearings through ports *l* in the spindle carrier; these ports carry sight-feed oil reservoirs, as shown in Figs. 1 and 2, and oil is conveyed down into the spindle bearings at each indexing. The spindle carrier has its bearings in the housing at *V*, the bearings being of cast iron. The main shaft of the machine is indicated at *B*, and transmits power to the spindles through helical gear *D* that meshes with gears *E* on the spindles. (See Fig. 5.) The spur gears *W* are for the purpose of driving the spindles when in operation for threading, the gear *W* being slidably keyed to the spindles. At all times except when the spindles are in the threading position, these gears *W* are kept thrust into a taper seat in the gears *E*, and the spindles are driven by the gear *D*. This friction is maintained by fingers *X* that are operated by clutches and yokes. At the time of threading, the clutches are cam-operated so as to release fingers *X*, and the friction drive between gears *W* and *E* is broken; thus at this time the spindles are not driven by the driving gear *D*, as gears *E* slip freely under its action, because its connection with gear *W* is broken. For threading, therefore, it is evident that gears *W*, operated by a special driving mechanism to be described later, are responsible for the rotation of the spindles. While the main shaft *B* passes through bronze bushings in the spindle carrier, none of the weight of the spindle carrier comes upon it, this weight being all taken on the spindle carrier bearings at *V*. Six speeds are available for the spindles, and these are effected by change-gears that may be placed upon the right-hand ends of the feed-shaft and cam-shaft, as illustrated in Fig. 5.

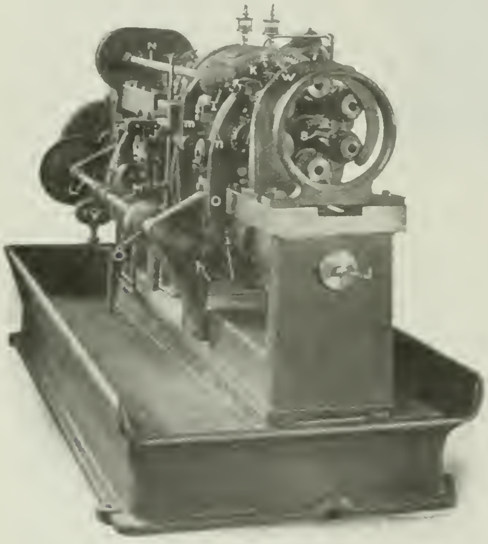


Fig. 3. View of Machine from Spindle End

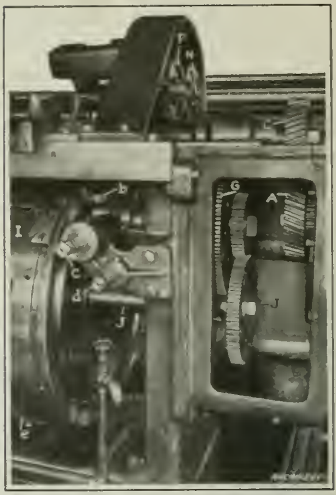


Fig. 4. View of End of Driving Shaft with Gear Guards removed

The Tool-slide

Fig. 8 shows the operation of the tool-slide to best advantage. Here also may be seen the arrangement of the six spindles, and, of course, there are six corresponding tool holding positions on the tool-slide, which is illustrated at *a*. Attention is called to the fact that the tool-slide is supported in extremely long bearings and that these bearings support the slide centrally from both sides so that there is no cramping action in its movement. While the main shaft *B* passes through a bronze bushing in the tool-slide, it receives none of the weight of the slide. There is no overhanging of the tool-slide in its bearings at any time during its movement. Fig. 4 gives the best idea of the operation of the tool-slide which, of course, is through the cam-drum *I*. Upon this drum are placed the cams that govern the operation of the slide and they act through a stud on the lower part of the tool-slide that is not visible in the illustration. The cam-drum is kept free from back-lash by a hardened steel roll *b* supported from the frame, that runs against the right-hand edge of the drum.

As previously mentioned, the cam-drum is driven by an internal gear and pinion shown at *H* in Fig. 5; and within the cam-drum in Fig. 4 may be seen the internal teeth with which the pinion meshes. This requires less power than would be the case if the power were transmitted to the cam-shaft direct, and the gear tooth action is better. A stud *c* carries a bevel pinion that meshes with a corresponding bevel gear on the feed-shaft which carries the small pinion *H*; and thus

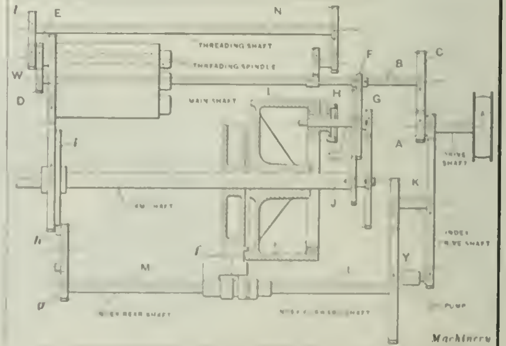


Fig. 5. Arrangement of Drive on New Britain Six-spindle Automatic Screw Machine

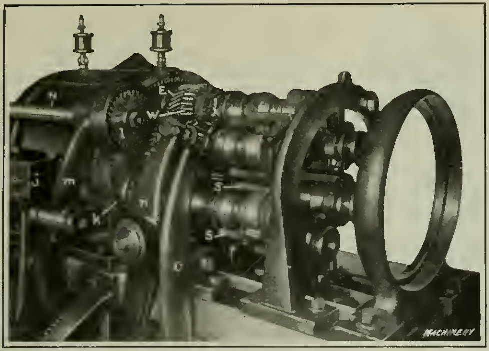


Fig. 6. View of Spindle Driving Gears

means are present for turning the cam-drum by hand when setting up the machine. A hand lever on stud *d* operates a clutch for disengaging the cam-shaft at any desired time, thus stopping the action of the tools. This clutch may also be thrown out from the rear of the machine. Attention is called to the fact that a laminated cam is made use of on the feed drum. This is a patented cam construction, in which the cam strip is composed of three leaves, which permits of the adjusting of one cam to any length of work within the capacity of the machine. An edge view of one of these laminated cams may be seen at *e* in Fig. 4. In order to save the laminated cam the shock of commencing its work, a solid block is placed on the drum ahead of it to take the shock of starting.

The Indexing Mechanism

The indexing of this machine is done at constant speed, irrespective of the speed of the main shaft or cam-shaft. When the indexing of a screw machine is done from the cam-shaft, the indexing motion is performed in a definite ratio to that of the other movements emanating from the cam-shaft. In the case of a very short job of turning, requiring say about ten seconds, the movements of the machine take place rapidly and the indexing is done at a correspondingly high speed. If, on the other hand, the job is a slow and difficult one, the indexing is also done very slowly in proportion. The indexing of the New Britain six-spindle machine takes place at a constant speed without regard to the length of the job on the machine. Referring to Fig. 5, it will be seen that there is no connection with the cam-shaft for indexing. By looking at this illustration in connection with Fig. 2, the method of indexing may be readily followed. As has been explained, the index shaft is in two sections—the forward section *L* that revolves continuously, and the rear section *M* that revolves only at the time of indexing. A clutch connects the two sections of the indexing shaft; and at each revolution of the cam-drum this clutch is tripped by the small edge cam *f*, Fig. 5. When the clutch is tripped, and the rear index shaft is caused to turn, gear *g* turns gear *h* through exactly one-half revolution, because gear *g* is just one-half the diameter of gear *h*.

Diametrically opposite each other on the side of gear *h* are two studs that operate the Geneva gear *i* which may be more clearly shown in the front view, Fig. 1, and also in Fig. 8. This gear is supported, but not driven, by the cam-shaft. The operation of the stud in the slot in the Geneva gear turns it exactly one-sixth of a revolution, and as this gear *i* is in mesh with the gear *k* of the spindle carrier (see Fig. 6) which is of the same diameter, the spindle carrier is also turned one-sixth of a revolution. Just previous to the indexing, a cam and cam-lever operated from the cam-shaft withdraw the locking bolt shown at *j* in Fig. 2. This is a wide heavy key that is normally kept in contact with the spindle carrier by spring pressure, engaging in one of the six slots equally spaced about the circumference of the spindle carrier. The cam releases the key so that when the spindle carrier has turned far enough to engage the locking bolt, it shoots into place and holds the spindle carrier until the time of next indexing. It is claimed that the Geneva motion is particularly adaptable to indexing mechanisms in that the starting motion is slow, gradually accelerating and then diminishing at the end of the motion.

The Cross-slide

The cross or forming slides of this machine are three in number, operating on the second, third, and sixth spindles. Provision has also been made for adding a cross-slide to the fourth spindle if the work to be performed requires it. Fig. 8 clearly illustrates the second and third spindle cross-slides, and their operation takes place by means of cam-levers operating from plate-cams on the cam-shaft. The rear cross-slide may be readily seen in Fig. 2, and is used principally for cutting off. The stock-feeding and chuck-closing operations are performed from the cam-drum at the extreme end of the cam-shaft. This operates on the clutches that feed the stock and close the chuck on the spindle in the first or lowest position, which is just above the top surface of the cam, as may be seen in Fig. 2.

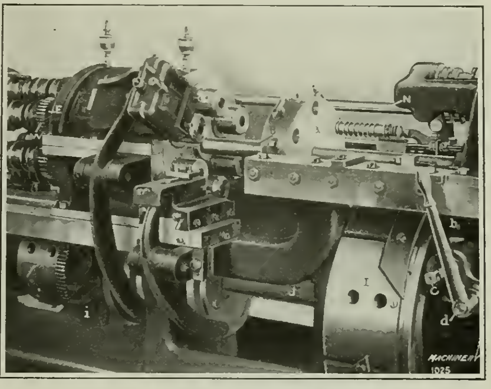


Fig. 8. Illustration of how Tool-slide operates

The Threading Spindle

The method of performing threading operations on this screw machine is somewhat different from the practice with

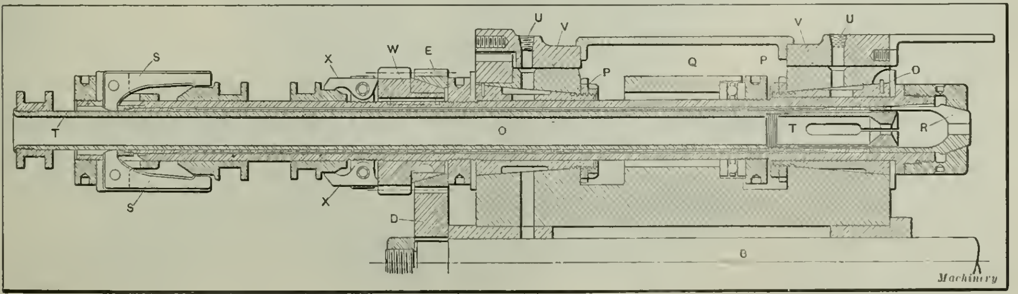


Fig. 7. Cross-sectional View of One of the Six Spindles of New Britain Automatic Screw Machine

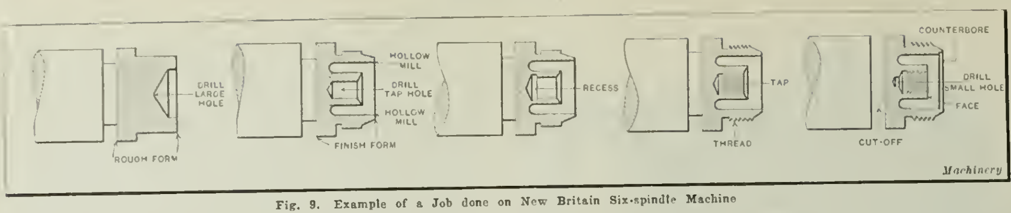


Fig. 9. Example of a Job done on New Britain Six-spindle Machine

other types of machines. Figs. 2, 3 and 5 illustrate this part of the machine to advantage. The threading shaft is shown at *N* and rotation is carried to it as has been explained in connection with Fig. 5. This shaft is mounted at the left-hand end, as viewed in Fig. 2, in a floating bearing that permits the entire shaft to be oscillated, thus allowing the gear *l* on the opposite end to be thrown into or out of mesh with the spindle gear *W* when actuated by lever *m* that is guided by a cam on the cam-shaft. The operation of this threading shaft is as follows: Just before the spindle carrier is indexed, the threading shaft and its gear are thrown away from the spindle to give the spindle carrier a clear path for indexing. As soon as the locking bolt has shot into place, a rise on the cam that governs lever *m* carries this lever back into its inner position with the gear in mesh with the gear *W* on the spindle at the threading position.

Simultaneously with this action lever *n* is operated by the cam on the cam-shaft and operates the spindle clutch that releases the spindle driving gear *E* from contact with the gear *W* that is now in mesh with the gear *l* on the threading spindle. By this means the spindle is operated at the correct threading speed. Before the indexing takes place, the threading shaft is again swung away and gear *l* is thrown out of mesh with the spindle gear. In addition to lever *n* as shown in Figs. 2 and 7, a brake lever *O* is operated from the cam-shaft. The upper end of this lever is fitted with a fiber plug and its function is to bear against the spindle and retard rotation just before the threading shaft gear *l* goes into mesh with the spindle gear. On the left-hand end of the threading spindle is a reversing shaft by means of which a left-hand rotation may be given the shaft when left-hand threads are to be cut. These reversing gears may be seen at *p* in Fig. 4, but are omitted in Fig. 5. Fig. 8 shows the threading die or tap-holder held on the tool-slide. This is fitted with a pusher-arm that presses against the rear of the holder to engage the threading die or tap on the work, after which it "leads" itself on. Spring fingers prevent the threading die holder from turning when in action.

Lubrication for the cutting tools is supplied through an oil pump that is direct-connected from the index drive-shaft. This may be seen at *Y* in Fig. 2, and the cutting lubricant is carried through piping to the center of the tool-slide. From this point internal passages in the tool-slide carry the lubricant to the six cutting points, thus obviating much visible piping. By referring to Fig. 3, which clearly shows the shape of the frame and base of the machine, it will be seen that the problems of chip clearance and oil drainage are well taken care of. Beneath the operating stations, the bed is cut away at an angle of 45 degrees to conduct the lubricant and chips to the base. The base is inclined to drain the oil down to the rear end of the machine, from which point it is pumped out and up to the lubricating point.

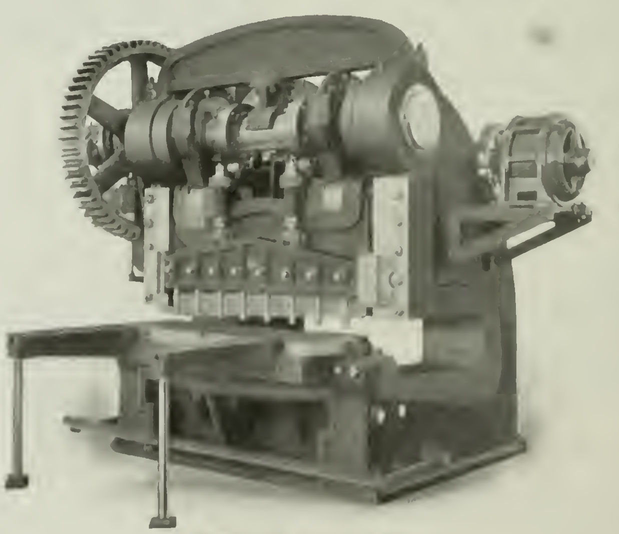
This machine may be furnished with either belt or motor drive, and is built in four sizes, namely, ⅝ inch by 3¾ inches, weighing 4000 pounds; 1 inch by 5 inches, weighing 5600 pounds; 1⅝ inch by 7 inches, weighing 10,200 pounds; and 2½ inches by 9½ inches, weighing 16,000 pounds. Fig. 9 shows the sequence of operations in making a screw machine product, and clearly indicates the advantages of the machine. This part would be difficult to produce on a machine having less than six spindles. The first operation of feeding the stock at the first spindle position is not shown. At the second position the piece is rough-formed and the large hole drilled. At the third position the piece is finish-formed, hollow-milled and the tap hole is drilled. At the fourth position, the tap hole is recessed. At the fifth position the outside diameter is threaded and the hole tapped. Then at the sixth and last position, the small hole is drilled, the end faced and the piece cut off complete.

BERTSCH GATE SHEAR

A recent product of Bertsch & Co., Cambridge City, Ind., consists of the heavy gate shear which is illustrated and described herewith. This machine has 72-inch blades and capacity for cutting 1¼-inch plates the full width of the machine. In order to stand up under this severe service the construction is made exceptionally heavy. The housings are supported by a cross-tie at the rear of the gate and another cross-tie overhead. The press is equipped with a toggle-joint automatic clutch, the action of which is positive and noiseless. The toggle-joint principle increases the engaging pressure, thereby insuring a full contact of the jaws. The clutch is disengaged by means of a hardened steel roller which runs on a renewable cast steel switch ring or sleeve.

DIAMOND SHEAR GRINDING MACHINE

The Diamond Machine Co., Providence, R. I., has recently completed two of what are believed to be the heaviest shear-blade grinding machines that have ever been built. These machines weigh about 10 tons each; the length of the beds is 24 feet, the operating space 47½ feet, and the capacity for grinding shear blades up to 180 inches in length. The knife bar is designed with bearings at intervals of 2½ feet, which rest on babbitted supports, the thrust of the grinding wheel being adequately supported in this way. The bar is adjusted to the required angle by means of a worm which is operated by a hand-wheel; and by removing the knife bar, the



Bertsch 72-inch Heavy Gate Shear

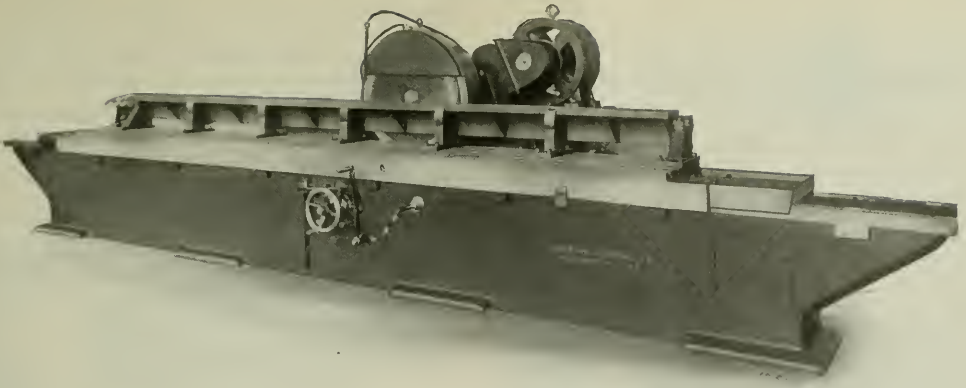


Fig. 1. Diamond Shear-blade Grinding Machine, said to be the Largest Grinder of its Kind ever built

machine is made applicable for face grinding through a vertical limit of 24 inches and a horizontal limit of 180 inches. In this way the machine may be used for face grinding operations when there is no knife grinding to be done.

The machine is similar to the heavy face grinding machine built by the Diamond Machine Co. The patented rear control is employed, by means of which the operator is enabled to handle all levers from the rear, which is the position from which he can most advantageously watch the progress of the grinding operation. Front control is also provided for use in setting up. The table is shifted by a system where the dogs merely remove a stop, thus allowing the shifting mechanism to come into play. This method insures positive and quiet operation. The spindle is of large diameter and carried in long phosphor-bronze ring-oiling bearings. The machine is self-contained, being driven from a single motor connected by gears or a chain drive. A vertical spindle pump with all bearings above the water level, as shown in the illustration Fig. 3, provides the required amount of water, and the guards are designed to effectively prevent water being thrown onto the floor, the water being returned to the settling tank.

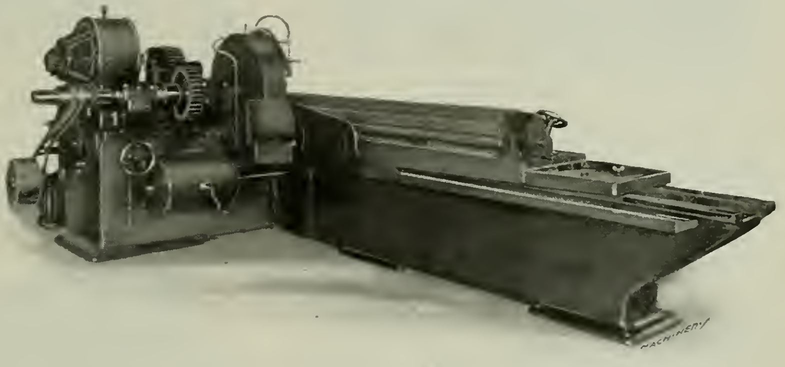


Fig. 2. End View of Diamond Shear-blade Grinding Machine, showing Arrangement of Drive and Rear Operating Mechanism

WOODS BORING AND GRINDING ATTACHMENT

For use in garages and machine shops which handle automobile repair work, the Woods Engineering Co., Alliance, Ohio, has developed a boring and grinding attachment for use on the milling machine or lathe. This attachment is intended for use in reboring and grinding scored or worn automobile cylinders and other work of a similar character. The attachment without the countershaft is shown in Fig. 1, and Fig. 2 shows it set up on a No. 3 Kempsmith milling machine. The range of the attachment is for grinding holes from 2½ inches in diameter up, and 11 inches in depth. It is provided with a 2-inch eccentric micrometer adjustment, and a 2⅜-inch and a 3½-inch wheel will grind all holes with diameters from 2½ inches up to 5¼ inches; larger diameters require correspondingly larger grinding wheels.

The spindle of the attachment is mounted in double-row S. K. F. annular ball bearings which are provided with means for excluding grit and retaining the lubricant in the bearing. The driving shaft also runs in ball bearings. Where it is feasible to do so, the countershaft is mounted on

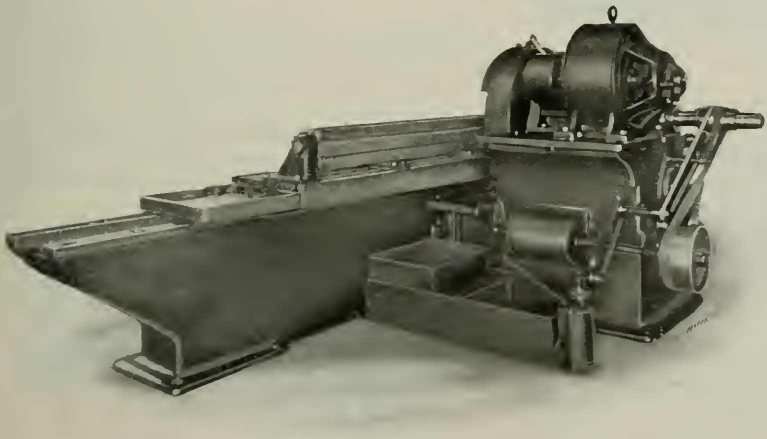


Fig. 3. Rear View of Diamond Grinder showing Arrangement of Settling Tank and Pump

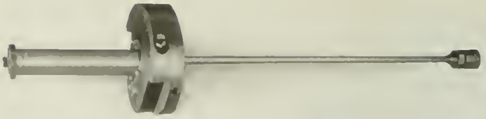


Fig. 1. Woods Boring and Grinding Attachment without Countershaft

the over-arm of the milling machine as shown in Fig. 2; and when mounted in this way the countershaft is provided with adjustment for maintaining the required belt tension. The entire attachment can be set up or removed in a very short time. When used on a lathe the countershaft is mounted overhead and the angle plates on which the cylinder is held are carried on a sliding base fastened to the lathe carriage. A vertical and longitudinal movement are provided to facilitate setting.

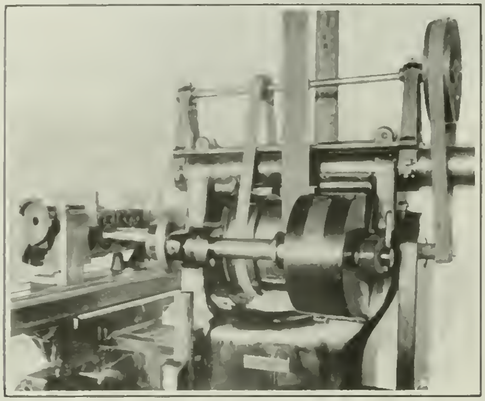


Fig. 2. Woods Boring and Grinding Attachment set up on No. 3 Kempsmith Miller

When a cylinder is so badly scored that it is necessary to bore it before grinding, a boring head is provided for use on the attachment in place of the emery wheel. The change from the boring head to the grinding wheel or *vice versa* requires very little time.

GREENFIELD INTERNAL GUIDE FOR PIPE THREADING TOOLS

Fig. 1 shows an internal guide for pipe-threading tools which has been developed by the Greenfield Tap & Die Corporation, Greenfield, Mass., for guiding the die to insure obtaining a straight thread; and Fig. 2 shows the trio pipe-threading die-stock of this company's manufacture equipped with the new guides. In addition to serving as a guide, it will be seen that a reamer point is provided which removes the burrs from the inside of the pipe as the guide enters, thus performing two operations simultaneously. The same form of guide is fitted to the duo pipe-threading die-stocks, the pipe threading sets for ceiling work, the ratchet pipe-threading die-stock and the die-stocks for threading thin metal tubing which are manufactured by the Greenfield Tap & Die Corporation.

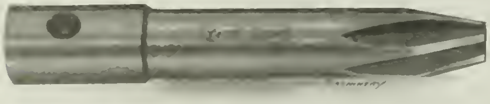


Fig. 1. "Little Giant" Internal Guide for Pipe Threading Tools

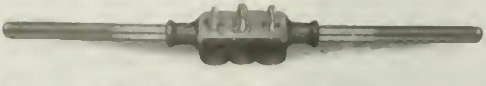
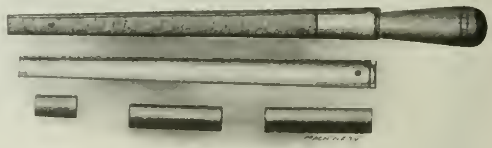


Fig. 2. Greenfield "Trio" Pipe Stock equipped with "Little Giant" Guides

STEPHAN EMERY WHEEL DRESSER

The C. H. Stephan Mfg. Co., 10-11 Mitchell Bldg., Springfield, Ohio, has recently placed an emery wheel dresser on the market in which the abrasive is furnished in the form of a stick. This stick fits into a tube which is made in two halves and held tightly in place by three tapered sleeves. The arrangement will be readily understood by referring to the accompanying illustration which shows the dresser with the three tapered sleeves and one-half of the tube removed. As the abrasive stick wears down, the tapered sleeves may be removed so that only the stick and the tube are used up. The possibility of using the same handle and sleeves over and over is the means of effecting an economy in the cost of dressers.

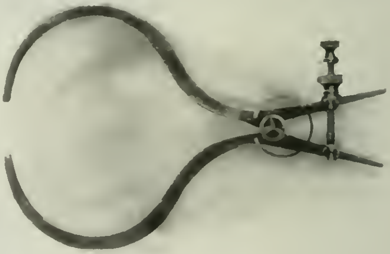


Parts of Stephan Emery Wheel Dresser

It will be seen that the handle has a small groove turned about 1 inch from the small end, and each half of the tube is made with a bead which drops into this groove in the handle. The tubes are stamped out under a punch press so that they are quite inexpensive. The abrasive stick is composed of a cutting material practically as hard as black diamond which is carried by a bond that is fused to enable the stick to be molded into the tapered form shown in the illustration.

PITTSBURG LOCK-JOINT CALIPER

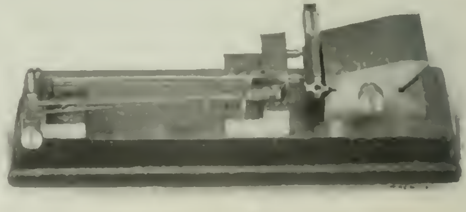
The lock-joint caliper shown in the accompanying illustration is a recent product of the Pittsburg Instrument Co., 236 Third Ave., Pittsburg, Pa. This tool is adapted for general use, but is particularly intended for calipering the inside of chambered cavities, reaching over flanges and for making other measurements of a similar character, as the locking device enables the caliper to be removed from such work after which the measurement can be taken in the usual way. Further description is unnecessary to make the use of the tool perfectly clear to any mechanic.



Pittsburg Lock-joint Caliper

REMINGTON SCREW LEAD INDICATOR

Considerable interest has recently been taken in the establishment of standard screw thread tolerances, and investiga-



Remington Indicator for testing Threaded Parts tions which have been conducted have shown that the pitch or lead of the thread is a most important factor in securing interchangeability of threaded parts. For the purpose of testing the lead of a screw or tap, the Remington Tool & Machine Co., Woburn, Boston, Mass., has developed a screw lead indicator which is shown in the accompanying illustration. The design of this instrument will be readily understood from the illustration. In this connection, it is important to know that the hardened 60-degree points are spaced either ½ or 1 inch apart and that the screw-holding block is milled to receive work of various diameters. Standard plugs are provided with the indicator for use in making accurate settings.

WEST HAVEN UNIVERSAL HACKSAW FRAMES

The Nos. 11 and 14 universal hacksaw frames which constitute recent additions to the line of the West Haven Mfg. Co., New Haven, Conn., are illustrated in Figs. 1 and 2. Fig. 1 shows the No. 11 frame with automatic grip extension, which is particularly intended for use out of doors or in any place where the tool will not receive the best of care. The "easy grip" handle is hollow so that excessive weight is avoided and the entire frame is sherardized so that it will not rust. This frame takes blades from 8 to 12 inches in length and is made of crucible steel.

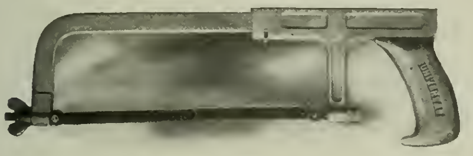


Fig. 1. No. 11 West Haven Hacksaw Frame

The No. 14 frame shown in Fig. 2 is also provided with the "easy grip" handle. It will be seen that this frame is quite similar to the No. 11 style except that it is nickel plated and provided with a new housing for the back which gives the frame uniform rigidity when using all sizes of blades from 8 to 12 inches. The housing is extended 2¼ inches from the post, thus providing a "solid-back" adjustable frame.

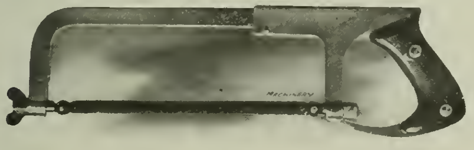
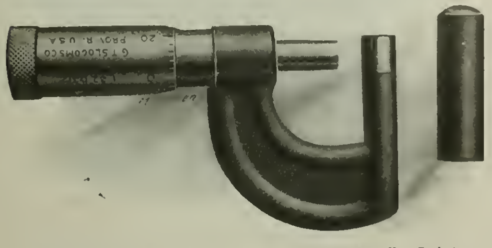


Fig. 2. No. 14 West Haven Hacksaw Frame

SLOCOMB BULLET-JACKET MICROMETER

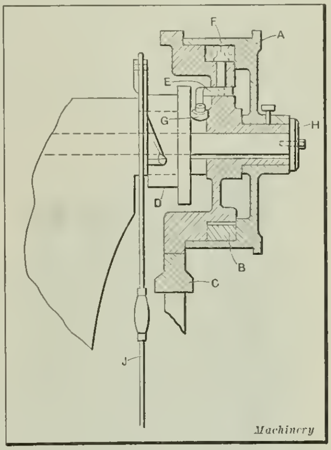
The accompanying illustration shows a special micrometer developed by the J. T. Slocomb Co., Providence, R. I., for the purpose of measuring the walls of bullet jackets. This tool is made from the regular Slocomb ½-inch micrometer, the lower end of the frame of which has been cut off and the small plug welded in place as shown in the illustration. The hole in the bullet jackets to be measured is 0.275 inch in diameter, and in using the micrometer the jacket is slipped over the plug and the thickness measured in the usual way. Measurements may be made to a depth of ⅝ inch. In this connection it should be noted that while the micrometer was made for a special purpose, it is also available for making general classes of measurements.


Slocomb Micrometer designed for Use in measuring Bullet Jackets

BEAUDRY FRICTION CLUTCH

In connection with the application of electric motor drive to the power hammers which they manufacture, Beaudry & Co., Inc., 141 Milk St., Boston, Mass., have developed the friction clutch which is illustrated and described herewith. The essential parts of this clutch consist of the pulley *A*, friction ring *B*, brake *C*, cam *D*, lever *E*, expansion pin *F*, roller *G* and washer *H* which holds the pulley in place.

The friction ring *B* is split to fit over the head of the expansion pin *F* and steel inserts are provided in the ring to afford protection against wear. The brake section *C* is keyed to the shaft and the pulley *A* runs loose on the hub of the brake, a grease cup being provided to lubricate the pulley bearings. The cam *D* is of spiral form, and is held in the neutral position through the action of a spring. The roller *G* is hardened and runs in a slot in the lever *E*.



Friction Clutch used on Beaudry Hammers

This clutch gives the operator perfect control of the hammer. By applying a light pressure, the pulley is allowed to slip, thus causing the hammer to deliver a light blow; and by increasing the pressure on the treadle, a heavier blow is obtained. It will be evident from the illustration that pushing down the treadle rod *J* causes the expansion pin *F* to tighten the friction ring *B* between the pulley *A* and brake *C* through the action of lever *E*, roller *G*, and cam *D*.

IMPROVED SELLEW DRILL HEAD

The multiple spindle drill heads manufactured by the Sellew Machine Tool Co., Pawtucket, R. I., which have been described in recent numbers of MACHINERY, were designed in such a way that they had to be set in a predetermined position on the quill of the drilling machine. This meant that the spindles were arranged either lengthwise or crosswise of the

Sellew Drill Head provided with Means of Adjustment around Quill

table and that the work must be put under the head to suit the position of the spindles. Recently the design of the Sellew drill heads has been modified to enable the head to be swiveled around on the quill of the drilling machine to suit the position of the work. This adjustment is accomplished by means of a clamping ring provided with a frictional taper joint and clamping lever. Only a slight turn of the lever is necessary to release the lower part of the head so that it may be swiveled around on the split sleeve at the top and then clamped in the desired position. It will, of course, be understood that the adjustment of the spindles of the head relative to each other is not in any way affected by the provision of this swivel adjustment of the head.

BUCKEYE BLUEPRINTING MACHINE

The Buckeye Engine Co., Salem, Ohio, has recently made several improvements on the vertical cylinder blueprinting machine which it manufactures. Among these improvements the following are noteworthy: An oil governor is provided to regulate the speed at which the arc lamp moves down through the cylinder, and a safety stop is provided on each machine which makes it impossible for the lamp to drop in case the cable which supports it should break. The oil governor consists of a pump which is driven by a drum around which the lamp cable is wrapped. This pump forces the oil through an orifice, the size of which may be regulated to adjust the speed at which the lamp moves.

Improved Buckeye Blueprinting Machine

An automatic cut-out is provided on all machines, making it unnecessary for the operator to give the machine his entire attention until the print is finished. By means of this cut-out, the current is automatically shut off when the lamp reaches the bottom of the cylinder. A movable crane is provided that reduces the height of each size of machine by about 7 inches, which is of advantage in rooms where the ceiling is low. Other features of the machine are the same as those of the well-known vertical cylinder type of blueprinting machine which has been built for years by the Buckeye Engine Co.

BUFFALO SLITTING SHEARS

The Buffalo Forge Co., Buffalo, N. Y., has recently added to the line of punches and shears with the main frames constructed of armor plate, a series of slitting shears with capacities for cutting plates ranging from $\frac{1}{8}$ to 2 inches in thickness. A noteworthy feature of these machines is the small amount of floor space which they occupy. This is largely due to the great strength of the armor-plate frame construction which enables the machines to be compactly designed. The illustrations show the ample amount of clearance which is provided in the frame to enable the stock to feed through smoothly and avoid distortion. The base is made of angle iron and securely riveted in place.

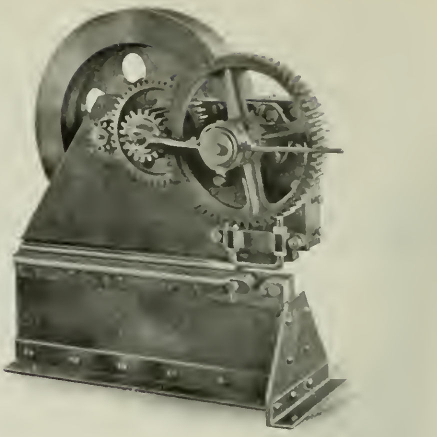


Fig. 1. No. 24 Buffalo Slitting Shear built with an Armor Plate Frame

In working out the design of these machines, particular attention has been paid to those features which provide for quiet, smooth operation. All gears have machine cut teeth, and the bearings are of ample proportions and bronze bushed. The plunger is of cast iron and accurately fitted between the frame and guide, the latter being bolted and doweled to the frame. Taper gibs are provided for taking up wear. The crank is made of cast steel and engages a tempered tool steel block. All shafts are accurately ground to size, and the flywheel shaft is lubricated by means of an oil ring, the flywheel being made large enough to enable the machine to cut stock of the maximum thickness for which it is adapted, for the full length of stroke without the flywheel slowing down more than 10 per cent.

The clutch with which these machines are regularly equipped is of the two-jawed type, and the jaws are reinforced with tempered tool steel pieces to prevent wear. The operator can run the machine continuously or make one cut and then stop in any required position. These machines are equipped with an adjustable stripper and are driven by the usual arrangement of tight and loose pulleys. The No. 24 machine will slit plates up to $\frac{1}{2}$ inch in thickness and will cut off round or square bars up to $\frac{3}{4}$ inch, flat bars $2\frac{1}{2}$ by $\frac{5}{8}$ inch, and angle irons up to 3 by $\frac{1}{4}$ inch. The floor space occupied is 3 feet 6 inches by 2 feet 6 inches, and the weight of the machine 1500 pounds. The No. 25 machine will slit plates up to $\frac{5}{8}$ inch in thickness and cut off round or square bars up to 1 inch, flats 3 by $\frac{3}{4}$ inch, and angle irons up to $3\frac{1}{2}$ by $\frac{3}{8}$ inch. The floor space occupied by the machine is 4 feet 2 inches by 3 feet, and the weight 2200 pounds.

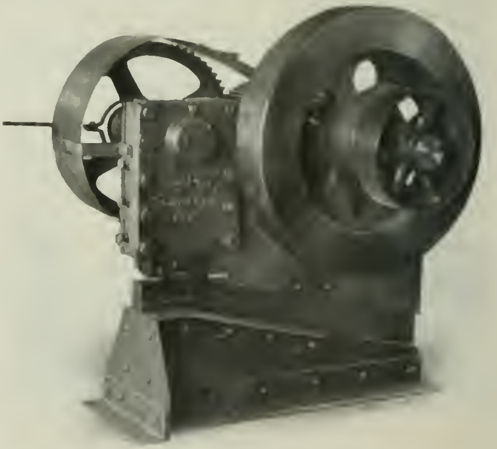


Fig. 2. No. 25 Buffalo Slitting Shear built with an Armor Plate Frame

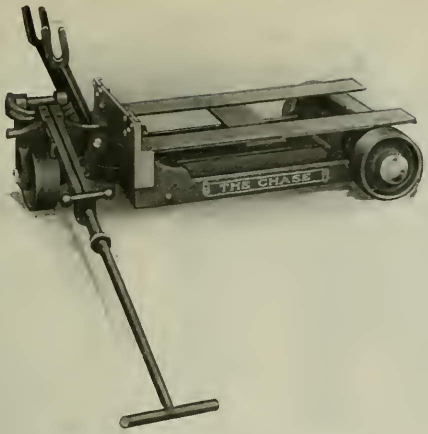


Fig. 1. Elevating Truck made by Chase Foundry & Mfg. Co.

CHASE ELEVATING TRUCK

There are many factories where material savings in the cost of production have been effected through the adoption of carefully worked out methods of passing the work along from department to department. In handling many classes of work a considerable amount of time is saved through the use of elevating trucks which are used in connection with skids or platforms upon which the work is carried. The accompanying illustrations show an elevating truck which has recently been placed on the market by the Chase Foundry & Mfg. Co., Columbus, Ohio. A feature of this truck is that the tongue may be turned at right angles to enable very short turns to be made, and this position of the tongue may be obtained just as readily when the truck is loaded as when it is empty. This is a valuable feature when handling work in busy factories where space is at a premium.

The elevating device is made of malleable iron and steel; it is of simple construction, locks automatically when raised, and releases automatically by the movement of the handle when letting the load down. The operator has full control at all times. The wheels are turned smooth on the face and are equipped with roller bearings. When it is necessary to protect the floors or when the noise made by cast-iron wheels would be objectionable, the trucks may be equipped with fiber wheels. Fig. 1 shows the truck empty and illustrates the way in which the tongue may be turned at right angles with the truck body; and Fig. 2 shows the truck in use with the regulation portable platform on which the work is loaded. For handling small or odd shaped pieces of work, portable bins may be used in place of the platform shown in Fig. 2.

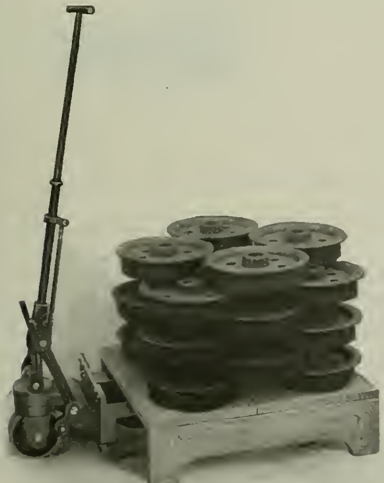
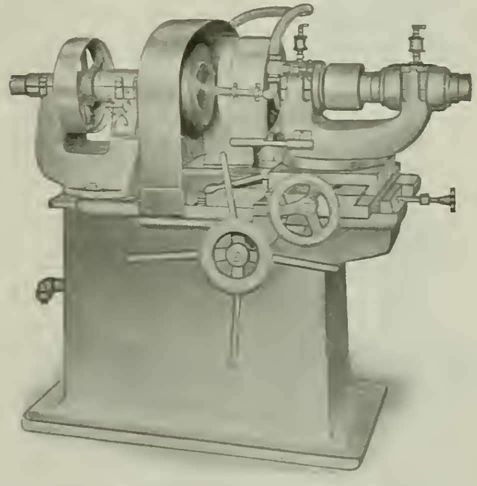


Fig. 2. Chase Elevating Truck in Use

BRIDGEPORT FACE GRINDER

The No. 28 face grinder equipped with a rotary magnetic chuck, which is shown in the accompanying illustration, is a recent product of the Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn. The work head of this machine may be swung around to any angle to provide for grinding concave or convex work, and the wheel head may also be swung around so that when using a cup-wheel only part of the cutting rim comes into contact with a piece of work which is being ground concave or convex. The work head has long self-oiling bearings and the wheel head is provided with tapered sleeve bearings which can be adjusted to compensate for wear. The wheel head is moved up to the work by means of a pilot wheel which operates a rack and pinion, and an adjustable stop is provided to prevent the wheel from being fed too far forward. Cross feed of the wheel head is provided by means of a handwheel which operates the usual form of feed-screw. The base of the machine forms a reservoir for holding water and a centrifugal pump delivers the water to the wheel.



Bridgeport No. 28 Face Grinder equipped with Rotary Magnetic Chuck

The principal dimensions of the machine are as follows: Height from floor to center of spindle, 42 inches; size of front bearing on work head, 7 inches long by 2½ inches in diameter; size of rear bearing on work head, 6 inches long by 2 inches in diameter; size of front bearing on wheel head, 4⅛ inches long by 2½ inches in diameter; size of rear bearing on wheel head, 3½ inches long by 2 inches in diameter; height from ways to center of spindle, 12 inches; diameter of magnetic chucks which can be used, 10 to 14 inches; size of cup-wheel, 9 by 5 by 1 inch; size of driving pulley on work head 12 by 3 inches; size of driving pulley on wheel head, 3½ by 5 inches; and weight of machine 2450 pounds.

BROWN & SHARPE MACHINISTS' SMALL TOOLS

The machinists' small tools shown in the accompanying illustrations are recent additions to the line of the Brown & Sharpe Mfg. Co., Providence, R. I. The "Rex" 1-inch micrometer shown in Fig. 1 was developed to meet the demand for an inexpensive precision measuring tool. The frame is a drop-forging shaped to give the maximum of strength and rigidity, without being too heavy. An improvement claimed for this caliper is the manner of placing the graduations on the hub above the measuring line for 0, 50, 100, 150, etc., and below the line for 25, 75, 125, etc. This facilitates reading the caliper. The principle will be readily understood by referring to the illustration where the graduations are clearly shown. All bearing parts and measuring surfaces are hardened and means are provided for compensating for wear of the screw and anvil. This tool is also made for metric readings from 0 to 25 millimeters.

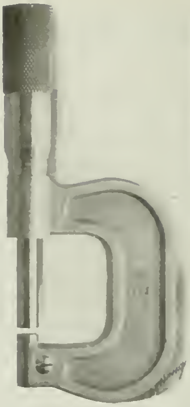


Fig. 1. "Rex" 1-inch Micrometer

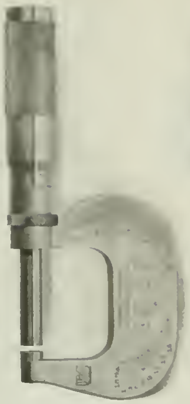


Fig. 2. B. & S. No. 12 Micrometer

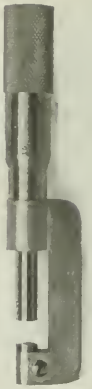


Fig. 3. B. & S. Hub Micrometer

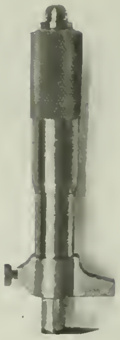


Fig. 4. Gear-tooth Depth Micrometer

The No. 12 micrometer caliper shown in Fig. 2 has the end of the frame tapered to allow it to be used in places where the ordinary type of micrometer will not enter. The thickness of the anvil is only 11/32 inch, but the frame is of a form which gives adequate stiffness to resist any tendency for the frame to spring. The graduations on the hub alternate above and below the measuring line, as in the case of the "Rex" micrometer shown in Fig. 1. A clamping nut is provided to clamp the spindle when it is desired to maintain a fixed setting. This caliper is made with a range of 0 to 1 inch and 0 to 25 millimeters.

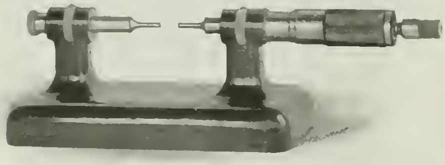


Fig. 5. B. & S. 1-inch Bench Micrometer

Another small tool which has been brought out by the Brown & Sharpe Mfg. Co. consists of the micrometer caliper shown in Fig. 3 which is used for measuring the exact length of hubs of cutters, the thickness of saws, etc. Fig. 4 shows a micrometer for measuring the depth of gear teeth which does away with the necessity of employing a large number of separate gages for this purpose. In Fig. 5 a 1-inch bench micrometer is shown, this tool being provided with a heavy base. It is intended for the use of toolmakers, jewelers, etc.

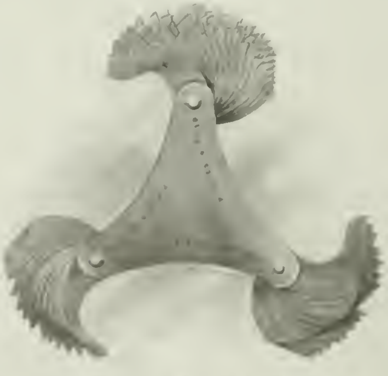


Fig. 6. V-thread Gage for 4 to 84 Threads per Inch

Fig. 6 shows an improved screw pitch gage for V-thread screws and nuts. This gage has a range of 51 pitches—from 4 to 84 threads per inch. This unusual number of pitches is made possible by the triangular form of the frame which serves as a very compact housing for the blades.

The dial test indicator shown in Fig. 7 is for the use of toolmakers, inspectors, and others who have frequent use for a tool of this nature. The base is sufficiently heavy to afford a firm support for the instrument, and four gage pins are placed at the corners of the base, which can be pushed down when it is desired to use the indicator against the side of a plate, straightedge, or in a T-slot. The dial is made to read to 0.001 inch or 0.01 millimeter and is adjustable to enable the gage to be set to read zero in any desired position. The Brown & Sharpe Mfg. Co. has also recently brought out a steel music wire gage to conform with the American Steel & Wire Co.'s new standard. This gage is of the usual round type and has a range of numbers from 000000 to 33. Decimal equivalents of the numbers are stamped on the reverse side of the gage.

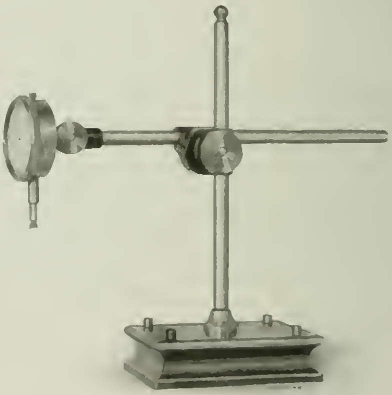
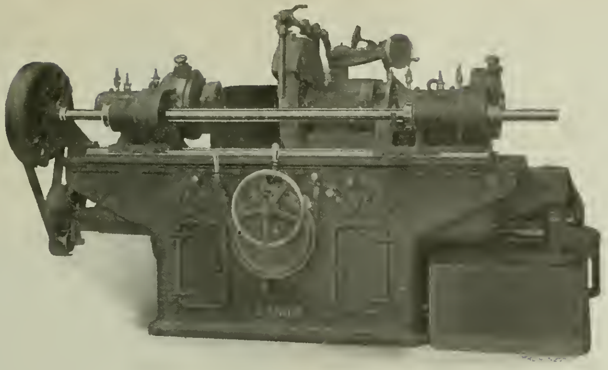


Fig. 7. B. & S. Dial Test Indicator and Stand

LANDIS CRANK GRINDER

The Landis fixed-throw crank grinder, which is illustrated and described herewith, is a recent product of the Landis Tool Co., Waynesboro, Pa. The heads of this machine are designed to provide for the rapid handling of crankshafts while grinding the pins, and in handling this work it is unnecessary to index the heads or take the crankshaft out of the machine until it is completely finished. The cranks are fixed in position by means of a locating pin which enters a hole in the flange on the crankshaft. The hole is drilled central with the pins and is ultimately used when clamping the flywheel to the crankshaft. The heads on this machine will accommodate both single- and double-throw crankshafts and are particularly adapted for shafts having a flange.

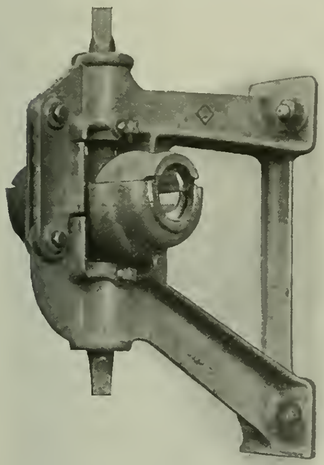
The throw of the machine can be changed by having other crankshaft carrying fixtures, such fixtures being provided for handling double-throw crankshafts up to 6 inches and single-throw crankshafts up to 8 inches. When grinding double-throw shafts it is only necessary to loosen the clamping bolts in the fixture and turn the crankshaft around to provide for grinding the other throws. The design of the heads allows the wheel to be worn down to a smaller diameter than is ordinarily possible; although it will, of course, be understood that the wheel cannot be entirely used up in grinding pins. The wheel can be worn down to a much smaller diameter in grinding the line bearings.



Landis Fixed-throw Crank Grinder

DODGE ADJUSTABLE BRACKET HANGERS

The accompanying illustration shows an adjustable ball and socket bracket hanger which has recently been placed on the market by the Dodge Mfg. Co., Mishawaka, Ind. These brackets are used in cases where it is necessary to support a lineshaft directly from the wall of a building and have it at a sufficient distance from the wall to enable the required size of pulleys to be used. The hangers are made in eight different sizes with capacities for supporting shafts ranging from 1 3/16 to 1 15/16 inch in diameter, and with extensions from the wall to the center of the shaft of 12 and 18 inches. The brackets may be equipped with either standard, capillary-oiling or ring-oiling bearings.

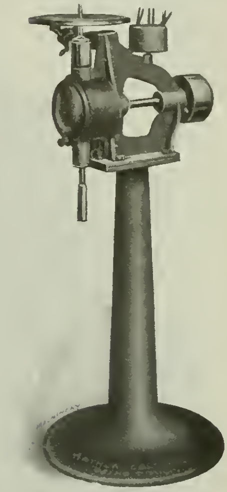


Dodge Adjustable Ball and Socket Bracket Hanger

COLTON FILING MACHINE

The Arthur Colton Co., Detroit, Mich., is now manufacturing the filing machine shown in the accompanying illustration. The file is held by a collet in the upper end of the spindle which is tightened by turning a hand nut at the lower end of the spindle. In order to change files or change the position of a file, it is merely necessary to turn the hand nut through one-half revolution, no tools being required for this purpose. All working parts of the machine are carefully protected from damage which would result through having filings or dust find their way into the mechanism.

The bearings are bushed and made interchangeable so that they may be readily renewed. The spindle is hardened and ground, and the reciprocating parts are counterbalanced to insure smooth running of the machine. The usual form of tilting table provides for filing the clearance in dies or other beveled work and the table is equipped with a removable disk to allow larger sized files to be used. The principal dimensions of the machine are as follows: diameter of table, 9½ inches; stroke of machine, 1½ inch; height to top of table, 43 inches; floor space occupied, 18 by 20 inches; and net weight of machine and countershaft, 135 pounds.



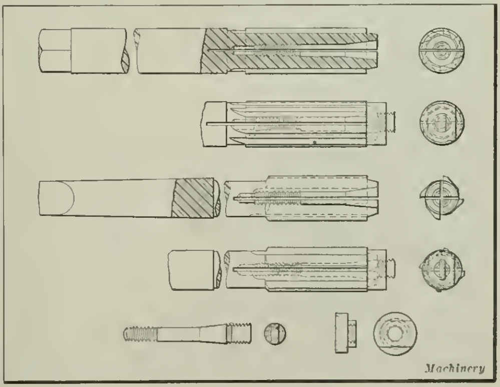
Colton Filing Machine

HJORTH ADJUSTABLE REAMERS

The Hjorth Lathe & Tool Co., 101 Tremont St., Boston, Mass., is now manufacturing a line of adjustable hand and machine reamers. These tools are made with Morse taper shanks or with straight shanks. The adjustment is readily made by turning a single stud with a tapered shoulder which expands the reamer blades. When the adjustment has been made, the stud is secured in place by a lock-nut. The expansion comes at the front end of the reamer, giving clearance for the full length of the fluted body which prevents the reamer from binding. Reference to the illustration will show that the reamer consists of three essential parts, *i. e.*, the body, adjusting stud and lock-nut. The adjusting stud and lock-nut are milled on the sides so that all adjustments may be made with an ordinary wrench. These reamers are made in forty-nine different sizes ranging from ¼ to 2 inches in diameter.

GOULD & EBERHARDT TURRET-TYPE RING GEAR ROUGHING MACHINE

Among the many interesting special machines at work in the plant of the Ford Motor Co. is the turret-type bevel ring gear roughing machine shown in Fig. 1, which is built by Gould & Eberhardt, Newark, N. J. Reference to the ac-



Hjorth Adjustable Reamers with Straight and Taper Shanks companying illustrations will show that this machine contains many interesting features in design and construction. One of the chief points of interest is the octagon turret to which twenty-four bevel ring gears are clamped. This turret rotates continuously, and is provided with a gear mechanism for changing the speed of rotation. The turret rotates slowly while the cutters are at work on the ring gear blanks, and about seven times as fast between cutting positions, or when passing from one side of the ring gear to the other. Reference to the diagram, Fig. 2, will show that the cutter passes straight across the front of the ring gear, and consequently cuts a groove first in one side of the blank and as the turret rotates further around cuts a groove in the opposite side, this method of cutting continuing on all of the gears that are clamped to the turret. Once during each complete rotation of the octagon turret, the gear blanks are all indexed one tooth. It will also be noted that two teeth are cut in each gear at one pass of the cutters, or in other words, 48 teeth are roughed out at each complete turret rotation.

The cutter spindle carries three cutters corresponding to the three rows of gear blanks fastened to the face of the turret. It is therefore obvious that the cutters are working on three gears at the same time. The cutter spindle, as well as the turret rotating mechanism, is driven from a single pulley, a change gear mechanism being interposed to get the correct speed for the cutter spindle and the rotation of the turret. The indexing mechanism for the individual dividing heads of work-holding plates also receives power from the same source.

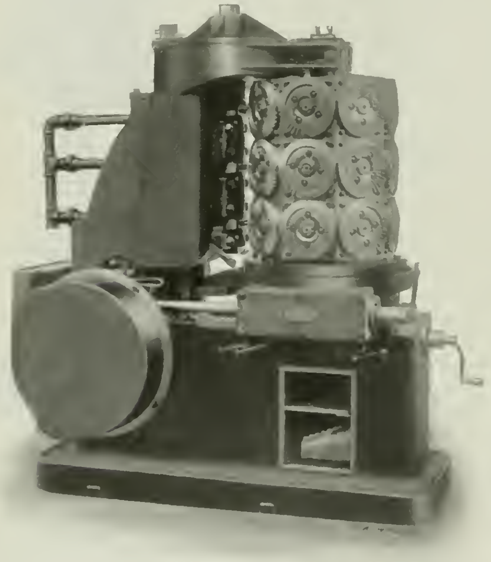


Fig. 1. Gould & Eberhardt Special Turret-type Bevel Gear Roughing Machine for roughing out Automobile Bevel Ring Gears

The method of operating this machine is as follows: The operator first places one gear blank in position, clamping it by a single nut and plate washer. The machine is then started and one of the cutters starts to work on this first gear. Another gear is then placed on the turret while it is working, and this is continued until the turret is completely loaded. About the time that the turret is completely loaded, one gear is, as a rule, completely cut and ready to be removed. This is then replaced by an uncut blank and the process of loading and unloading continues. By following this method of operating this machine, it is not necessary to stop it at all to load and unload, and the machine is cutting practically all the time. Of course, when the machine first starts up it is not working on three gear blanks, but when the turret has been filled up, no cutter is idle. Fig. 3 shows very clearly just how this sequence of cutting progresses. At *A* it will be seen that two teeth in the gear blank have been completed; at *B* six; at *C* ten; at *D* twelve; and at *E* fourteen; whereas, the teeth in the gear at *F* are completely roughed out and the gear is ready to be removed from the turret.

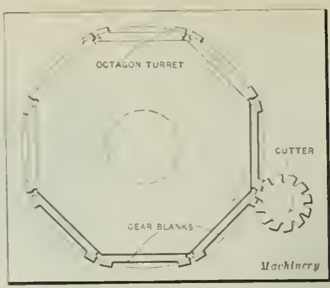


Fig. 2. Diagram showing Octagon Turret and how Ring Gears are presented to Cutter

The ring gears cut on this machine are 8 inches pitch diameter, have forty teeth, 5 pitch, 1-inch face width, and are made from vanadium steel drop-forgings. The gashing cutters are 5½ inches in diameter, and run at 140 surface feet per minute. They work on the arc of a circle and leave, approximately 0.010 inch of material to be removed from the sides of the teeth in the gear planer. When the cutters are working, the turret is rotating at a speed of from 15 to 16 inches per minute, and about 112 inches per minute when passing from one side of the gear to the other. One operator can attend to two machines and the product of each machine varies from 180 to 240 gears in eight hours, or in other words, one gear is turned out complete every 2 2/3 to 2 minutes.

FLATHER AUTOMATIC GEAR-CUTTER

The No. 2 automatic gear-cutting machine for spur and bevel gears, which is illustrated and described herewith, has recently been placed on the market by the E. J. Flather Mfg. Co., Nashua, N. H. This machine is provided with eight changes of speed and twelve changes of feed. The cutter carriage can be adjusted to any angle up to 90 degrees and graduations are provided which indicate the angle of eleva-

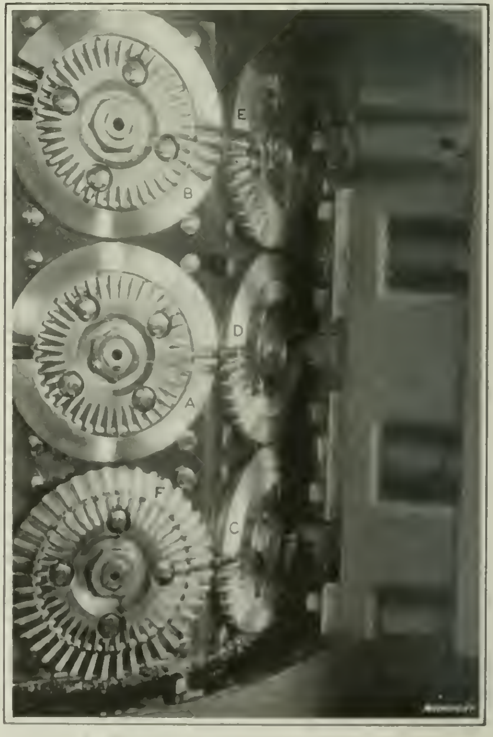
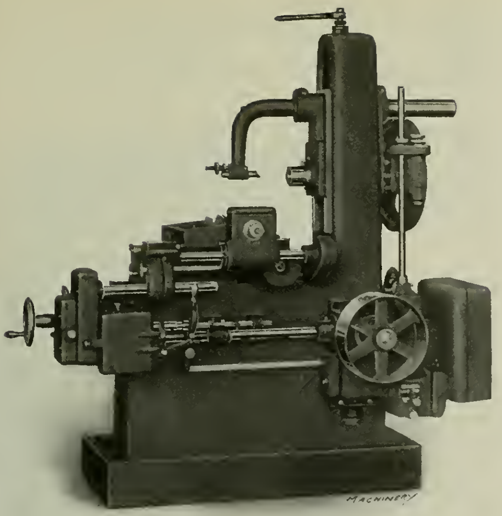


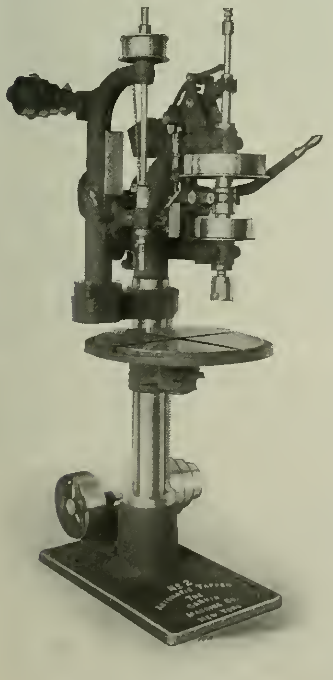
Fig. 3. Close View of Octagon Turret showing Progressive Cutting of Teeth on Ring Gears as Turret rotates



Flather No. 2 Automatic Gear-cutting Machine

tion. Sidewise adjustment is provided for the cutter to permit of cutting bevel gears. The cutter is returned at a rapid and constant speed which is independent of the speed or feed at which it is working. The elevating screw is mounted on ball bearings and operated by a handwheel which is provided with a dial graduated to 0.001 inch.

The index mechanism operates at constant speed and index change gears are provided for cutting all numbers of teeth from 12 to 100 inclusive and from 100 to 400 with the exception of prime numbers and their multiples. The equipment consists of a cutter centering indicator, change gears, wrenches, countershaft, oil pump and fittings, and change gear tables. The principal dimensions of the machine are as follows: Capacity for cutting gears up to 24 inches in diameter by 8 inches face width, with teeth up to 5 diametral pitch; diameter of cutter arbor, ⅞ inch, hole in front end of work-spindle, No. 12 B. & S. taper; diameter of hole through spindle, 1 inch; and weight, about 2500 pounds.



Garvin Combination Drilling and Automatic Tapping Machine

DRILLING AND TAPPING MACHINE

The combination drilling and automatic tapping machine, illustrated herewith, is a recent product of the Garvin Machine Co., Spring and Varick Sts., New York City. The machine consists of the Garvin No. 2 automatic tapping machine on which the drill head is mounted and driven by an independent countershaft. The drill head has a capacity for driving drills up to ½ inch in diameter and the tapping machine will drive U. S. S. taps from ¼ to ¾ inch in size in cast iron. The action of the tapping machine is automatic after the tap has been started. It will be evident that this machine enables work to be drilled and tapped without requiring it to be moved from one machine to another; hence a reduction of machining time is effected.

NEW MACHINERY AND TOOLS NOTES

Compressed Air Meter: New Jersey Meter Co., Plainfield, N. J. A compressed air meter known as the "tool-ometer" which is suitable for measuring the amount of air used by pneumatic tools.

Welding Outfit: Searchlight Co., Chicago, Ill. An oxy-acetylene welding outfit adapted to meet the requirements of the average machine shop. The torch is provided with seven interchangeable tips.

Electric Hoist: Link-Belt Co., Chicago, Ill. This hoist was designed for use in places where there is very little head room, permitting it to be used in locations where only a hand-chain block can be employed.

Punch Press Air Compressor: Benjamin Electric Mfg. Co., Chicago, Ill. A small air compressor for use on punch presses where compressed air is employed to eject the work from the dies or blow away dust and scale.

Portable Hydraulic Forcing Press: Metalwood Mfg. Co., Detroit, Mich. A portable hydraulic press which has a capacity of 8000 pounds pressure per square inch. The press is made in various sizes with capacities from 60 to 400 tons.

Milling Attachment: Hoenig's Machine Works, East Liverpool, Ohio. This attachment is adapted for use on lathes swinging from 12 to 24 inches. The attachment is supported by the regular toolpost and the cutter is driven by the headstock spindle.

Curved Blade Grinding Attachment: Stockbridge Machine Co., Worcester, Mass. An attachment for use in connection with the "quick sharp" grinding machine of this company's manufacture, which adapts it for grinding tapered or curved machine knives.

Tapping Attachment: F. Wiard, Detroit, Mich. A tapping attachment adapted for operation in either a horizontal or vertical position. The chuck collet is of the floating type which prevents the breakage of taps and provides for obtaining an evenly finished thread.

Small Slotting Machine: Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa. A 5-inch stroke slotting machine especially designed for use in finishing the breech mechanism on army rifles. The machine is also adapted for a variety of tool-room work.

Forge: Monarch Engineering & Mfg. Co., Baltimore, Md. A forge for heating tool steel and drill rod, which burns oil or gas. The forge may be operated on any desired air pressure and is intended to meet the requirements of mines and smelters, in addition to its use in manufacturing plants.

Pneumatic Riveting Hammer: Hanna Engineering Works, 2059 Elston Ave., Chicago, Ill. A 100-ton pneumatic riveter which has a reach of 48 inches and a 24-inch gap. The machines are furnished with air cylinders having a piston stroke of 22 inches and a 6-inch travel of the riveting die.

Forcing Presses: Atlas Press Co., Kalamazoo, Mich. One of these is a press especially designed for use on the bench or lathe, although it can be equipped with pedestal legs. A pressure of 12 tons may be obtained. The other press has capacity of 15 tons and is mounted on the usual form of pedestal.

Transfer Trucks: George P. Clark Co., Windsor Locks, Conn. These trucks are of the type used in connection with small elevated skids or platforms upon which the work is placed. One truck has a capacity for a maximum load of 2200 pounds. The other truck has a capacity for loads ranging from 500 to 1000 pounds.

Bench Drills: Millers Falls Co., Millers Falls, Mass. Two types of bench drills. On the first, quick change of speed is obtained by shifting a knurled barrel between the gears, and the feed is obtained by hand. The second machine is similar to the first, except that the feed is obtained by raising the table with a ratchet lever.

Sensitive Drill: Cincinnati Pulley Machinery Co., Cincinnati, Ohio. A machine known as the "Avey" No. ½ drilling machine, which is made in either the bench or column type, and in combinations of from one to six spindles. Spindle speeds up to 12,000 R. P. M. are available and the machines take drills up to ⅜ inch.

Cutting-off and Centering Machine: Etna Machine Co., Toledo, Ohio. This machine was formerly made by the

Holton Co., and is now manufactured in a somewhat altered design by the Etna Machine Co. In its original form, the machine was illustrated and described in the September, 1913, number of MACHINERY.

Shrapnel Shell Painting Machine: Canadian Fairbanks Morse Co., Toronto, Ontario, Canada. A portable machine for use in applying the rust-proof paint to shrapnel shells to meet the requirements of government specifications. With this machine it is possible to apply three coats of paint to a shell in less than one minute.

Blueprinting Machine: Wickes Bros., Saginaw, Mich. A continuous electric blueprinting machine which is of simple and compact design, and easy to operate. The contact between the tracing and the paper is secured by a single continuous belt that passes around the feed rolls to the printing cylinder in which the light is located.

Time Study Watch: M. J. Silverberg, Peoples Gas Bldg., Chicago, Ill. A direct reading time study watch with a dial which shows the usual decimal divisions of a minute, and also figures which indicate the computed output per hour from single operations performed in respective intervals of time marked by corresponding graduations.

Hydraulic Bulldozer: Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. This bulldozer may be operated from either an accumulator or pump, the pressure being controlled by a double-acting poppet valve. The table is 24 by 48 inches in size; the ram is 12 inches in diameter and has a stroke of 12 inches. The capacity is 150 tons.

High-speed Hacksaw Machine: West Haven Mfg. Co., New Haven, Conn. A machine equipped with a hydraulic oil ram which performs four functions, i.e., it lifts the saw off the work on the return stroke, raises the frame to any height, lowers the frame and holds it in any required position. The machine is equipped with a double removable vise.

Hydraulic Wheel Press: Chambersburg Engineering Co., Chambersburg, Pa. This is said to be one of the largest hydraulic wheel presses which has ever been built, the claim being based not only on its weight, but on the distance between tie bars, the maximum opening, and the speed of operation. The design follows closely along established lines.

Quick-acting Wrench: Automatic Wrench Mfg. Co., Boston, Mass. A wrench provided with means for instantaneous adjustment by simply placing the object to be turned between the jaws, then pushing a thumb trigger and pressing the movable jaw up against it. With the movable jaw in position, the grip is maintained by an automatic locking clutch.

Oxy-acetylene Welding Outfit: Imperial Brass Mfg. Co., 12-14 West Harrison St., Chicago, Ill. A welding apparatus in which the oxygen passes at high velocity through a spiral groove that imparts a whirling motion to it before entering the mixing chamber. This is said to cause the oxygen to mix more thoroughly with the acetylene before the gases reach the combustion point.

Friction Clutch: Conway & Co., Cincinnati, Ohio. A friction clutch of unusually simple design which consists of three principal parts, viz., the pulley or drum, the expansion member and the cone. A wide range of adjustment is provided on this clutch and it is adapted for use on all kinds of machine tools, countershafts and special machinery. The clutch is made in all sizes up to 12 inches.

Electric Welding Machines: Agnew Electric Welder Co., Detroit, Mich. A No. 10-D and a No. 20-D spot welding machine and a No. 20-C butt welding machine have recently been placed on the market by this company. Important features of both types of machines are that the working points are water-cooled; and that the high tension wires are enclosed so that accidental contact with them is impossible.

Recording Pyrometer: Wilson-Maeulen Co., 1 E. 42nd St., New York City. A pyrometer known as the "Tapalog." The special feature of this instrument is that the carriage carrying the chart, ribbon and other parts of the recording mechanism is pivoted to drop away from the galvanometer when it is required to change the chart. This obviates the danger of damaging the galvanometer. The record is made on the under side of the chart.

Portable Electric Grinder: Hisey-Wolf Machine Co., Cincinnati, Ohio. A portable electric toolpost grinder which is made in a variety of styles and sizes for operation on both direct and alternating current. By simply loosening two screws at the commutator end of the motor, the cap can be removed to give access to the brushes, brush-holders and electrical connections. The direction of rotation can be instantly changed by reversing the two lead wires.

Vertical Spindle Surface Grinder: Blanchard Machine Co., 64 State St., Cambridge, Mass. On this machine an individual driving motor is provided and the use of a driving belt has been eliminated, the essential parts of a standard motor being incorporated in the wheel head in such a manner that they are protected from the detrimental effect of moisture or dirt. Thorough ventilation is provided. In this way, the power is applied direct to the spindle which carries the abrasive wheel, providing a very efficient drive.

Improved Features of Lathe Design: Greaves-Klusman Tool Co., Cincinnati, Ohio. On the lathes of from 16 to 30 inches swing manufactured by this company certain noteworthy improvements have been incorporated. The 20-, 22-, 24- and 30-inch lathes are equipped with either three-step cone and double back gears or with an all-geared head. The spindle nose of the 16-, 18- 20-, and of the 22-, 24-, and 30-inch sizes are made in standard sizes so that faceplates and chucks are interchangeable. The apron has the mechanism mounted in the back plate with bushings in the front plate acting merely as supports. The beds are heavily webbed to provide greater rigidity.

* * *

NEW HAVEN MEETING OF THE A. S. M. E.

The New Haven branch of the American Society of Mechanical Engineers held its regular spring meeting at the Mason Laboratory of the Sheffield Scientific School, Yale University, on Wednesday, April 21. The general subject of the meeting was "The Development of Machine Tools." The meeting was well attended and very successful. Two sessions were held, one in the afternoon and one in the evening. Three papers were read at each session.

At the afternoon meeting, at which Prof. Lester P. Breckenridge presided, the first paper, read by Prof. Joseph W. Roe of the Sheffield Scientific School, dealt with the "Early History of Machine Tools." In a brief, but comprehensive review, the history of machine tools was traced from the early English pioneers down to the New England machine tool builders in the earlier half of the past century. L. D. Burlingame's paper on "Modern Developments in Milling Machines," reviewed the history of this type of machine, as developed by the Brown & Sharpe Mfg. Co., Providence, R. I., and showed briefly its universal application. A. L. DeLeeuw, of the Singer Mfg. Co., Elizabethport, N. J., read a paper on "Milling Cutters and Cutting Tools," in which he briefly outlined the remarkable results obtained by the use of helical milling cutters and circular rotating lathe tools—the latter a radical development which is likely to have far-reaching effects when machines adapted for the use of these tools have been developed. Cutting speeds of over 650 feet per minute have been successfully obtained by this type of tool in turning steel or cast iron.

At the evening meeting, presided over by H. B. Sargent, a paper on "Modern Development in Vertical Boring and Turning Machines" was read by E. P. Bullard, Jr., of the Bullard Machine Tool Co., Bridgeport, Conn., in which the development of this type of machine, from the earliest form of a "lathe placed on end," to its present highest development in the automatic vertical turning machine, was shown. D. DeLancey, of Waterbury, Conn., read a comprehensive paper reviewing a complete series of "Special Forms of Presses for Working Sheet Metal," calling attention to the work for which the different types were best adapted, and the general features of their design. The last paper read was on "Grinding as a Manufacturing Process," by H. W. Dunbar, of the Norton Grinding Co., Worcester, Mass. Especial attention was given in this paper to form-grinding and to grinding with wide wheels.

The papers were of unusual interest in that they traced the development of the various classes of machine tools from the earliest or simplest forms to the most modern and highly developed types. All the papers were illustrated by lantern slides.

* * *

The first record of the use of cast iron dates back to 1543 when a cannon was made in England from this material. It is believed, however, that the method of casting iron was known previous to this date, because in 1595 a cannon weighing 6000 pounds was made, and it is doubtful if such progress could have been made in fifty years. The first record of cooking utensils being made from cast iron is found 160 years after the first cannon was cast, so it seems that in those days armament led in the metallurgical field as it does to a great degree at the present time.

CONTINUOUS ROD-CASTING PROCESS

CONSTRUCTION AND OPERATION OF A CASTING MACHINE DESIGNED TO SIMPLIFY THE MANUFACTURE OF RODS AND WIRE

BY EDWARD K. HAMMOND[*]

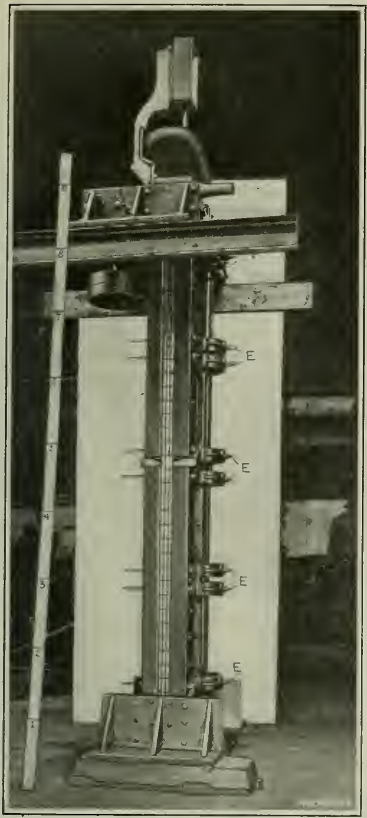


Fig. 1. Front View of Mellen Rod Casting Machine showing Idle Side of Chain of Mold Sections

IN the manufacture of rod and wire the usual practice is to cast the copper, brass, etc., into ingots which are first hammered and then rolled out into rods of a size which can be passed through the drawing dies. Perfectly satisfactory results—so far as the quality of the work produced in this way is concerned—are obtained by this method, but anyone who is familiar with the manufacture of rod and wire knows that it is an industry in which a large investment is required for equipment, and in which the labor and power cost is relatively high. With the view of reducing the investment in equipment and the cost of labor necessary to bring the metal into the form of rods that are ready for the drawing dies, the Continuous Casting Corporation, Kinney Bldg., Newark, N. J., is at present working on the development of a machine and process for the continuous casting of rods of brass, copper, aluminum, lead, zinc and soft metal alloys. This process is the invention of the company's president, Grenville Mellen. Through its use, a single operation converts the molten metal into rods that are ready to be drawn. The machine is provided with a receiver into which the molten metal is delivered from any suitable form of melting furnace. From this receiver it flows into a continuous mold formed by two sets of mold sections—each of which forms half of a continuous two-part mold—that are carried on two endless chains. The metal is carried along in this traveling mold and passed out in the form of a solid rod which can be carried on directly to the drawing dies. The mold sections run over sprockets and are returned to the starting point where the molten metal is being delivered into the mold. As long as the machine is kept running and supplied with molten metal a continuous rod will be produced.

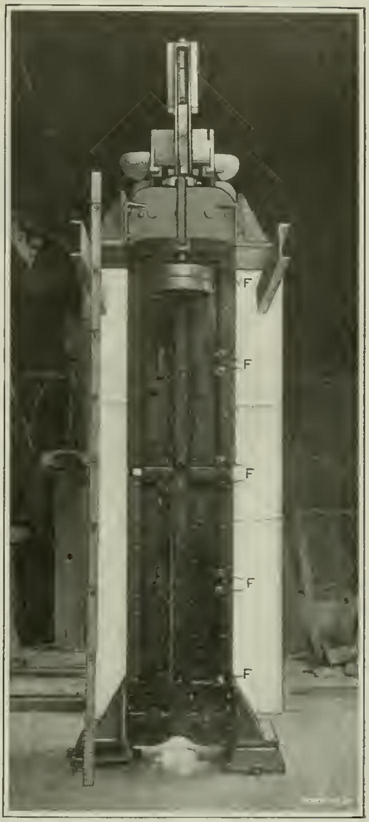


Fig. 2. Side View of Machine showing Arrangement of Drive and Means for adjusting Guide Bearings

The Construction of the Mold

Fig. 3 shows a close view of a portion of the chains of mold sections entering the top of the machine. Referring to this illustration it will be seen that the sections are machined with a semi-cylindrical groove *A* running longitudinally in them; and these two grooves come together to form the continuous cylindrical mold in which the rod is cast. It will also be noticed that at the end of each block forming the mold sections there is a slightly raised boss *B*. The surfaces of these bosses are accurately finished so that they fit tightly together, and the same is true of the faces of the mold sections in which the grooves forming the mold are machined. The necessity for this care in machining will be evident, as any opening in the joints would result in the casting of "fins" on the rod. The necessity for close fitting joints also made it desirable to adopt a special method of guiding the mold sections into the machine. If these sections were simply carried over the ordinary form of chain sprockets, the ends of the sections would rub together and this would inevitably result in wear and consequently in loose joints. In order to overcome this difficulty a special form of cam guides is provided at the top of the frame of the machine. The rollers *C* which are carried by pins mounted in the mold sections, as shown in Fig. 3, run in these cam guides and result in rocking the mold sections in such a way that they move into the machine without the ends coming into contact until such a time as the bosses *B* at the ends of the sections are pressed together by the thrust of the sprockets over which the chains run.

Both the outer faces of the mold sections and the sides *D* are accurately machined to engage with guides which hold the sections in alignment while passing through the machine. Of the two guides which engage with the sides *D* of the mold sections, one is fixed and the other held in contact with the sections through spring pressure. The tension of the springs employed for this purpose may be adjusted by means of screws, this adjustment being made by regulating the nuts shown at *E* in Fig. 1. These guides are made in four sections because, as the molten metal solidifies, its temperature is reduced and the temperature of the mold sections is increased. As a result, the blocks expand and by having the guides in four sections instead of in a single piece, adjustment is automatically made for the difference in the size of the sections. The pressure of the springs regulated by nuts *E* is supplied to the movable guides by means of pins which cause the movable guides to be pushed in against the mold sections, with the result that the sections are pressed against the fixed guide. A similar arrangement of one fixed and one movable guide engages the front and back faces of the traveling mold. In this case the tension of the springs which press the movable guides against the mold sections is regulated by means of screws *F*. These screws operate wedges which are moved so as to compress or release the springs for adjusting their tension to the required degree. Through the action of these two pairs of guides the sections are held in proper alignment and the faces of each pair of sections are held in close contact with each other.

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[*] Associate Editor of MACHINERY.

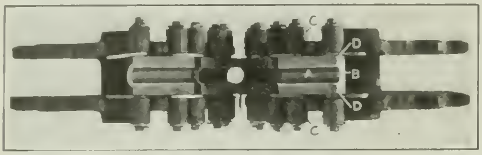

Fig. 3. Top View showing Mold Sections coming together to form Mold

In addition, it is necessary to hold the ends of the sections in close contact. It will be evident from the preceding description of the guides that the alignment of the mold sections through the spring pressure applied to the guides will inevitably result in frictional resistance to the movement of the mold sections. This resistance is not of any great magnitude but it serves one very valuable purpose. The sprockets over which the chains of mold sections run exert a certain thrust which tends to move the chain forward. This movement is resisted by the friction of the mold sections in contact with the guides, and the result is that the ends of the sections are held in close contact with each other. In this way the possibility of metal leaking out of the mold through spaces between the ends of the sections is effectually eliminated. The sprockets which drive the chains of sections are located at the top of the machine and the shafts on which they are mounted are driven by two worm-wheels which engage with a common worm, this worm being driven by the tight and loose pulley arrangement shown in Fig. 2. A similar pair of sprockets at the bottom of the machine return the chains of mold sections, these sprockets being merely idlers over which the chains run.

Fig. 4 shows the mold in process of opening at the bottom of the machine, and a finished rod coming out. By referring to this illustration it will be seen that in spite of the precautions taken to hold the mold sections in accurate alignment and to keep the joints in close contact, the surface of the rod cast in the machine still shows lines which indicate that it was cast in a mold composed of sections. However, the marks of the sections left on the rod due to the joints in the mold are very slight, and these are "ironed" out by the passage of the rod through the drawing dies. It is said that the rods are of uniform structure and free from defects; and that the product drawn from these rods does not show any trace of these marks when it is finished.

In using this machine it will be evident that a great deal of heat must inevitably be given up to the mold sections in cooling the metal from the molten condition in which it is delivered to the machine, to a solid rod which is turned out at the lower end This heat would soon result in the destruction of the mold were not some special means provided for dissipating it. The provision made for keeping the machine cool consists of having a series of jets which spray water onto the mold sections. The water is not turned on until the molds have reached a temperature sufficiently high to vaporize it, and as a result, the molds are perfectly dry at a distance a few inches above the uppermost jet. Where this method of cooling is used, no difficulty has been experienced from excessive heating of the mold and it has been found feasible to run the machine continuously. When casting [illegible]-inch brass rods traveling at a speed of 42 feet per minute, with a distance of 8 feet between the centers of the sprockets over which the mold sections run, it has been found that the temperature of the mold does not exceed 450 degrees F.

Factors which affect the Rate of Production

The rate at which rod can be produced in this machine is naturally dependent upon the speed with which the metal can be cooled from the molten state into rod which can be handled after it leaves the machine. Several factors affect this rate, the more important of which are the melting point of the metal which is being cast into rods, the temperature at which it is feasible to handle the metal after it leaves the machine, the specific heat of the metal in question, its specific gravity, and the size and cross-section of the rod. It will, of course, be evident that in operating the machine to cast metal with a high specific heat, it is necessary to run slower than would be the case with a metal of lower specific heat. This is due to the fact that the metal with a high specific heat is required to give out a greater amount of heat in order to cool it down to a point where it can safely leave the mold ready for subsequent handling. As the amount of surface of the mold sections exposed to the cooling water is constant, the variation of operating conditions to handle metals of different characteristics is obtained by varying the speed at which the machine is run. The statement made in regard to metals of different specific heats also holds good in the case of metals with high melting points or high specific gravity. If a machine is to be used constantly for one given class of metal which gives out an exceptionally large amount of heat while changing from the molten to the solid condition, provision may be made for increasing the rate of speed at which the machine is operated by increasing the height of the machine, so that there is a greater length of cooling water through which the mold sections pass before releasing their grip on the rod of metal.

An idea of the rate at which rod can be produced on this machine may be obtained from the fact that in tests which have been conducted it is stated that ⅞-inch copper rod was turned out at the rate of 26 feet per minute, while ⅝-inch aluminum rod was produced at the rate of 60 feet per minute. This difference in the rate of production is due to the difference in the melting point, specific heat and specific gravity of the two metals. For a ten-hour working day, the capacity of the machine is from 15 to 30 tons of rod.

How the Machine is Operated

Figs. 1 and 2 show two transverse channel irons near the top of the machine. In practice, these would be the beams in the floor; and the receiver into which the molten metal from the melting furnaces is poured would thus be located in a convenient position for delivering this metal to the machine. The machine itself would extend through the floor so that the cast rod would be taken out on the floor below and delivered to the drawing machine. Details of the arrangement would, of course, be modified to meet the requirements of individual cases. The arrangement of the casting shop is shown diagrammatically in Fig. 5. Each ma-

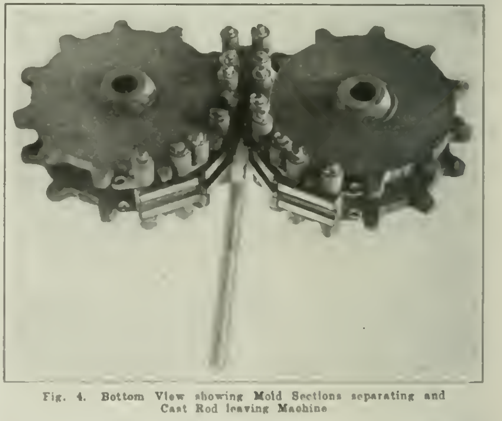

Fig. 4. Bottom View showing Mold Sections separating and Cast Rod leaving Machine

chine has a capacity for the output of a battery of forty-one melting furnaces holding 220-pound crucibles, and six heats would be made in a ten-hour day. The receiver *A* on the machine into which the molten metal is poured has a capacity for 194 pounds of metal. This receiver is equipped with an automatic control device *B* which is actuated by a solenoid magnet connected to a battery circuit, one terminal of which is grounded on the machine and the other attached to a graphite valve projecting into the mold orifice. When the metal in the mold rises to contact with the graphite terminal, it closes the circuit and draws down the graphite valve to partially shut off the flow of metal into the mold. When the molten metal recedes from the terminal, the electric circuit is broken and the beam on which the terminal is carried swings up and opens the entrance to the mold to allow the metal to flow more freely.

It will, of course, be evident that the crucible *C*, from which the molten metal is being poured into the receiver on the machine, has been carried over from the melting furnace *D*. The machine is driven by a variable speed motor *E* which regulates the speed according to the metal which is being cast, the regulation of the motor being controlled by the wheel *F*. A safety device is incorporated in the drive so that if any unusual condition arises, a safety pin will be sheared off and prevent damage being done to the mechanism. The rod as it leaves the machine is rolled up on a reel *G*. It has already been stated that the mold sections are cooled by water jets, and these are shown at *H* in Fig. 5. Mold-cleaning brushes *J* are located above the jets, these brushes being made of steel and employed to remove any deposit from the mold sections as they are returned to the top of the machine ready to come together again to receive a fresh supply of molten metal. A facing is applied to the mold sections by the air brushes *K* in order to prevent trouble from the metal sticking to the mold. It will be evident that in starting the machine the mold will have to be plugged up to hold the molten metal until it has time to solidify. At first a plug of metal was used, but experience has shown that a plug made of waste will retard the flow of metal through the mold sufficiently to give it time to solidify.

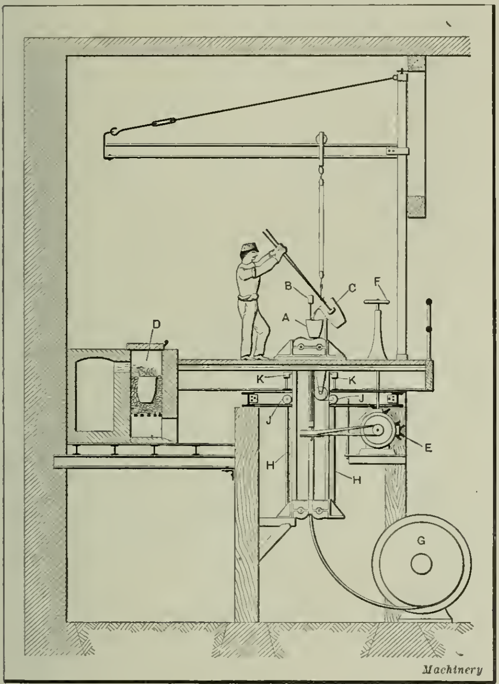

Fig. 5. Diagram showing Arrangement of Casting Shop equipped with Mellen Rod Casting Machine

Advantages of the Mellen Process

It is not the purpose of this article in any way to exploit the Mellen process for casting metal rods, but as the chief merit lies in its ability to simplify the preliminary stages of rod and wire manufacture, a comparison of the work of casting rods in this machine, which has already been described, with that of producing rods by first casting ingots and then rolling them out, will prove instructive. The customary practice of rod and wire mills is to melt the metal and then cast it into ingots 3 to 5 inches square and from 4 to 6 feet in length. These ingots are then rolled out in the usual form of rolling mills, from ten to thirty passes being required to reduce the ingot to a ⅞-inch rod. Approximately thirty men would be needed to look after this work, and the rolling mill equipment used would consume a large amount of power. From 3 to 4 horsepower is required to drive the Mellen machine. It is unnecessary to call the attention of those familiar with rolling mill practice to the expense incident to the maintenance of the rolls or the amount of floor space required to handle the work, owing to the considerable length of the rod into which the ingot is rolled. The first cost and the expense of fuel and maintenance for furnaces used to heat the rods where rolling is employed is also avoided by the Mellen process. Another feature is that accidents which occur in the operation of rolling mills are avoided by having the rods cast in the machine where the hot metal is kept completely enclosed. Thus the Mellen process is a factor in the much talked of "Safety First" movement.

Another advantage of this method is the elimination of trouble due to oxidation. Where the metal is cast in ingots and then rolled out into rods which can be handled in the drawing dies, it is obviously necessary to heat the work for the rolling operations, and as the red-hot metal is in contact with the oxygen of the atmosphere, it is impossible to prevent this surface from becoming coated with a layer of oxide scale. As compared with this process, the rods cast by the continuous process have the molten metal delivered into an enclosed mold in which it solidifies out of contact with the air. The rod of metal emerging from the lower end of the machine has cooled down far enough so that the oxygen in the air will no longer affect it. When all of these facts are taken into consideration and compared with a method by which it is possible to cast the rods direct, using a machine of compact form which requires little power to drive it, it would seem that the Mellen process for the continuous production of rods should be one that will find wide application.

* * *

A great deal has been said of the origin of the safety movement, and it will interest manufacturers to know that the earliest record of systematic production is that of the Crane Co., Chicago, which in 1897 began to provide eye protectors for its men. In 1898 it put this work on a systematic basis, giving the glasses to the men free of charge and requiring operators as far as possible at that time to wear the glasses constantly when they were exposed to flying bits of metal, emery, dust and to the glare of hot metal. Dr. A. M. Harvey, who was at that time, and who still is, the company's chief surgeon, was the originator of this plan of providing glasses for the men. The fact that since the company has been providing glasses eye injuries to its employes have been cut down to an extremely low point, proved the value of having adequate eye protection for workmen in shops. Crane & Co. posted signs conspicuously in their plant drawing the attention of the men to the necessity of using glasses and the fact that the glasses were provided free of charge. The company is one of the best known industrial concerns in the safety movement, and much of its success is due to the thoroughness and activity of Dr. Harvey.

* * *

The reference on page 621 of the April number of MACHINERY on heat-treating shrapnel shells was incorrect. Instead of an oil bath for tempering, a muffle furnace heated to a temperature of 1000 degrees F. was used for drawing the temper of the shrapnel shells for a distance of about two-thirds of their length.

SURFACE COMBUSTION APPLIANCES

The combustion of gas without the admixture of oxygen is inefficient for heating; the ordinary fantail gas burner produces both light and heat, but as a means for heating it is very inefficient, while the Bunsen burner, in which gas and air are mixed before reaching the combustion zone, generates little light and much heat. The Welsbach mantle lamp is a Bunsen burner apparatus in which a highly refractory material is heated to incandescence to produce light. The mixture of air and gas required for perfect combustion is explosive and the ordinary Bunsen burner cannot be used with a perfect mixture as it back-fires and the flame snaps out. Hence, in all ordinary Bunsen burners it is necessary to supply an excess of air or gas in order to maintain continuous combustion.

A new development in gas burners for heating has been in process of development to which allusion in these columns has previously been made. An article was published in the May, 1912, number on "Surface Combustion," describing experiments made by Prof. Bone of England, which had demonstrated that the efficiency of gas heating could be greatly increased if the combustible mixture was directed through a porous refractory medium like fire-brick or onto a bed of granulated refractory material. Dr. Charles E. Lucke of Columbia University had also experimented with surface combustion, and had taken out patents in America. The Bone and Lucke interests were combined, the American rights being vested with Dr. Lucke and his associates, while the British rights were similarly vested with Prof. Bone. This process of combustion is comparable with that of the Welsbach burner, but its object is to produce radiant heat instead of light.

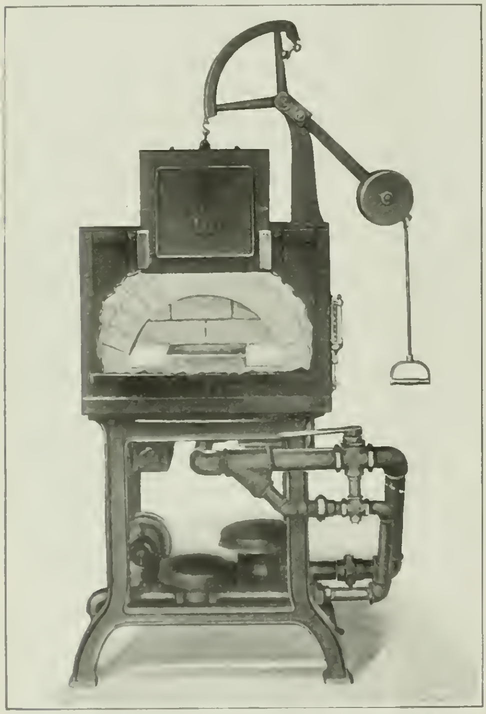

Fig. 1. Surface Combustion Gas Furnace for heat-treating Metals

The Surface Combustion Co., 148-150 W. 52d St., New York City, has acquired the rights under the Lucke and Bone patents for industrial applications. Fig. 1 shows a gas furnace of the surface combustion type, for which a saving of gas of fully 35 to 40 per cent over the ordinary types of equal capacity is claimed. The furnace comprises an ordinary fire-brick arch with channels at each side of the hearth in which an artificial highly refractory, granular material is placed. The mixture of gas and air is supplied through these beds of granular material, having first entered the mixing chamber which communicates with the fuel beds above through a large number of small metal pipes, each about $\frac{1}{8}$ inch diameter. The reason for feeding the fuel to the fuel bed through small pipes is to prevent back-firing. The combustion zone is thus fixed, and the combustible mixture neither blows off nor heats back.

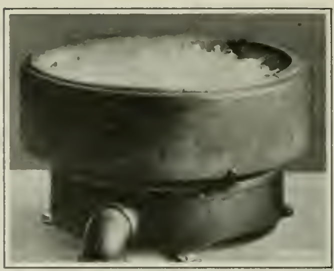

Fig. 2. Surface Combustion "Fire" for Melting Pots

The gas is supplied at ordinary city main pressure, equivalent to a head of about three to four inches of water. The air blast is delivered at an equal pressure, by a small blower driven by an electric motor. Suitable control apparatus actuated by diaphragms is furnished for both the air and gas pipes to insure balance of the fuel and air supplied.

The combustion is characterized by the absence of flame drafts and roar. The interior of the furnace is filled with incandescent gas; the heat, while intense, is very uniform and is exceptionally suitable for heating steel for hardening. The absence of drafts and local variations in temperature favors uniform heating and minimizes the trouble of distortion.

Fig. 2 shows the form of surface combustion apparatus recommended for melting pots, the shape being circular. It consists of a cast-iron cup lined with fire-brick and filled with refractory material. The mixing chamber forms the base and between the base and the bottom of the fuel bed are interposed numerous small pipes to feed the fuel to the fuel bed.

Fig. 3 shows another form of surface combustion "fire," this being rectangular in shape but otherwise of the same style as Fig. 2. The illustration is of a fire having a bed about eighteen inches wide and three feet long. Larger sizes can be made, but for very large sizes it is recommended that a number of comparatively small units be grouped. There is no limit to the size of a surface combustion fire, but for practical reasons they are preferably made in units of small size to facilitate manufacture and to save expense when making repairs.

Surface combustion fires can be run efficiently at temperatures in excess of 3000 degrees F. In fact, platinum which melts at 3191 degrees F. may be readily and rapidly melted. It is possible to consume efficiently a volume of gas equivalent in heating power to 150 pounds of coal per hour per square foot of fuel bed while not more than sixty to seventy pounds per square foot of grate area can be burned on locomotive

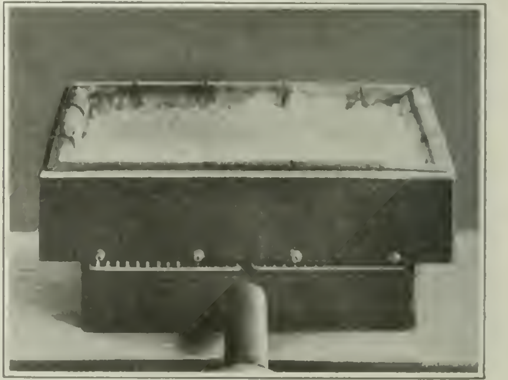

Fig. 3. Surface Combustion "Fire" Rectangular in Shape for Industrial Applications generally

boiler grates. This intensity of fuel consumption coupled with almost perfect combustion produce an intensely hot radiant fire. There being no excess of air, a minimum of heat is carried off in the waste gases. The possible applications of surface combustion are innumerable, but one of common interest that promises to increase the domestic use of gas is in gas stoves and heaters. It saves gas and improves cooking facilities greatly.

* * *

CONVENTION OF THE NATIONAL METAL TRADES ASSOCIATION

At the seventeenth annual convention of the National Metal Trades Association held at the Hotel Astor, New York City, April 14-15, there was a registered attendance of 194 members and guests. President Herbert H. Rice of the Waverly Co., Indianapolis, Ind., presided. The order of proceedings was as follows:

Wednesday Morning Session

The convention was called to order at 9:30 and an address of welcome was delivered by H. N. Covell, president of the New York and New Jersey branch. After the preliminary business of roll call, reading of minutes, and the appointment of convention committees on credentials, resolutions, constitution, auditing and convention had been attended to, President Herbert H. Rice read his report. Mr. Rice referred briefly to the objects which had led to the founding of the association and the work which had been accomplished through cooperative effort. He had no change of policy to advocate, but expressed his opinion that one of the most obvious lines of development which the association could undertake would be that of making further increases in membership. Next in order came the report of Treasurer F. C. Caldwell, which showed the financial status of the association to be very satisfactory.

The report of Commissioner John D. Hibbard pointed out that the fiscal year of 1914-15 had witnessed the development of two movements of marked importance to the National Metal Trades Association; first, the development of a method of procedure in conducting investigations by the Federal Commission on Industrial Relations; second, the closer affiliation and cooperation of national organizations of employers through conference boards. Mr. Hibbard referred very briefly to the investigations of the Federal Commission on Industrial Relations, and then went on to tell of the benefits accruing from the cooperation of national organizations of employers through the establishment of conference boards, explaining the results which could be accomplished through cooperative effort where the effort of the individual proved ineffective. Other general matters of interest to the association were touched upon, including the work of safety inspection. The final officer's report was that of Secretary H. D. Sayre.

The reports of standing committees included the following: Industrial Education, F. A. Geier, chairman, Cincinnati Milling Machine Co., Cincinnati, Ohio; Apprenticeship, W. A. Viall, chairman, Brown & Sharpe Mfg. Co., Providence, R. I.; Membership, John W. O'Leary, chairman, Arthur J. O'Leary & Son Co., Chicago, Ill.; and Publicity, Justus H. Schwacke, chairman, William Sellers & Co., Inc., Philadelphia, Pa.

In the report of the committee on industrial education some particularly interesting figures were quoted as to the relative earning capacity of industrial workers who had received vocational training before entering the factory in which they found employment and those who came unprepared. These figures were quoted from the bulletin of the National Association of Corporation Schools and are as follows: A comparison was made of fifty-one children who had received no preliminary training and fifty-one children who had received trade training, average age of both groups fourteen years. The average wage of the untrained children who had been working for six months was $4.30 per week; that of the trained, $6.85; the average wage of untrained children who had been working for one year was $5.10 per week, and that of trained $9.50 per week; of the untrained children who had been working for two years the average wage was $5.85, while that of the trained sixteen-year-old worker was $10.84. These figures certainly make an excellent plea for industrial education from both an economic and humanitarian point of view.

In the report of the committee on apprenticeship, mention was made of the resolution passed at the annual meeting of the association in 1913 to employ a man to assist in the organization of apprenticeship systems in the shops of members of the National Metal Trades Association. It has been realized that a man competent to fill such a position satisfactorily must, of necessity, possess exceptional qualifications, and up to date a suitable appointee for this position has not been discovered. The committee called upon the members of the association to assist them in discovering a man suitable for this post. Reference was made to a meeting called by M. W. Alexander with the object of forming a conference board on the training of apprentices, and the committee expressed itself as of the opinion that such a board could accomplish very valuable work. The following resolution was placed before the convention: "Resolved that the National Metal Trades Association authorize the participation of a committee with the conference board on training of apprentices, and that the executive committee allow the necessary dues and the expenses of such a committee, provided said committee upon investigation approves the work of the conference board on training of apprentices." This resolution was passed.

During the interval between the morning and afternoon session a buffet luncheon was served.

Wednesday Afternoon Session

The Wednesday afternoon session was devoted to a report of the committee on prevention of industrial accidents, W. H. Van Dervoort, chairman, Root & Van Dervoort Engineering Co., East Moline, Ill., and a discussion of this report by William H. Doolittle, safety inspector of the National Metal Trades Association; a talk on "Cooperation Work of National Employers' Associations through Conference Boards," by Magnus W. Alexander, General Electric Co., West Lynn, Mass.; a talk entitled "State Legislation and the Business Man in Politics," by Dudley Taylor; and an illustrated talk entitled "Highways and Hedges of Many Managers of Men," by Walt. S. Goodwin.

The convention banquet was served at 7 P. M., the speakers of the evening being Frederick P. Fish of Boston, Mass., and Alfred W. Martin of New York City.

Thursday Session

The Thursday session was devoted to an address by Daniel Davenport, explaining how the responsibility of members of trades unions for the acts of the officers of the union had been legally established; a paper by Walter Drew, National Erectors' Association, New York City, dealing with the work of the Federal Commission on Industrial Relations; the reports of convention committees; the report of the nominating committee, F. C. Caldwell, chairman, H. W. Caldwell & Son Co., Chicago, Ill., and the election and installation of officers. The following officers were elected for the forthcoming year: President, Herbert H. Rice, the Waverly Co., Indianapolis, Ind.; first vice-president, George Mesta, Mesta Machine Co., Pittsburg, Pa.; second vice-president, W. H. Van Dervoort, Root & Van Dervoort Engineering Co., East Moline, Ill.; treasurer, F. C. Caldwell, H. W. Caldwell & Son Co., Chicago, Ill. Counsellors: W. A. Layman, Wagner Electric Co., St. Louis, Mo.; Paul B. Kendig, Seneca Falls Mfg. Co., Seneca Falls, N. Y.; J. W. Higgins, Worcester Pressed Steel Co., Worcester, Mass.; M. B. McLauthlin, George T. McLauthlin Co., Boston, Mass.; Justus H. Schwacke, William Sellers & Co., Inc., Philadelphia, Pa.; and Henry D. Sharpe, Brown & Sharpe Mfg. Co., Providence, R. I.

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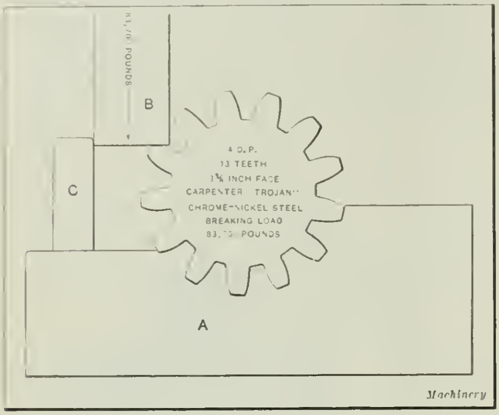
A description of the Gorton universal engraving machine designed especially for engraving tire molds, appeared in the March number. An illustration of a chain tread rubber tire mold appeared in the article, which was erroneously designated as being for the "Goodyear" make of tire, whereas it was for the United States tread tire made by the Morgan & Wright Co. of Detroit, Mich.

TEST OF POWER FORCING PRESS PINION

The ram of the forcing press made by the Lucas Machine Tool Co., Cleveland, Ohio, has a rack cut in one side, and it is operated by a pinion engaging the rack. The pinion thus sustains the full load, which in the case of a fifteen-ton press may be 30,000 pounds—concentrated on one tooth. If made of the same material as the ram, the pinion would be considerably weaker than the rack, but the aim, of course, is to design the press so that all parts will be nearly equal in strength. The pinions are made of alloy steel heat-treated, and some tests recently made showed a high resistance to fracture.



Block used for testing a Steel Arbor Press Pinion to Destruction

The illustration shows a testing block *A* made from a piece of steel about eight inches long, four inches wide and three inches thick, planed to fit and support five teeth of a thirteen-tooth, four diametral pitch pinion—the size used on a fifteen-ton press. The face or width of the teeth is 3⅜ inches. The test load was concentrated on one tooth by the thrust block *B*. The studs *C* are provided to give lateral support to the thrust block. The pinion that gave the best results in the tests was made from Carpenter "Trojan" crucible chrome-nickel steel, heat-treated and showing a hardness of 61 to 65 on the Shore scleroscope scale. The ultimate load causing failure was 83,700 pounds or nearly three times the full load capacity of the press for which it was designed.

TEST OF ARBOR PRESS PINION

Load in Pounds	Deflection in Inches	Load in Pounds	Deflection in Inches	Load in Pounds	Deflection in Inches
30,000	......	50,000	0.002	67,500	0.006
32,500	......	52,500	0.002	70,000	0.006†
35,000	0.001	55,000	0.002	72,500	......
37,500	0.001	57,500	0.003	75,000	......
40,000	0.00125	60,000	0.0035	77,500	......
42,500	0.00125	62,500	0.004	80,000	......
45,000	0.00125	65,000	0.005*	83,700	Failure
47,500	0.00125	......	......	......	......

Machinery

* Elastic limit. † Permanent set, 0.002 inch

As a matter of fact, of course, more than one tooth of the pinion carries the load when engaged with the rack and so the factor of safety is still higher. The table was compiled from the record of the test made by James H. Herron, mechanical engineer for the Lucas Machine Tool Co.

F. E. R.

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ELECTRICAL PRECIPITATION OF SUSPENDED MATTER

The dispersal of fog by electrical precipitation is theoretically possible, and perhaps it may be developed to a practical state that will render navigation safe in harbors and other dangerous places when fogs are thick. It was known as early as 1824 that finely divided particles carried in suspension in the air could be deposited on a plate by means of the brush discharge from a static machine. No practical progress was made, however, owing to the fact that the static machines then available were entirely inadequate for any commercial application. In 1850 the same phenomenon was reported in the *Mechanics Magazine* of London, and attention was called to the fact that it provided a means of throwing down finely divided particles carried in suspension in the air. In 1884, Sir Oliver Lodge, without knowledge of previous discoveries, reported before a meeting of the British Society of the Chemical Industry his discovery of this phenomenon, and patents upon the general principle were taken out at that time in Great Britain and several other countries. In 1905 Prof. Cottrell, then connected with the University of California, took up the work. He instituted the high-potential direct current for the static machine formerly employed, and arranged to tap off the peak of the voltage wave from a high-potential alternating-current circuit, thus securing a high-potential unidirectional source of energy. This permitted the practical application of the process to sulphuric acid plants, powder works, cement plants and smelters. At Riverside, Cal., ninety tons of cement dust per day are recovered from the flues of the Riverside Portland Cement Works by this process, with a power expenditure of only 35 kilowatts.

The theory of the process is that the solid conducting particles in suspension become charged in passing through the intense static field formed by a voltage of from 30,000 to 60,000 volts. These particles are driven away from the field of greatest intensity by the interaction between the charge and the static field. Other solid particles are also driven out, doubtless by collision with the charged particles. A recent application of the principle is the removal of tar from producer gas which is to be used in a gas engine. A recent installation for this purpose has been made at the plant of the Ford Motor Co., Detroit, Mich. In passing the gas through an intense static field, the particles of tar become ionized and intense molecular activity results. The fine particles of tar vapor collide and form into large globules, which are then easily removed by mechanical filtration. Electrical precipitation has been experimented with as a means of solving the smoke problem, but it has not been so successful along these lines as it has been in the commercial applications which involve the removal of fumes and dust.

* * *

A SUGGESTION FOR TECHNICAL SCHOOLS

BY HENRY R. OILSON*

The object of all manufacturers is to standardize their different products so that they can be made cheaply in quantity. One concern may be making sewing machines; it may sell tens of thousands a year, yet each part in one of those machines must be interchangeable with the same part in all the other machines. To accomplish this requires an elaborate and complicated set of special tools and gages, on the accuracy and economical operation of which the existence of the concern depends. Another firm may be manufacturing electrical devices, making them in million lots out of sheet metal, requiring dies and presses. These presses may be single-acting, double-acting, automatic or multiple slide as the case requires. This necessitates the design of blanking, forming and drawing dies, also the design of combination dies which perform two or more functions at each operation of the press. Hence, the most important factor in manufacturing today is the correct design and operation of the special tools, dies and gages used, and it is one to which the majority of technical schools throughout the country are paying too little attention, with the result that manufacturers have to train their men along these lines as best they can, or hire them away from someone else.

There is no other form of design which teaches the sense of proportion better, or gives the student greater insight into the strength and use of the different metals, together with hardening, tempering, etc. It further has the advantage of bringing clearly before the student's mind the adaptability, adjustment and range of work of the different machine tools or presses in connection with which the special tools or dies he is designing are to be used. In other words, it reinforces and broadens his knowledge of the uses of machine tools, and shows him their possibilities. Many special tools are of complicated design, requiring careful calculations.

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* Consulting Engineer, Ambridge, Pa.

A clear knowledge of how each part of a machine or device is to be manufactured is vitally important and necessary to the engineer designing and developing it, and that knowledge can only be obtained by actual training in the design and use of special tools. A technical graduate starting in a manufacturing plant is handicapped unless he has some knowledge of this subject. Therefore it would seem that courses of lectures with data sheets, supplemented by work in the drawing-room and shop along these lines would prove a valuable adjunct to the student's training and tend to reduce the gap now existing between the class-room and the plant. It is suggested that parts of a machine or commercial device be taken into the drawing-room, and each student assigned a part which requires a set of machine operations to be performed upon it. Have him lay out the special tools, inspection gages, etc., for manufacturing his parts in quantity, interchangeably, emphasizing the principles governing the proper design, handling and commercial operations of the tools. The men will look with increased interest upon their machine laboratory work, and note many details in connection with machine tools which would otherwise escape their attention.

Is it not true that part of the time which is now devoted in technical schools to general machine, mill or factory design could be spent more profitably as indicated above? No manufacturer takes a graduate directly from the class-room into his engineering department and expects him to lay out a manufacturing plant with its equipment. Work of this nature is undertaken only by engineers of experience who are familiar with all requirements, for capitalists, who have money invested, insist on accurate results in a minimum time, and spend their money only on the best talent obtainable; but an engineer to accomplish these things must be familiar with manufacturing processes, and the most important and universal process is the making of interchangeable parts.

During the last ten years the writer has employed a number of technical graduates who had been out of school less than a year. They had no conception of the design or uses of special tools. Men of this description can figure stresses, strains, etc., which is good, but of the all-important factor of manufacturing they know practically nothing. Manufacturing methods have been revolutionized in the past twenty years, and what the industries need are technical men who can step from the class-room to the plant, and assume their share in producing dividends, without having to pass through a shop training or apprenticeship period of one or more years before their real worth begins to be manifested.

Courses in mathematics and applied mechanics are excellent, but in the senior year should not instruction be given (part of the time at least) more in line with what manufacturers will actually require of a man at the beginning, than to try to instill into the student's mind those things which his employer knows he can obtain successfully only from an engineer of experience and which will come naturally to the student with experience and be in line with the development and broadening of his mind?

* * *

GRINDING MILLING MACHINE TABLES

The Rockford Milling Machine Co., Rockford, Ill., has found that grinding the tops of its milling machine tables on a "Diamond" surface grinder materially improves the character of the surface. The top surface of the table is ground after the slides have been scraped in, the grinding being the last operation. The advantages of this practice are that a very smooth, hard surface is produced that resists wear and that can be easily cleaned. The table top is made an accurate plane by the grinding method and it calipers within limits of 0.00025 inch at the corners, plus or minus, but the advantage resulting from the hard, smooth surface as regards cleanliness is of more importance. An ordinary planed surface, no matter how smooth it appears to be, can never be wiped perfectly clean with waste or wiping cloths. Small particles of lint will adhere to the minute projections in the surface and chips too small to be readily noticed with the naked eye will remain. These beneath a parallel or a vise throw them out of level and tend to produce inaccurate work. On the ground table the smallest chip is readily seen and removed, and fibers of waste do not adhere.

* * *

PERSONALS

James Rushworth has succeeded Arthur Pletz as secretary and general manager of the Aurora Tool Works, Aurora, Ind.

B. F. Stowell, for the past nine years master mechanic of the Hendee Motorcycle Co., is now with the Van Norman Machine Tool Co., Springfield, Mass., as mechanical engineer.

Lee H. Parker, for the past ten years with the Stone & Webster Engineering Corp., and prior to that with the General Electric Co., has been made president of the Spray Engineering Co., Boston, Mass.

Edward W. Dodge, for many years connected with the Norton Co., Worcester, Mass.—for the past six years in the capacity of sales manager—has resigned; after taking a short rest he will become sales manager of the Waltham Emery Wheel Co., Waltham, Mass.

Paul O. Unger, known as an organizer and systematizer of factories manufacturing registers, typewriters, firearms, etc., has resigned his position as production engineer of the Angldile Computing Scale Co., Elkhart, Ind. Mr. Unger has not yet announced his plans for the future.

Fred A. Geier, president of the Cincinnati Milling Machine Co., Cincinnati, Ohio, has purchased the interest of Larz Anderson in the Cincinnati Shaper Co. and the Cincinnati Gear Cutting Machine Co. of Cincinnati. P. G. March will continue as president. The business will be extended on much broader lines than heretofore.

E. R. Markham, a well-known expert in the heat-treatment of steel, writer of articles on steel and its treatment, and for several years past in charge of the machine shop of the evening school of the Rindge Manual Training School, Boston, Mass., has associated himself with the A. C. Fay Co., Inc., 5 Hanover St., Boston, Mass., as consulting engineer for the purpose of putting casehardening materials on the market.

L. F. Hamilton, in charge of the advertising and specialty department of the National Tube Co., Frick Bldg., Pittsburg, Pa., has returned from an extended business trip to the Pacific Coast in connection with the exhibit at the Panama-Pacific Exposition. The National Tube Co.'s exhibit is part of the U. S. Steel Corporation's exhibit which is located in the Mines and Metallurgy building and occupies 44,000 square feet—the largest single exhibit at the exposition.

Merrill G. Baker was appointed assistant general manager of sales of the American Vanadium Co., Pittsburg, Pa., taking effect March 1. Mr. Baker was born in 1880 and graduated from Dickinson College in 1904. Immediately upon leaving college he entered the employ of the Cambria Steel Co. in the operating department and was rapidly promoted until he entered the sales department in 1906. In 1912 he became assistant to the general manager of sales in charge of the rail and structural departments, which position he resigned to assume his present duties.

Paul B. Liebermann, formerly assistant chief engineer of the Sprague Electric Works, has joined the Hyatt Roller Bearing Co., Newark, N. J., as engineer of tests. Mr. Liebermann graduated from the Royal Technical Institute, Charlottenburg, Berlin, in 1897, receiving honorable mention for laboratory research work. He followed the German custom of serving an apprenticeship, and then entered the employ of the German-General Electric Co., railway engineering department, of Berlin. In 1902 he became identified with the Sprague Electric Works, having charge of the development of an electric dynamometer. Mr. Liebermann will have full charge of all tests, both laboratory and field, of the Hyatt Roller Bearing Co. for the purpose of determining the exact saving to be effected by the adoption of roller bearings of all applications.

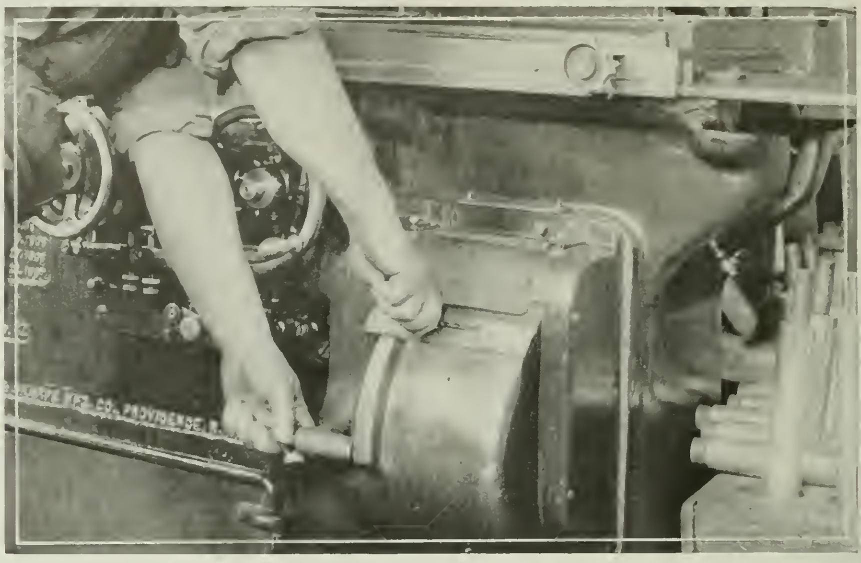
* * *

OBITUARIES

Fred L. Smith of the S. A. Smith Mfg. Co., Brattleboro, Vt., died March 25, aged forty-nine years.

George W. Prentiss, a well-known wire manufacturer of Holyoke, Mass., died April 2, aged eighty-five years.

Phelius Colby, treasurer and manager of the Colby Mfg. Co., Springfield, Mass., died April 11 of pneumonia, aged sixty-two years.



The Picture Tells The Story

At a Glance You Can See One Reason For Fast Production in Grinding Under Conditions That Are Favorable to The Operator

This man is setting up a job on a Brown & Sharpe Plain Grinding Machine. It happens that this particular job has been done before, so the foreman of the grinding department simply gave the operator a record of the work speed and table travel previously used. You can see how easy it is for him to duplicate this combination. A quick-change gear mechanism is located on the machine bed each side of him. He reaches to the one which controls the table travel, drops a lever, moves the index slide knob to the required position and brings the lever into position again. Turning to the mechanism which controls the headstock rotation he does the same thing. The machine is then set, ready to do the job under conditions which assure profitable results.

But even if the job had not been done before, no difficulty would have been experienced. The foreman would tell the man the finish required and indicate in a general way how to get it. The rest could be left to the operator and in the same quick, efficient manner he could try speeds and feeds until the best combination had been secured.

BROWN & SHARPE MFG. COMPANY,

OFFICES: 20 Vesey St., New York; 654 The Bourse, Philadelphia, Pa.; 626-630 Washington Blvd., Chicago, Ill.; 305 Chamber of Commerce Bldg., Rochester, N. Y.; Room 419, University Block, Syracuse, N. Y.
REPRESENTATIVES: Baird Machinery Co., Pittsburgh, Pa., Erie, Pa.; Carey Machinery & Supply Co., Baltimore, Md.; E. A. Kinsey Co., Cincinnati, O., Indianapolis, Ind.; Pacific Tool & Supply Co., San Francisco, Cal.; Strong, Carlisle & Hammond Co., Cleveland, O., and Detroit, Mich.; Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; Perine Machinery Co., Seattle, Wash.; Portland Machinery Co., Portland, Ore.

More Details About These Mechanisms

Each of these quick-change gear mechanisms is self-contained and independent of the other. They give a powerful, positive drive and offer a wide range of speeds and feeds.

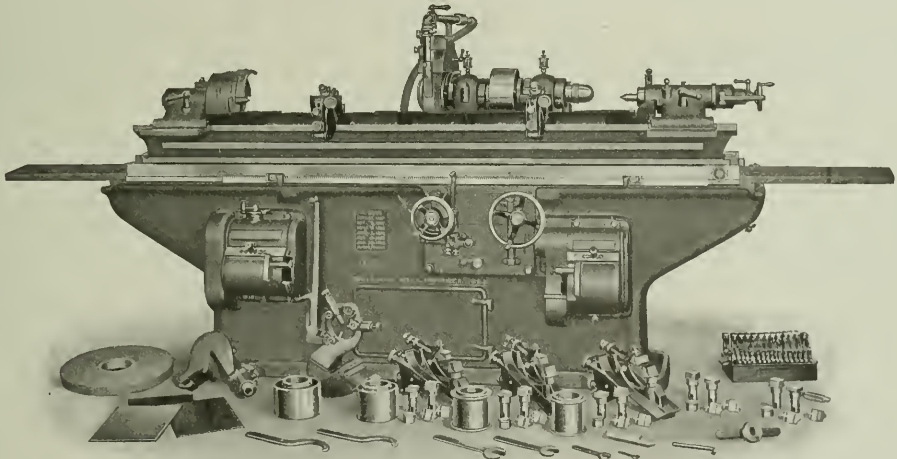
This complete separation of feeds and speeds is an important factor in commercial grinding as it permits the use of any combination of speed and feed for either roughing or finishing, and greatly increases the productivity and usefulness of the machine.

The long lever near the left-hand gear mechanism controls the entire machine independent of the wheel. When thrown in it locks the mechanism, thus preventing damage to the gears through being thrown in while running.

The automatic cross feed, the combination plain and universal back rests, provision for varying wheel speeds, an automatic belt tightener which insures a constant wheel speed, are among interesting features of our line of large manufacturing grinding machines of which the

B. & S. No. 16 Plain Grinding Machine

shown below is typical. It has a capacity for work up to 10″ diameter and will take 72″ in length. Designed with the features just described, this is a machine that will economically produce accurate, high-grade work and keep your grinding costs uniform and consistently low. Furthermore it is a machine that will find much favor with your operators. Write us for full particulars.



Our Booklet on Grinding Wheels—Free

This booklet will prove invaluable to a grinding machine operator. It fully describes the characteristics and qualities of various wheels and their adaptability to various classes of work. A postal brings you one—free.

PROVIDENCE, RHODE ISLAND, U. S. A.

CANADIAN AGENTS: The Canadian Fairbanks-Morse Co., Ltd., Montreal, Toronto, Winnipeg, Calgary, Vancouver, St. John, Saskatoon.
FOREIGN AGENTS: Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow; F. G. Kretschmer & Co., Frankfurt, a/M., Germany; V. Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway; Schuchardt & Schutte, Petrograd, Russia; Fenwick Freres & Co., Paris, France; Liege, Belgium; Turin, Italy; Zurich, Switzerland; Barcelona, Spain; The F. W. Horne Co., Tokio, Japan; L. A. Vail, Melbourne, Australia; F. L. Strong, Manila, P. I.

THE REX MICROMETER ON PAGE 69

Nathaniel L. Bradley, president of the Bradley & Hubbard Mfg. Co., Meriden, Conn., manufacturer of gas and electrical fixtures, died at his home in Meriden, March 18, aged eighty-four years.

C. W. MacCord, professor emeritus in Stevens Institute of Technology, Hoboken, N. J., died at his home in Hoboken April 13, aged seventy-nine years. He was connected with Stevens Institute from the time of its opening in 1871. He was the author of a number of books on drawing and machine design.

COMING EVENTS

May 20-21.—Spring convention of the National Machine Tool Builders' Association at Atlantic City. Marlborough-Blenheim Hotel, headquarters. Charles E. Hildreth, general manager, Worcester, Mass.

May 26-28.—Annual convention of the Master Boiler Makers' Association, Chicago, Ill. Harry D. Vought, 95 Liberty St., New York City, secretary.

June 3-5.—Joint convention of the American Supply & Machinery Manufacturers' Association and the National Supply & Machinery Dealers' Association. Hotel Bellevue-Stratford, headquarters, Philadelphia, Pa.

June 7-11.—Third annual convention of the National Association of Corporation Schools at Worcester, Mass. H. W. Dunbar, general chairman of the convention committee, Norton Co., Worcester, Mass.

June 9-11.—Annual convention of the American Railway Master Mechanics Association, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

June 14-16.—Master Car Builders' annual convention, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

June 14-17.—Summer meeting of the Society of Automobile Engineers on board the steamer "Noronic" of the Northern Navigation Co., leaving Detroit June 14. Coker F. Clarkson, secretary, 1746 Broadway, New York City.

June 19-26.—Annual convention of National Graphic Arts Exposition in the Coliseum, Chicago, Ill. Publicity manager, A. D. V. Storey, National Exposition Co., 200 Fifth Ave., New York City.

June 22-25.—Spring meeting of the American Society of Mechanical Engineers at Buffalo, N. Y. David Bell, chairman of the general committee, Buffalo; C. W. Rice, secretary, 29 W. 39th St., New York City.

June 22-26.—Annual convention of the American Society for Testing Materials. Hotel Traymore, Atlantic City, N. J., headquarters. Edward Marburg, secretary, University of Pennsylvania, Philadelphia, Pa.

July 19-21.—Seventh annual convention of the American Railway Tool Foremen's Association, Chicago, Ill. Hotel Sherman, headquarters. Owen D. Kinsey, secretary and treasurer, 7223 Ridgeland Ave., Chicago, Ill.

August 17.—Annual meeting of the International Railroad Blacksmiths' Association, Philadelphia, Pa. A. L. Woodworth, secretary-treasurer, C. H. & D. Railway, Lima, Ohio.

September 9-11.—Swedish engineering convention in the United States; meeting in Chicago. Secretary, Eastern organization committee, E. Oberg, 183 68th St., Brooklyn, N. Y.; secretary Western organization committee, C. G. Axell, 601 City Hall Square Bldg., Chicago, Ill.

September 25-October 2.—Annual exhibit of the Foundry and Machine Exhibition Co., Atlantic City, N. J., in conjunction with the American Foundrymen's Association convention. Foundry & Machine Exhibition Co., 1949 W. Madison St., Chicago, Ill.

September 27-October 1.—Annual convention of the American Foundrymen's Association, Atlantic City, N. J.

SOCIETIES, SCHOOLS AND COLLEGES

Syracuse University, Syracuse, N. Y. Catalogue for 1915-16 containing roster and courses, including the courses of the fourteenth summer session from July 5 to August 13.

Massachusetts Institute of Technology, Boston, Mass. Bulletin of summer courses for 1915 in architecture, biology and public health, chemistry, civil engineering, drawing, electrical engineering, English, mathematics, mechanical engineering, mechanical arts, mechanics, modern languages and physics.

Columbia University, New York City. Bulletin of the summer session 1915, comprising day and evening classes in accounting, architecture, assaying, bookkeeping, civil engineering, chemistry, economics, electrical engineering, law, mathematics, mechanical drawing, mechanics, medicine, mineralogy, metallurgy, physics, etc.

Swedish Engineering Convention in the United States, 1915. Secretary of Eastern Organization Committee, Erik Oberg, 183 68th St., Brooklyn, N. Y. Program of the Swedish Engineering convention to be held in Chicago, September 9-11, 1915, containing also the list of names of those who have announced their intention to participate. Up to the present time the list contains 170 names from the United States and it is expected that this number will be doubled. About 50 engineers from Sweden are expected to attend.

National Association of Master Steam and Hot Water Fitters, 260 W. Broadway, New York City. Chart of the 1915 U. S. Standard Schedule of Flanged Fittings and Flanges, adopted March 20, 1914, by a joint committee of the National Association of Master Steam and Hot Water Fitters, the American Society of Mechanical Engineers and the Committee of the Manufacturers on Standardization of Fittings and Valves, and applying to standard weight fittings for 125 pounds working pressure and extra heavy fittings for 250 pounds working pressure. Price of chart, $1.

University of Wisconsin, Madison, Wis. Bulletin of the fifteenth annual summer session of the college of engineering, which will be held at Madison during the six weeks period beginning June 21. Special courses will be given in electrical, steam, and hydraulic engineering, gas engines, machine design, mechanical drawing, mechanics, shopwork and surveying. All courses in the university summer session are open to engineering students. Special courses have been arranged for manual arts and vocational teachers. Further information can be obtained by addressing Dean F. E. Turneaure, Madison, Wis.

Pratt Institute, Brooklyn, N. Y., held the annual exhibition of day work April 29-May 1, inclusive, during which time the exhibition was open to the public and the students were engaged in their regular work, thus affording visitors an opportunity to inspect the methods, equipment and general facilities of the school for conducting practical training. Pratt Institute is a pioneer in the field of industrial education and for many years has been developing courses of the kind for which there is so great a demand today. The school offers day and evening courses for both men and women in a great variety of vocational subjects, including fine and applied arts, household science and arts, architectural design and construction, library management, kindergarten training and technical and trade courses for men along many important lines. The school of science and technology especially is of interest to men engaged in technical and trade pursuits. It provides instruction in applied mechanics and machine design, applied electricity, applied chemistry and tanning, machine work and toolmaking, carpentry and building, pattern making, plumbing, foundry and forge work and sheet metal work.

NEW BOOKS AND PAMPHLETS

How to Make a Low-Pressure Transformer. By F. E. Austin. 14 pages, 4½ by 7 inches. Illustrated. Published by Prof. F. E. Austin, Hanover, N. H. Price, 25 cents.

This pamphlet describes the construction of a transformer to reduce electrical pressure from 110 volts to about 8 volts as a minimum, for experimental purposes, such as operating low voltage tungsten lamps, ringing door bells, etc. The directions should enable an amateur to make a successful transformer having good efficiency. The author states that the efficiency of transformers made in accordance with his instructions has been found to be over 90 per cent in many cases, and never below 85 per cent.

Directions for Designing, Making and Operating High-prassura Transformers. By F. E. Austin. 46 pages, 4¾ by 7½ inches. 21 illustrations. Published by Prof. F. E. Austin, Hanover, N. H. Price, 50 cents.

This pamphlet is a companion to the author's work on making a transformer for low pressures. It describes the making of a step-up transformer, giving 20,000 volts, for wireless telegraphs, telephones, for operating tube lamps and X-ray tubes. The mathematical matter is treated in a simple way that is well within the comprehension of the amateur who would be interested in building a high-pressure transformer for experimental purposes. All materials are specified and all calculations are worked out for the model described. Probably no exercise would give the average student a firmer grasp of electrical principles than the building of a piece of apparatus like this transformer.

Gurney Ball Bearing Handbook. 140 pages, 5½ by 8½ inches. Published by the Gurney Ball Bearing Co., Jamestown, N. Y. Price, loose leaf, unbound, $1.50; bound in plain covers, $1.75; in flexible loose leaf binders, $2.50.

The data were compiled chiefly in the interest of the automobile trade and comprise the following: Ball bearing data, general static tables, front hub bearings, transmission bearings of gasoline pleasure cars, transmission bearings of gasoline commercial cars, third member bearings of gasoline pleasure cars, third member bearings of electric pleasure cars, third member bearings of gasoline commercial cars, third member bearings of electric commercial cars, differential bearings of gasoline pleasure cars, differential bearings of electric pleasure cars, differential bearings of gasoline commercial cars, differential bearings of electric commercial cars, rear hub bearings of gasoline pleasure cars, rear hub bearings of electric pleasure cars, rear hub bearings of gasoline commercial cars, rear hub bearings of electric commercial cars. These data should be of value to all classes of engineers connected in any way with motor car problems and the general problems of power transmission.

Machine Shop Management. By John H. Van Deventer. 374 pages, 4 by 6¾ inches. Illustrated. Published by McGraw-Hill Book Co., Inc., New York City. Price, $2.50.

This work is gotten up in handbook style; it is printed on thin paper and bound in flexible leather, making it convenient to carry in the pocket or keep on the desk. In selecting the matter for this book for machine shop executives, two tests were applied to the material, viz: "Does it relate to an element or mechanism of machine shop management actually in use"? and "Can the element or mechanism be used in all probability in other machine shops?" If the answer was negative, the material was rejected. Hence, the result is a book well suited to the busy executive in charge of machine shops or plants including machine shops. The contents follow: Organization; Systems; Committee Plans; Suggestion Systems; Apprenticeship; Functions of Drafting Department; Systems of Numbering Product Parts; Standardization of Drawings; Unit Assemblies; Filing Methods; Changes; Finish, Limits and Checking; Selection of Equipment; Installation and Repair; Machine Numbering; Machine Location and Arrangement; Power Required by Various Tools; Tool-room Methods; Standardization of Machines and Tools; Purchase Methods; Shop and Production Orders; Stock and Stores Methods; Physical Inventory; Inspection; Routing; Dispatching; Scheduling; Steering and Tracing; Time Keeping; Working Hours; Pay-roll Methods; Time Study; Rate Setting; Instruction and Operation Cards; Compensation and Wage Methods; Costs; Burden; Sources of Cost Information; Duties of a Traffic Manager; Causes of Delay in Shipments; Tracing Methods; Safety; Mechanical Safeguards; Fire Prevention; Sanitation.

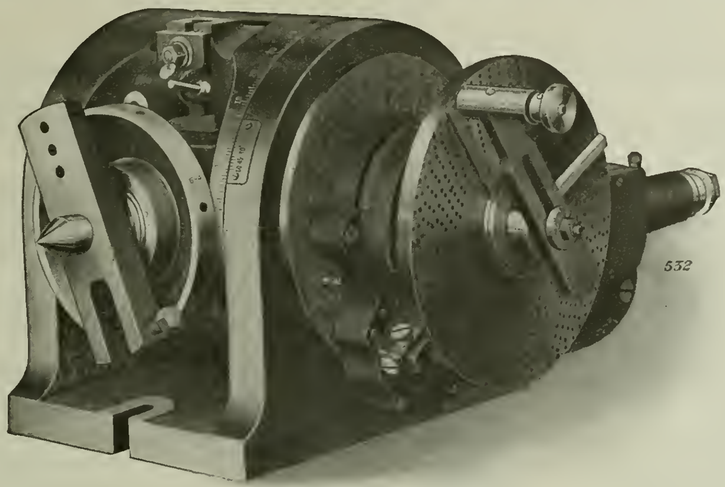
Factors in Foreign Trade. 56 pages, 6 by 9 inches. Published by the Bureau of Manufactures, Department of Commerce and Labor, Washington, D. C., as No. 7 of the Miscellaneous Series.

This valuable government publication deals with the factors in foreign trade of greatest importance to American manufacturers, viz., language, currency, weights and measures, postal rates and parcel post facilities. Data on language, currency, weights and measures and postage are included for the following countries: Canada, Mexico, Newfoundland, St. Pierre and Miquelon, British Honduras, Costa Rica, Nicaragua, Guatemala, Honduras, Panama, Salvador, British West Indies, Cuba, Danish West Indies, Dominican Republic, Dutch West Indies, French West Indies, Hayti, Porto Rico, Argentina, Bolivia, Brazil, British Guiana, Chili, Colombia, Dutch Guiana, Ecuador, French Guiana, Paraguay, Peru, Uruguay, Venezuela, Austria-Hungary, Belgium, Bulgaria, Denmark, Finland, France, Germany, Greece, Italy, Malta, Netherlands, Norway, Portugal, Roumania, Russia, Servia, Spain, Sweden, Switzerland, Turkey, United Kingdom, British India, Ceylon, China, Dutch East Indies, French Indo-China, Japan, Persia, Siam, Straits Settlements, Australia and New Zealand, Philippines, Society Islands, Abyssinia, Algeria, Belgian Congo, British East Africa, British South Africa, British West Africa, Egypt, French Africa, German Africa, Italian Africa, Liberia, Madagascar, Mauritius and Seychelles, Morocco, Portuguese East Africa, Portuguese West Africa, Tripoli, Barbary, Tunis, Zanzibar. Equivalents of metric weights and measures, conversion tables, price comparison and foreign currency and signs and abbreviations—data of use to all concerns dealing with foreign countries—are included.

Tha A B C of Iron and Steel. Edited by A. O. Backert. 354 pages, 8 by 11 inches. 222 illustrations. Published by the Penton Publishing Co., Cleveland, Ohio. Price, $5.

The Penton Publishing Co., publisher of the "Iron Trade Review," has, by this book, added a valuable work to the literature of the iron and steel industry. This literature is already extensive, but most of it presupposes a considerable knowledge of all the branches of the business. The present book, however, provides a means whereby the large number of people engaged in mechanical work, who are anxious to become familiar with the methods and processes of one of the country's most important industries, may do so through the medium of a book specifically written for the purpose, and covering the subject in broad, general outline, giving a satisfactory perspective of the whole industry. The work is, therefore, in a sense, elementary in nature, but covers fully not only the practical but the commercial phases of the industry to which it is devoted. The volume furnishes a simple, concise and at the same time comprehensive exposition of the primary processes involved in the conversion of iron ore into finished forms, and it should be of great interest to those who are eager to get a general idea of the processes which iron and steel pass through from the mine until they are ready to be delivered into the hands of the user. The processes are described by men who are recognized authorities on the subjects on which they have written. It is, however, impossible in this brief review to mention the names of these writers; it is of more importance to give the heads of the eighteen chapters in order to indicate the field covered by the book. These are as follows: Iron Ore and Mining Operations; Beneficiating Iron Ores; How to Determine Value of Iron Ores; Transportation of Ore on Great Lakes, Ore-handling at Lower Lake Ports; Manufacture of Bee-hive Coke; Manufacture of By-product Coke; Manufacture of Pig Iron; Manufacture of Wrought Iron; Manufacture of Crucible Steel; Manufacture of Bessemer Steel; Manufacture of Open-hearth Steel. The Rolling Mill Industry; Wire and Wire Rods, Manufacture of Gray Iron Castings, Manufacture of Malleable Castings, Manufacture of Steel Castings; Electric Steel. In addition, the book contains statistics of the American iron and steel industry, a directory of the iron and steel works of the United States and Canada, and a directory of manufacturers of iron and steel in the United States and Canada, classified by products. An index, well compiled, completes the book.

CINCINNATI TOOL ROOM MILLERS

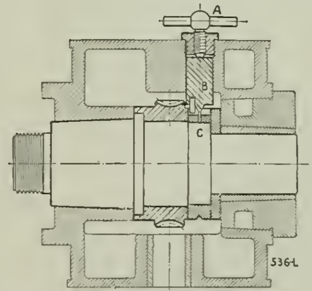


You probably use a UNIVERSAL DIVIDING HEAD more than anything else in the tool room. You frequently want to set the spindle at an angle, and you should be able to clamp the spindle carrier in any position so rigidly that it can't move under a cut.

The DIVIDING HEAD on all Cincinnati Universal Tool Room Millers provides for this. The spindle carrier swings on large trunnions (8½" diameter on the 12" head) which are held by clamps gripping their entire circumference. They will not be distorted by continuous use and the carrier will not move under a cut. The alignment of the spindle will therefore be maintained. When taking a cut it is desirable to clamp the spindle. Ours is provided with an aligning clamp, acting on the spindle endwise, holding it securely between shoulders and at the same time adjusting it closer to its bearing. This insures the greatest operating accuracy.

It is provided with the usual universal side index plate and also a direct indexing plate on the spindle for low numbers. The change from one system of indexing to the other is made in a few seconds without disturbing any adjustments. We test the alignments and indexing of every head to closer limits than were thought possible a few years ago. Consider these things when buying a Universal Miller.

Ask for our complete Milling Machine Catalogue.



HORIZONTAL SECTION OF CINCINNATI DIVIDING HEAD.

The spindle clamp consists of a split ring, C, that is spread by the wedge B by tightening the screw A, thus clamping the spindle endwise, securely, without crowding it out of alignment.

The Cincinnati Milling Machine Co.

CINCINNATI, OHIO

NEW CATALOGUES AND CIRCULARS

DeKalb Wagon Co., DeKalb, Ill. Catalogue 5 on DeKalb motor trucks.

George P. Clark Co., Windsor Locks, Conn. Circular of the Clark three-wheel transfer truck made in different capacities from 1000 to 2200 pounds.

Dodge Mfg. Co., Mishawaka, Ind. Circular of the Dodge adjustable wall and socket bracket hangers with standard and self-oiling bearings.

Ingersoll-Rand Co., 11 Broadway, New York City. Form 4032 descriptive of the Ingersoll-Rand "Jackhamer" equipped with type "JM-6" mounting.

Northern Engineering Works, Detroit, Mich. Bulletin 33, descriptive of air hoists, air jacks, pneumatic traveling cranes and pneumatic jib cranes.

General Electric Co., Schenectady, N. Y. Bulletin 40500, devoted to the subject of alternating-current generators for direct connection to reciprocating engines.

General Electric Co., Schenectady, N. Y. Bulletin 48015 illustrating and describing Type M transformer for operating electric stop motion of textile machinery.

Armstrong Cork & Insulation Co., Pittsburg, Pa. Pamphlet describing "Nonpareil" high-pressure covering for high-pressure and superheated steam lines, boilers and other heated surfaces.

Bridgeport Engineering Co., Bridgeport, Conn. Catalogue of Bridgeport wood-working tools, including patternmakers' sander, trimmer, miter box, metal-top saw table and quick-acting clamps.

Cooper Hewitt Electric Co., Eighth and Grand Sts., Hoboken, N. J. Catalogue of Cooper-Hewitt electric lamps for all photographic processes, supplied in direct-current or alternating-current outfits.

Peerless Electric Co., Warren, Ohio. Bulletin 34 containing data on "Peerless" multipolar motors and generators. Bulletin 36 on "Peerless" direct-current bipolar generators and motors of fractional horsepower sizes.

Armstrong Cork & Insulation Co., Pittsburg, Pa. Pamphlet entitled "Good Furnaces made Better," descriptive of some of the applications of "Nonpareil" insulating brick in heat-treating furnaces, enameling plants, furnace doors, ovens, etc.

Spray Engineering Co., 93 Federal St., Boston, Mass. Bulletins entitled "Washing and Cooling Air for Steam Turbine Generators," and "Sprays for Cooling Condensing Water," devoted to the subject of systems for cooling and cleaning air and water.

Scranton Pump Co., Scranton, Pa. Bulletin 101 of Scranton duplex piston pumps, illustrating the features of design of these pumps and giving dimensions of the various sizes. The pamphlet also gives directions for setting and operating Scranton pumps.

Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. Bulletin 5000 illustrating various types of hydraulic pumps of sufficient strength to meet every high-pressure requirement. The bulletin also shows a few types of hydraulic valves.

Crescent Tool Co., Jamestown, N. Y., is issuing a series of circulars on its combination and universal pliers and adjustable wrenches. The company will supply these to dealers for distribution with the name of the dealer printed on the front covers.

Surface Combustion Co., 148-150 W. 32nd St., New York City. Pamphlets on surface combustion fires and their industrial applications, describing and illustrating tuyeres and refractory beds designed by Dr. Charles E. Lucke for burning gas efficiently without flame.

Ingersoll-Rand Co., 11 Broadway, New York City. Form 3015 describing the Ingersoll-Rand line of portable air compressors and the work for which they are adapted. The various types are gasoline engine driven, oil engine driven, steam driven and electric driven.

Pittsburg Emery Wheel Co., Rochester, Pa. Standard grinding wheel price-lists and rules for calculating the list prices. 16 pages, 6 by 9 inches. The pamphlet also includes rules for calculating the list prices of special shape wheels, and should be useful to all purchasers of grinding wheels.

Van Dorn & Dutton Co., Cleveland, Ohio. Bulletin [illegible] entitled 'A Feature of Lowest Operating or Maintenance Cost" pertaining to gears and pinions for electric railway, mill and mine service. These gears are heat treated by the "V. D. & D." process to insure strength and long service.

Automatic Steam Trap & Specialty Co., Detroit, Mich. Catalogue 8 treating of the "Barton" expansion automatic steam trap and containing 11 illustrations that show a number of applications of this trap. The "Barton" steam trap will operate both vacuum and gravity systems at all pressures.

Chicago & Northwestern Ry., Chicago, Ill. Safety Bulletin 15 in the form of a chart showing the reduction in deaths and injuries to the Northwestern Railway men since the organization of the "Safety First" committee. The number killed decreased from [illegible] in 1910 to 49, in 1914, and the number injured from 8104 in 1910 to 5520, in 1914.

Lagonda Mfg. Co., Springfield, Ohio. Booklet T 1 entitled "Lagonda Boiler Room Specialties," describing and illustrating the various types of Lagonda boiler tube cleaners with latest improvements and boiler quick repair tools. The book also covers automatic cut-off valve and multiple [illegible]. Copy may be had on request.

Barratt-Cravens Co., [illegible] Federal St., Chicago, Ill. Circular of the [illegible] ball bearing multitruck, capacity up to 4000 pounds, for use in shops, mills, factories, warerooms and all places where boxes and material are handled in large quantities. One man can load and unload the truck instantly, thus saving much time and labor in handling materials.

Schuchardt & Schutte, 90 West St., New York City. Circular of the S. & S. divided machine vises for planing, milling, shaping, drilling, slotting and other machining operations where the ordinary machine parallel vises are commonly used. These vises were designed to economize space, and to hold the work firmly without tendency to lift from the table.

United States Electrical Tool Co., Sixth Ave. and Mt. Hope St., Cincinnati, Ohio. Catalogue 12, illustrating and describing "United States" portable electrically driven hand and breast drills, electric radial drills, electrically driven grinders, and grinding and buffing outfits. The book also includes general instructions on the care of electrical tools.

Otis Elevator Co., 11th Ave and 26th St., New York City. Catalogue descriptive of the various types of gravity spiral conveyors for conveying merchandise, etc., made by this company. The latter part of the book describes ten typical systems used in ten different lines of business for lowering goods on the Otis gravity spiral conveyor.

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletin 1003 on Type Q brakes, used chiefly on cranes and other types of hoisting apparatus. Bulletin 1039 on E. C. & M. reversing motor planer drive. This equipment was designed for driving a reversing planer directly by an electric motor which is automatically reversed at the end of the cutting and return strokes.

Woburn Gear Works, Woburn, Mass. Catalogue giving prices, catalogue number, dimensions, etc., for spur gears, racks, internal gears, bevel gears, worm-gears, ratchets, sprockets and chains, etc. This company does not carry many spiral gears in stock, but all kinds and sizes are made promptly to special order, and all kinds of gears are also made to order from rawhide and fiber.

Woods Engineering Co., Alliance, Ohio. Circular of a boring and grinding attachment for milling machines or lathes, especially adapted for re-boring and grinding worn automobile cylinders. The grinding wheel is given a planetary motion, the range of eccentricity being two inches. The attachment is thus applicable to the grinding of multiple cylinders which could not be swung on the centers of their respective bores.

Cincinnati-Bickford Tool Co., Cincinnati, Ohio. Circular of the "Cincinnati" tapping chucks designed to facilitate the operation of tapping in horizontal, upright, and radial drilling machines. The quill of the chuck is provided with ball bearings, so applied as to reduce frictional resistance of the tap leading into the work, and thus to avoid the trouble with stripped threads often encountered with tapping chucks in general.

Fort Wayne Electric Works of General Electric Co., Fort Wayne, Ind., has issued an index of its bulletins, giving the subject, the old series number, and the number of the bulletin that succeeds or is succeeded by each bulletin. Some of the new publications are: Bulletin 45201 on type A transformers of large capacities; Bulletin 46100 on type M demand indicators; and Bulletin 48100 on commutating pole direct-current crane and hoist motor.

Celfor Tool Co., Buchanan, Mich. Catalogue 15, listing and briefly describing all the standard tools comprising the "Celfor" line, which includes twist drills, flat twist drills, flat drills, bonding drills, track bits, centering drills, ratchet drills, oil-tube drills, blacksmith drills, three-fluted drills, four-fluted drills, flue-sheet drills, chucking reamers, taper reamers, locomotive reamers, drill chucks, drill sockets, lathe tool-holders, tool bits, flue cutters, and drill gages.

General Electric Co., Schenectady, N. Y. Bulletin 41500, describing General Electric small direct- and alternating-current motors of the drawn shell type. These are all fractional horsepower motors which have been especially designed for application to the diversified forms of small machines which may be driven by electric power. They range in capacity from 1/30 to 1/4 horsepower, inclusive, are wound for either direct or alternating current, and are furnished for use on circuits of standard voltages.

Automatic Wrench Co., Boston, Mass. Leaflet on the "Barnsley" automatic wrench, which has been designed to meet the demand for a simply constructed quick-acting wrench that can be quickly adjusted to size and used with one hand. The wrench is operated by merely placing the object to be turned between the jaws, and pressing the jaw in, or drawing the jaw in with the thumb-trigger until it strikes the object, the automatic locking clutch then comes into action, holding the work firmly between the jaws.

General Electric Co., Schenectady, N. Y. Bulletin 44104, describing one of the new line of General Electric ventilated commutating pole motors. This motor has a rated capacity of 80 horsepower on 600 volts, but, due to the special feature of induced ventilation, has a greater service capacity than motors of the closed type with the same hourly rating. A more detailed description is given in Bulletin A 4171. The new bulletin contains a schedule of speed tables and characteristic curves of the motor.

Olmsted Flint Co., Cambridge, Mass., is issuing a pamphlet entitled "The Velap Story," which tells about a new form of lap for leather belting. This lap comprises a dovetail splice, one end of the belt being cut wedge-shaped and inserted into the end of another strip which has been opened up V-shaped to receive it. In applying to pulleys, the apex of the wedge is run in the same direction as the belt travels. Thus no exposed lap ends run against air or pulley, and consequently trouble from lifted lap ends is eliminated.

New Departure Mfg. Co., Bristol, Conn. Catalogue on "New Departure" ball bearings, treating of the ball bearing and its development, what ball bearings mean to the car owner, why the ball bearing has the least friction, the strength of chrome alloy steel balls, the fallacy of the point contact, loads bearings must sustain. The last section of the book contains detailed descriptions of the four types of "New Departure" ball bearings, viz., the double-row bearing, the single-row bearing, the radax ball bearing, and the magneto ball bearing. Tables give dimensions and price lists of these various types.

Charles H. Besly & Co., 120-B N. Clinton St., Chicago, Ill. Booklet illustrating and describing the No. 19 53-inch Besly grinder. The booklet is illustrated with views taken in a number of plants, showing the grinder under actual working conditions. In this type of grinder the work is laid on the face of the disk wheel and held there by gravity, the grinding wheel being kept loaded with as many pieces as it will accommodate. This machine is used principally for jointing and flatting large work with a comparatively small area of finished surface, such as gear-cases, split shaft bearings, foundry flasks, etc.

George Gorton Machine Co., Racine, Wis. Catalogue on the Gorton 2-E patent heavy-duty cutting-off machine of the 13-inch size. This machine is designed for constant hard service on 8-inch to 13-inch rounds and 3-inch to 9¼-inch squares, and it can be used for any other size or shape that will come within a 13-inch circle. The book contains a complete description of the machine, illustrated by halftones and line drawings that make the various details very clear. The capacity of the machine for heavy work is shown by the full-size reproductions of chips produced by this machine on pages 24 and 25. Some of the cuts actually made by this machine are also illustrated.

Blaisdell Machinery Co., Bradford, Pa. General catalogue on the Blaisdell line of air compressing machinery and vacuum cleaner systems. Some of the subjects treated are: uses of compressed air, compressed air in textile manufacturing, air-lift pumping system, compressed air in steam hammers, extraction of gasoline from natural gas, volumetric efficiency of air compressors, comparison of single and duplex compressors, high compressor speeds, air compressor installation and operation. Following this descriptive matter, a large number of tables are given of value in connection with air compressing machinery. The various types of air compressors made by this firm are also illustrated and described.

Boston Elevated Ry. Co., Boston, Mass. Pamphlet containing data presented to the American Museum of Safety in competition for the Anthony N. Brady Memorial gold medal for the year ending June 30, 1914. The gold medal was awarded to the Boston Elevated Railway Co. by the jury of award, consisting of Bion J. Arnold, Prof. George F. Swain, James McGraw, William J. French, and Frank J. Sprague. The jury awarded the replica of the gold medal in silver to Hon. Russell Adams Sears, general attorney of the company, as the member of the operating staff who has most contributed to the successful record of the company, and the replica in bronze to Henry Vinton Neal, mechanic, an employe of the company whose services were of the greatest value in the promotion of safety and health.

Bantam Anti-Friction Co., Bantam, Conn. Bluebook for 1915, containing data on ball and roller bearings. The appendix comprises a reprint of an article on "Ball Bearings and Roller Bearings" by W. S. Rogers, published in the "Engineering Magazine," that contains information on the design of ball and roller bearings and results obtained in practice with various typical forms. The typography of the book is unusual, the printing being done entirely in blue, and the lettering and illustrations appearing in white. The tables and drawings are all on right-hand pages, the left-hand pages being left open for data or memoranda which the engineer or designer may desire to add from time to time. It has been the aim to make the blue book so complete that the draftsman can design and lay out bearings for any load or speed. Any draftsman or engineer can obtain a copy of this publication upon request.

TRADE NOTES

O. A. Gray Co., Cincinnati, Ohio, builder of Gray planers, has appointed the Swind Machinery Co., Bourse Bldg., Philadelphia, Pa., selling agent in the Philadelphia district.

C & C Electric & Mfg. Co., Garwood, N. J., announces that its St. Louis agent, the Morse Engineering Co. has removed from the Central National Bank Bldg. to the Chemical Bldg.

Hendey Machine Co., Torrington, Conn., has broken ground for a one-story brick addition to its plant, 60 by 90 feet. A large foundry will also be erected in the near future but plans for this have not yet been announced.

Bridgeport Arms Co., Bridgeport, Conn., is a new concern building a large plant in Bridgeport for the manufacture of firearms which, as soon as completed, will give employment to 2000 persons, and to a larger number later.

Burd High Compression Ring Co., Rockford, Ill., has removed its general and executive offices from the Masonic Temple to 307-309 S. Main St., Rockford, where larger quarters have been taken to accommodate its rapidly increasing business.

Seth Thomas Co., Thomaston, Conn., will erect a large plant on the site of its present case shop, which will combine the three present plants, movement, case, and marine and watch into one immense plant with a floor space of about 275,000 square feet.

JUNE MACHINERY 1915

How We came to have the Micrometer Caliper[*]

Historical Sketch of the Development of Fundamental Principles and Improved Features

By Luther D. Burlingame[†]

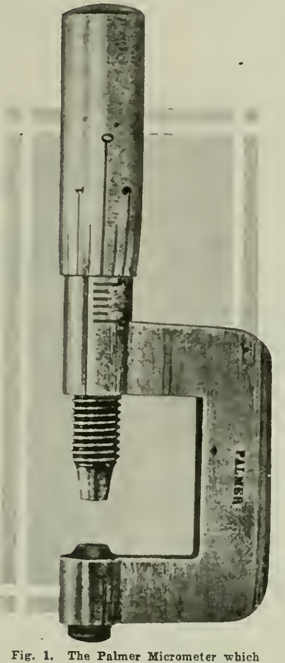


Fig. 1. The Palmer Micrometer which is believed to be the First Micrometer Caliper

In this article, Mr. Burlingame presents a chronological record of the development of the micrometer caliper. Starting with the patent granted to Jean Laurent Palmer, of Paris, France, on September 7, 1848, for the first typical instrument of this type, the development of the different forms of micrometers, and of the improvements which have been made in standard and special purpose instruments of this type, is followed right through to the latest developments of well-known American makers of micrometers.

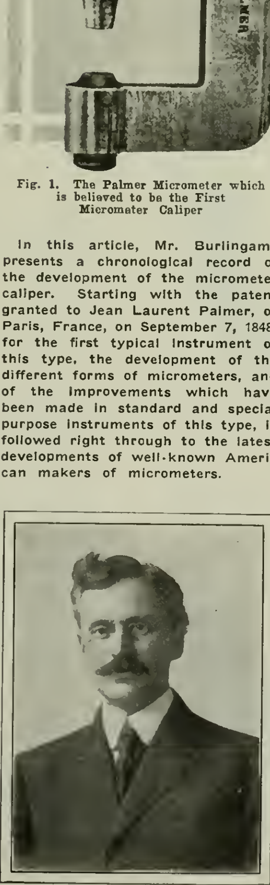
There seems to be so much uncertainty regarding the origin of the micrometer caliper and the steps taken in its development, and such loose statements have been made concerning these matters, that the subject appears to be one of sufficient importance and interest to warrant bringing the facts together in the form of a brief history. Such a history shows that, like many other important inventions, the micrometer caliper is the result of a gradual evolution, and is the product of many minds and many hands. Of the three great divisions into which all mechanical progress can be grouped, *i.e.*, metallurgy, mechanism and measurement, the micrometer caliper has come to hold a prominent place in the field of measurement.

The First Micrometer Caliper Patented in 1848 by Palmer

The evidence which is now available shows that credit for the origin of this instrument, as we now know it, must be largely accorded to a French inventor and machinist by the name of Jean Laurent Palmer, who was working at the time in Paris. Palmer's "screw caliper," as he called it, was patented in France September 7, 1848, and was manufactured under the name of the "Systeme Palmer." Fig. 1 shows the Palmer caliper as it was made for the market, and Fig. 2 is reproduced from the patent application. There did not seem to be any general appreciation of the importance of this tool until the year 1867, when it was seen by Joseph R. Brown and Lucian Sharpe, when on a visit to the Paris Exposition of that year, where they were exhibitors. They were impressed with the possibilities of such a tool when properly made, and brought one back with them on their return to America. Soon after, they commenced the manufacture of a small sized micrometer, suitable for measuring sheet metal and wire, placing it on the market in 1869 under the name of the "pocket sheet metal gage." The reason for placing this size on the market was that there had been a request from the Bridgeport Brass Co. for a tool to measure sheet brass, following a controversy which had arisen as to the correct thickness of a shipment of sheet brass.

The Laws Micrometer for Measuring Sheet Brass

S. Wilmot, of the Bridgeport Brass Co., had designed a gage for the purpose of measuring this stock and had six of these instruments made by a skilled machinist named Hiram Driggs, under the direction of A. D. Laws, who was then in charge of the mechanical department of the Bridgeport Brass Co. The matter had been taken up with J. R. Brown & Sharpe, with the idea of having them make these gages, and the one shown in Fig. 3 with Mr. Laws' name stamped on it is now in the possession of the Brown & Sharpe Mfg. Co. This tool was not considered to be of commercial value, because the cylinder was so completely covered with spiral and straight lines intersecting each other that it was impossible to put any figures upon it; and without figures, it was very difficult to read. The reading of thousandths of an inch was made by means of a spiral line of the same pitch as the screw running around the cylinder, this being crossed by lateral lines. While the Palmer micrometer had a coarse thread, reading only as fine as tenths of millimeters (about 0.004 inch) and was crudely made, it gave the idea of the present system of divisions; and this system was adopted for the Brown &



Luther D. Burlingame[‡]

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[*] For additional information on micrometers published in MACHINERY see also "Micrometer Caliper as a Machine Shop Gage," December, 1914; "Large Outside Micrometers," February, 1914; "A Three-point Micrometer and Its Uses," May, 1913; "Ball Point vs. Anvil Point Thread Micrometers," May, 1910; and "Some Micrometer Measuring Instruments," September, 1904, and other articles referred to.

[†] Address: 15 Catalpa Road, Providence, R. I.

[‡] Luther D. Burlingame was born in Whitestown, N. Y. He served an apprenticeship with the Brown & Sharpe Mfg. Co., Providence, R. I., in drafting and machine shop practice, and has remained continuously in the employ of the Brown & Sharpe Mfg. Co. ever since. He was its chief draftsman for twenty-six years and is now its industrial superintendent. He has given much attention to industrial service, patent matters, organization and welfare work. Mr. Burlingame is an active member of the American Society of Mechanical Engineers, being chairman of the sub-committee on machine shop practice. He has contributed papers to its proceedings and those of other engineering societies and many articles to the technical press. He is a past-president of the Providence Association of Mechanical Engineers.

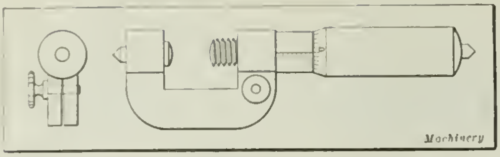
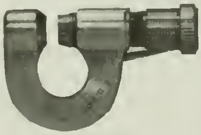


Fig. 2. Reproduction of a Drawing in Palmer's Patent Application

Sharpe pocket sheet metal gage, while the general form of the gage designed by Mr. Wilmot was followed, adding, however, means of compensation for wear of both the measuring screw and the measuring surfaces, as shown in Fig. 4.

It has been suggested that Brown & Sharpe may have got the idea of the micrometer caliper from the screw-operated punch, Fig. 5, which is shown in Vol. II of Holtzapffel, a book which was at that time in their possession. This simply illustrates how little appearances can be depended on to determine who is really the inventor. The introduction of the 1-inch micrometer caliper, Fig. 6, followed that of the pocket sheet metal gage, it being shown in the Brown & Sharpe catalogue of 1877, and here, for the first time, the name "micrometer caliper" was used. It is not known how soon after this date the instrument came to be familiarly called a "mike."



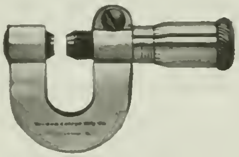


Fig. 3. First American Micrometer—made by the Bridgeport Brass Co.
Fig. 4. Brown & Sharpe Pocket Sheet Metal Gage

The Earliest Micrometer Gages

It must not be understood that because credit has been given to Palmer as the originator of the micrometer caliper, there had not been earlier steps taken to produce micrometer tools for measuring. The earliest that we have record of was a micrometer invented by William Gascoigne of Yorkshire, England, this being described in the "History of Interchangeable Manufacture" by W. F. Durfee, "A. S. M. E. Transactions," Vol. 14, page 1251. It is there stated that Gascoigne's micrometer consisted of two parallel jaws, moved by a screw with a divided head. James Watt also turned his attention to the designing of a micrometer gage, and one of his make, which is shown in Fig. 7, is now preserved in the South Kensington Museum in London. This has a screw and rack adjustment for the sliding jaw with one dial reading for complete turns of the screw and another for fractional turns.

One of the earliest micrometers that our records show to have been made in America is illustrated in Fig. 8; this was made by R. Hoe & Co., of New York, about 1858. This is a bench micrometer with one jaw that can be set to even inches, while the other can be adjusted for divisions of an inch, end measuring bars being used for making the setting. The reading is secured by means of graduations on the dial which forms the head of the adjusting screw. Either inside or outside measurements can be made with this instrument, as will be readily seen

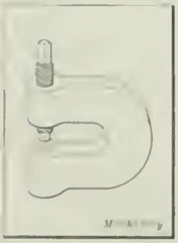


Fig 5. Screw-operated Punch suggested as Forerunner of Micrometer

Other Early Brown & Sharpe Designs

An early form of micrometer made by J. R. Brown & Sharpe, which was probably designed by Joseph R. Brown, was a sheet metal gage standing on three legs, Fig. 10, the measuring screw being turned from below and the graduated dial revolving with it. This instrument was put on the market in 1867. Another micrometer of Mr. Brown's design, Fig. 9, for measuring up to 4 inches in diameter, was made about 1875. This is in the form of a sliding bar adjusted by a screw and reading to a vernier, one of the measuring points being connected to a series of multiplying levers to make it possible to use this instrument as a limit gage, or to show variations of measurement without resetting.

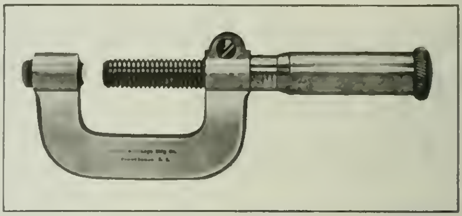


Fig. 6. The Brown & Sharpe 1-inch Micrometer Caliper

The Victor Micrometer Caliper

Pratt & Whitney made a bar micrometer measuring instrument, Fig. 11, about 1881, the micrometer heads for which were made by the Victor Sewing Machine Co., of Middletown, Conn. The latter company was one of the earliest competitors of Brown & Sharpe in the micrometer business. They took up the manufacture of micrometer calipers about 1878, and on April 23 of that year, a patent was issued to one of their employes named George M. Pratt, covering the features of the U-shaped frame and the inserted hardened measuring points. In 1883, Brown & Sharpe bought the micrometer business of the Victor Sewing Machine Co. and commenced the manufacture of 1- and 2-inch micrometers, Fig. 12, made under their patents. At the time when this transfer was brought about, Frank Spalding had charge of the making of micrometer calipers for the Victor Sewing Machine Co. and was working as a contractor for them. He, in cooperation with Mr. Pratt, who was superintendent and a stockholder, can be credited with the improved features of

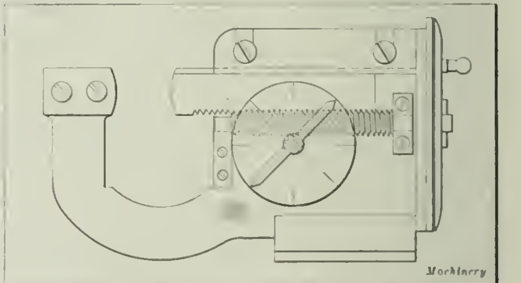


Fig. 7. Micrometer Gage made by James Watt

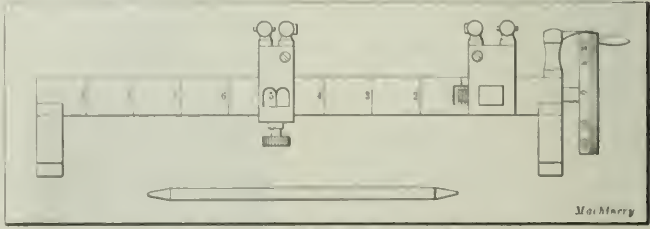


Fig. 8. An Early American Micrometer of the Bench Type, made by R. Hoe & Co., about 1858

design and the very high-grade methods used in the manufacture of their calipers. He was induced to enter the employ of Brown & Sharpe at the time the transfer was made, and brought with him the parts of calipers remaining unfinished. Among these were five hundred frames for 2-inch micrometers, several thousand of this size having already been made and sold before the transfer. These remaining frames were finished at the Brown & Sharpe Works, and new lots at once started.

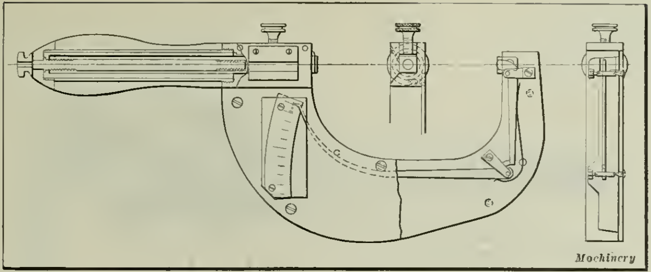


Fig. 9. An Early Micrometer with a Capacity up to 4 inches

Large Size Micrometers

J. T. Slocomb, in the December, 1914, number of MACHINERY, gives the impression that micrometers with capacities above 1 inch were not regularly made for the market until a later date. It will be seen, however, from the above facts, that even as early as 1883 they were becoming widely used. The manufacture by Brown & Sharpe of 3-inch micrometers of the same general design as the 2-inch size, and also of larger sizes, followed soon after the introduction of the 2-inch micrometer. One design of the 6-inch size, made about 1885, is shown in Fig. 13. The making of bar micrometers had been begun by Mr. Spalding before leaving the Victor Works, and was later taken up by Brown & Sharpe, the design being as shown in Fig. 14.

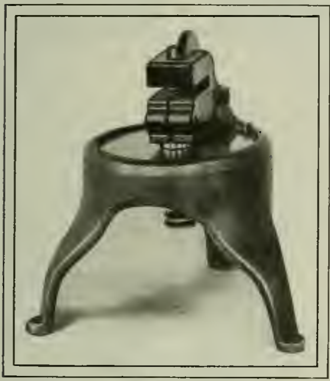


Fig. 10. Sheet Metal Gage designed by Joseph R. Brown

Prof. John E. Sweet invented a micrometer gage for adjustment through a wide range of sizes that also possessed other interesting features, which he patented on March 10, 1885. This gage, which is shown in Fig. 15, was made by the Syracuse Twist Drill Co. There has been a growing demand for larger and larger sizes of micrometer calipers, so that sizes up to 20 inches are now regularly listed, and larger sizes are made to order. Fig. 17 shows a 38-inch size.

Vernier Divisions of Thousandths

In the "reminiscences" of J. T. Slocomb just referred to, mention is made of a 2-inch micrometer caliper which he saw when in the employ of the Brown & Sharpe Mfg. Co., in the possession of one of the foremen. This no doubt refers to a micrometer which was made by William G. Burnham before he entered the employ of the Brown & Sharpe Mfg. Co.; and this micrometer has an interesting history. Mr. Burnham made it while with J. F. Blair & Co., of Camden, N. J. At that time the design of a micrometer with a protected screw had just been brought out, so that the one made by Mr. Burnham, Fig. 16, was of an up-to-date design. Not only this, but he added a feature of refinement in making his caliper with a vernier reading to sub-divide the thousandths of an inch. It was done by graduating parallel lines on the barrel, as shown at *A*. While Mr. Slocomb in his article jokingly speaks of this micrometer as having been "graduated with a monkey-wrench," it is, as a matter of fact, not only well made but accurate to a degree beyond what would have been expected when it is understood that practically all of the operations of screw cutting, graduating, etc., were performed on an engine lathe. This, however, was an engine lathe especially made for precision work. Shortly after Mr. Burnham entered the employ of the Brown & Sharpe Mfg. Co. the feature of providing a vernier to read to ten-thousandths of an inch was adopted for some styles of their calipers. It is not known whether or not this method originated with Mr. Burnham. There is an old French micrometer in the possession of the Brown & Sharpe Mfg. Co. at present which has a similar feature, and which may have been earlier in date than Mr. Burnham's.

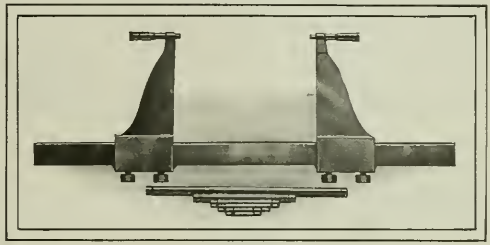


Fig. 11. Bar Micrometer Measuring Instrument made by Pratt & Whitney

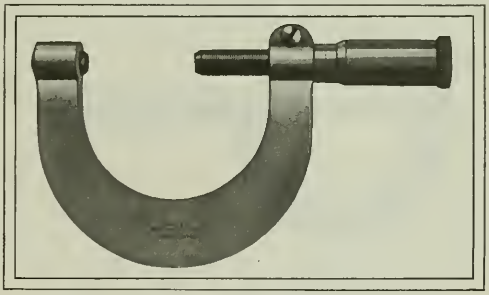


Fig. 12. Victor Micrometer with U-shaped Frame and Hardened Measuring Points

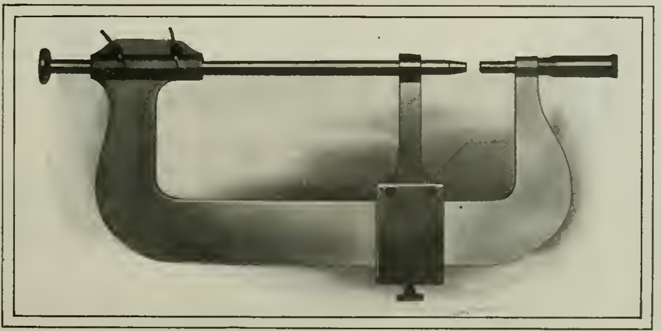


Fig. 13. A 6-inch Brown & Sharpe Micrometer made about 1885

Protected Screw

The feature of having the screw protected and the spindle supported in a bearing at the front end was first introduced by A. J. Wilkinson, of Boston, being made under the Barnes patent of July 3, 1883. An earlier Barnes patent, dated January 30, 1883, had a cap to protect the screw thread. It was made in the form of a bar micrometer, Fig. 18, and like the Brown design shown in Fig. 9, has means of indicating variations in size by a system of multiplying levers.

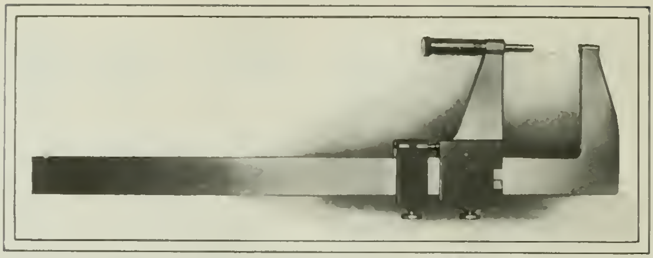


Fig. 14. An Early Form of Brown & Sharpe Bar Micrometer

The Speeder

While not the earliest example of a "speeder" for quickly adjusting the measuring screw, the Barnes micrometer plainly shows the provision of such a feature. The speeder later became the subject of a patent taken out by L. S. Starrett. About this same time, Cyrus Carleton, a designer in the employ of the Brown & Sharpe Mfg. Co., brought out an improved method of taking up the wear of the adjusting screw; and J. Moffitt, of Southbridge, Mass., made further improvements, so as to avoid having openings exposed to the dirt. The Barnes, Carleton and Moffitt patents were acquired by the Brown & Sharpe Mfg. Co., and in 1884 this firm commenced the manufacture of micrometers, having the features of improvement covered by them, as shown in Fig. 19. Also, for the first time, the practice of stamping decimal equivalents on the frame was followed, this feature also being the suggestion of Mr. Moffitt.

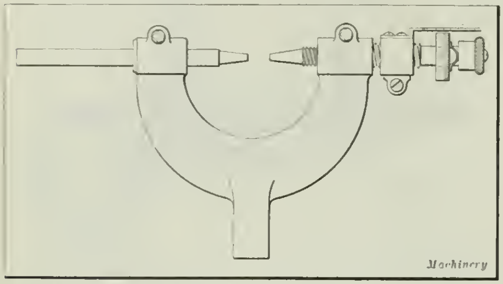


Fig. 15. Micrometer Gage with a Wide Range of Adjustment, designed by John E. Sweet

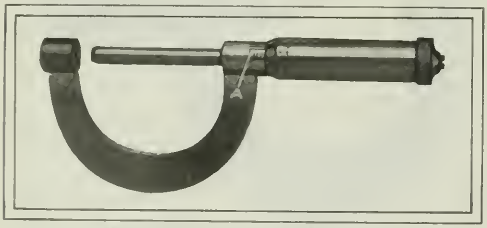


Fig. 16. Micrometer with a Protected Screw and Vernier to subdivide Thousandths of an Inch

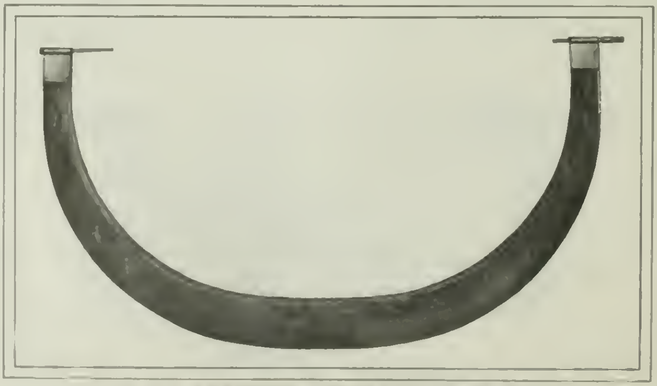


Fig. 17. A 38-inch Micrometer with the Familiar U-shaped Frame

The Ratchet Stop

In addition to the speeder for quickly adjusting the position of the spindle, which has already been mentioned, another feature of refinement is the ratchet stop by which the micrometer can be brought to the same reading regardless of the difference in the degree of sensitiveness of touch of different operators. The use of the ratchet for this purpose was patented by George W. Church, of Roseville, N. J., on May 22, 1883, and one of his micrometers having this feature is shown in Fig. 20. It has been claimed that here, again, the French designers anticipated the American; but whether or not the ratchet stop was used prior to the date of the Church patent, friction devices for the same purpose were used at an earlier date; Fig. 21 illustrates the patent of A. Bonnaz of Paris, dated August 19, 1873.

The Clamping Device

An important feature in the development of micrometer calipers consisted of providing a clamping device, so that the spindle could be locked in position without changing its setting in the slightest degree, and many efforts were made to solve this problem. While various means were tried out for this purpose, the early designs were faulty, because in almost all cases the setting was likely to be disturbed when the spindle was clamped—a defect fatal to the securing of accurate measurements. The importance of this feature has led to persistent efforts being made to remedy the defect. The micrometer on which a patent was granted to Palmer in 1848 was provided with a device, Fig. 2, which might be used either as a means of adjustment for the wear of the screw or as a clamping device. One of the earliest clamping devices which came into practical use, and one which is in use to some extent at the present day, was devised about 1885 by Frank Spalding. This consists of a bushing drawn against the spindle by a clamping screw, as shown in Fig. 19.

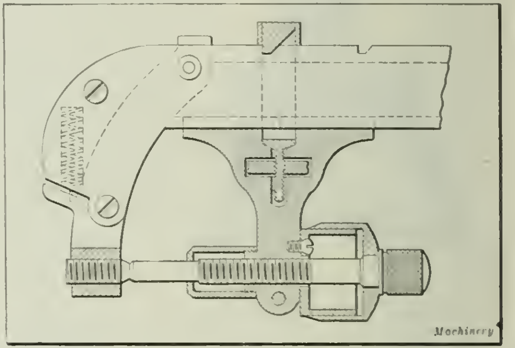


Fig. 18. Feature of a Protected Screw and Support for the Spindle at the Front End

On August 24, 1886, John T. Usher,

of Elmira, N. Y., patented a micrometer gage having an enclosing ring with tapering threads to clamp the spindle in position, as shown at *B* in Fig. 37. This was a gage for inside measurement and will be referred to later under that heading, as it was also one of the earliest inside micrometer calipers. Two years later John A. MacDonald, of Lowell, Mass., brought out a bar caliper, Fig. 22, using a similar means for clamping the thimble in position. In the late eighties, L. S. Starrett took up the manufacture of micrometer calipers, and on July 29, 1890, he also patented a clamp nut for locking the spindle of a micrometer. This had a taper on the inside of the nut instead of using a tapering thread, the design being shown in Fig. 23. On December 30, 1902, Frank Spalding patented another form of clamping device, Fig. 24, especially designed to avoid moving the spindle in the slightest degree when clamping. This clamping device is inserted in a slot in the frame, and is the one now used in the Brown & Sharpe micrometers. To illustrate from how many sources the features of the present-day micrometer have been derived, reference may be made to Fig. 25, where some of these features, together with their inventors, are indicated.

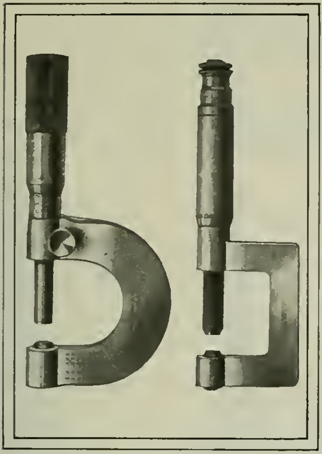


Fig. 19. Brown & Sharpe Micrometer combining Improvements covered by Barnes, Carleton and Moffitt Patents
Fig. 20. Micrometer provided with Church Ratchet Stop

Screw Thread Micrometer

Another application of the micrometer principle is the measuring of screw threads. On December 27, 1887, George E. Whitehead, then superintendent of the Providence Tool Co., secured a patent for a screw thread micrometer, covering practically the same features that are now used. (See Fig. 26.) When he showed this tool to Brown & Sharpe he was taken to a toolmaker, Martin Hiscox by name, who had charge of making and maintaining the tools used in the sewing machine and small tool work. Mr. Hiscox showed him a tool then in his possession having almost identically the same features; and it was afterward learned that J. M. Carpenter, of the J. M. Carpenter Tap & Die Co., had also made a screw thread vernier caliper, Fig. 28, as early as 1875, which may be the earliest tool of this character which was made. Later, Brown & Sharpe and others took up the regular manufacture of screw thread micrometers.

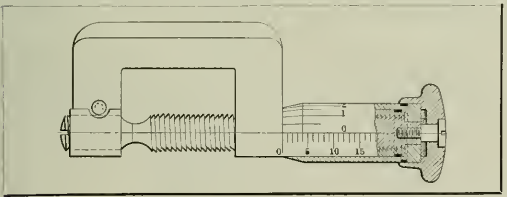


Fig. 21. Micrometer provided with Bonnaz Friction Stop

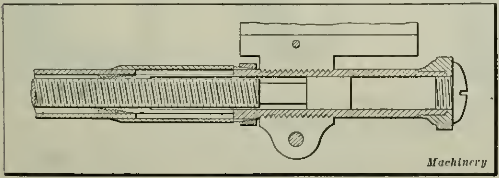


Fig. 22. John A. MacDonald's Method of clamping Micrometer Thimble

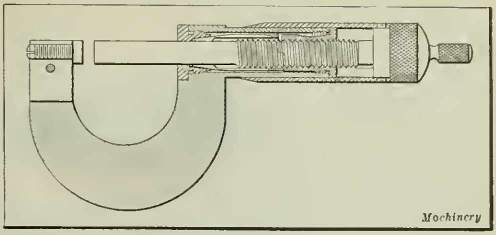


Fig. 23. L. S. Starrett Clamp Nut for locking Micrometer Spindle

Quick Adjustment

Many efforts have been made to provide quick adjustment for the micrometer spindle, so that it could be moved bodily a considerable distance and retain its accuracy when again set. Besides the example shown by the illustration of the Barnes design, Mr. Barnes and other employes of A. J. Wilkinson made many attempts to produce a successful quick-adjusting or "shifting" micrometer. Such a micrometer was patented by L. S. Starrett and C. P. Fay, on September 24, 1889. A patent for the later Starrett design, taken out in the name of L. S. Starrett and J. A. Adell, January 2, 1906, is the one now placed on the market by the L. S. Starrett Co., which is shown in Fig. 27.

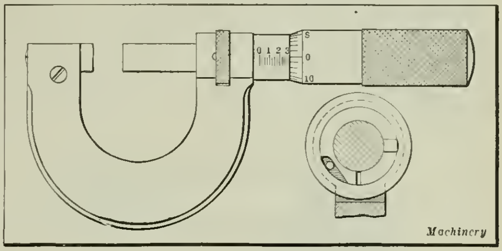


Fig. 24. Form of Clamping Device now used on Brown & Sharpe Micrometers

Direct Reading

Even though the Palmer system of micrometer reading was such a great improvement over any others suggested, the fact that there still remained a possibility of making a mistake in the reading has led to many attempts to produce a direct-reading micrometer caliper. On April 11, 1893, a United States patent was issued to J. Ciceri Smith, of Edinburgh, Scotland, for a direct-reading micrometer, one design of which is shown in Fig. 29. This patent was acquired by the Brown & Sharpe Mfg. Co., although micrometers of this design were never made by them. But it was not until the Spalding direct-reading micrometer, shown in Fig. 30, was developed, during the years 1911-1913, that the point was reached where such a micrometer was successfully placed upon the market. This micrometer was fully illustrated and its working described in MACHINERY for January, 1914.

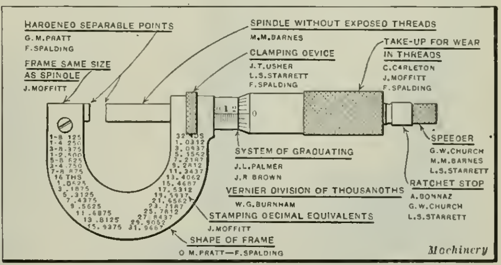


Fig. 25. Features of the Modern Micrometers, and their Inventors

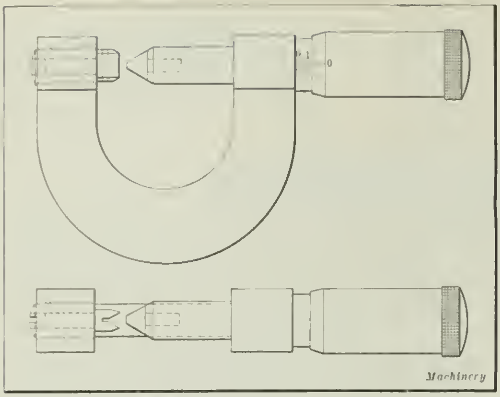


Fig. 26. An Early Type of Screw Thread Micrometer

Heavy Frames

Another recent demand has been for heavy-frame micrometers, made to stand continuous service, and the wear and tear of such work as that handled by the grinding department and others, where the micrometers must be subject to hard usage and sometimes remain clamped in one position for making a large number of duplicate measurements. Such a design, brought out about the year 1911, is shown in Fig. 31. This form of micrometer was first suggested by Charles H. Norton of the Norton Grinding Co., and following the suggestion, Mr. Spalding made a model which resulted in an order for twenty-five each of the 1- and 2-inch sizes for use in the Norton grinding department. Subsequently, this form of micrometer was placed on the market.

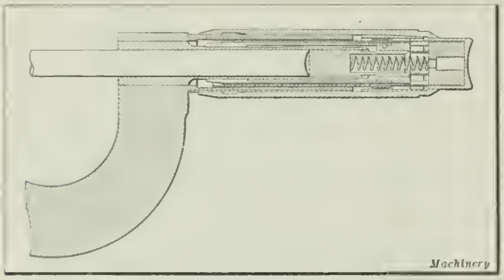


Fig. 27. Mechanism of the L. S. Starrett Quick-adjusting Micrometer

High Finish

The idea usually associated with a fine measuring tool is that it should have a very high finish, and there is a feeling that the care taken by the workman in making a tool has some connection with its finish. It was felt, however, that a need existed for a cheaper form of micrometer, without such high finish; and a line of such calipers was designed and introduced by J. T. Slocomb, a design patent for the same having been taken out by him on April 13, 1897. One of the J. T. Slocomb micrometers is shown in Fig. 32. A new line of low priced micrometers has just been placed on the market by the Brown & Sharpe Mfg. Co., known as the "Rex" micrometers, one of which is shown in Fig. 33. These have been fully described in the May, 1915, number of MACHINERY.

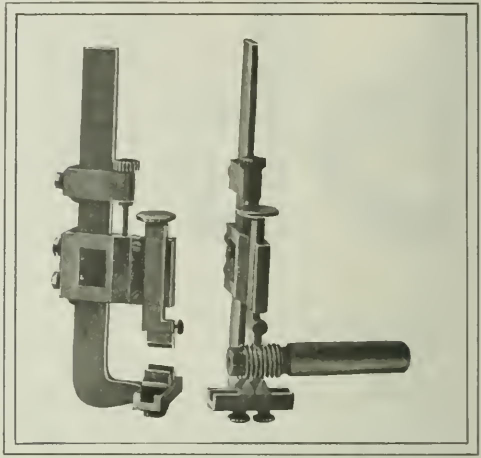


Fig. 28. Screw Thread Vernier Caliper made by J. M. Carpenter 1875 (MACHINERY, December 1912, page 253)

Micrometers for Use in Rolling Mills

Among other forms of micrometers are those for use in measuring at a considerable distance in from the edge of the work, the prototype of which, Fig. 34, was made by Cyrus Carleton about 1882. The present design is shown in Fig. 35, and the opposite extreme used for measuring in restricted places is illustrated in Fig. 36.

Inside Micrometers

The inside micrometer gage seems to have been independently invented by several persons. A patent was issued to John T. Usher, of Elmira, N. Y., on August 24, 1886, for the gage shown in Fig. 37; and this patent claims, among other

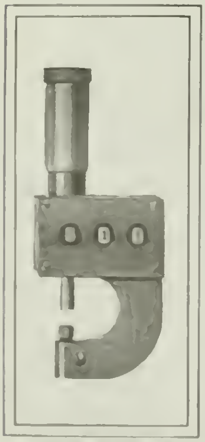


Fig. 29. Direct-reading Micrometer invented by J. Cleerl Smith

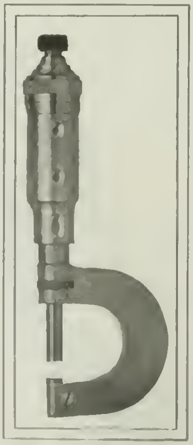


Fig. 30. Spalding Direct-reading Micrometer made by Brown & Sharpe

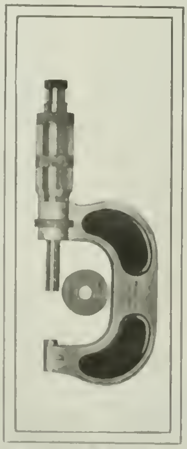


Fig. 31. A Heavy Type of Micrometer adapted for Hard Usage

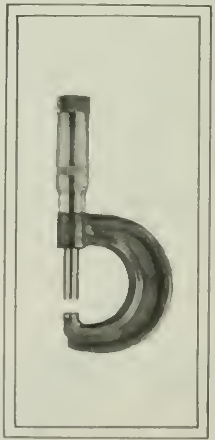


Fig. 32. The J. T. Slocomb Micrometer Caliper with Drop-forged Frame

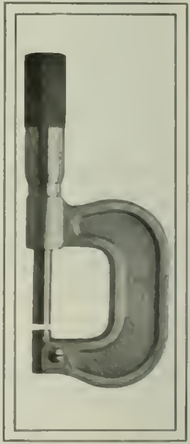


Fig. 33. The Brown & Sharpe "Rex" Micrometer Caliper

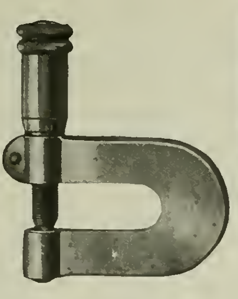


Fig. 34. Prototype of the Deep Bow Micrometer

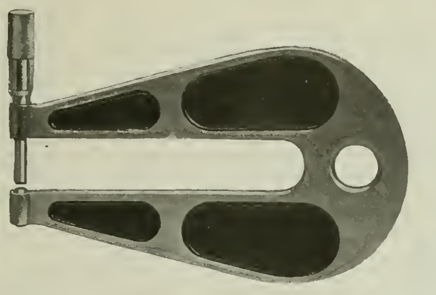


Fig. 35. Present Form of Micrometer used for measuring at a Distance from Edge of Work

features, the use of a handle *A*. Another inventor, David G. Brown, of Philadelphia, made application for a patent for a "micrometer pipe gage" on March 18, 1885; he was apparently ahead of Usher, although his patent was not issued until after Usher's. Brown's gage, which is shown in Fig. 38, may be considered the prototype of the tubular micrometers. On April 26, 1884, John L. Jacobs, then a machinist at the Brown & Sharpe works, made a drawing of an inside micrometer caliper, Fig. 39, of the type which has since been put on the market by that company. The latest type of tubular micrometer made by the same firm, which was designed by Frank Spalding, is shown in Fig. 40. The micrometer principle has been applied to many other forms of tools, such as the micrometer depth gage, etc., each of which has its own stages of development, but practically all can be traced back to the Palmer micrometer, brought to America in 1867 by Joseph R. Brown and Lucian Sharpe.

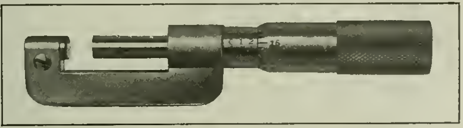


Fig. 36. Micrometer used for measuring in Restricted Spaces

* * *

BIG BUSINESS ECONOMICS

The advantages that flow from large capital wisely invested are quite apparent in modern manufacturing plants, especially those in the metal-working industries. Steel-concrete buildings equipped with the sprinkler system reduce the fire hazard to a minimum; hence the insurance rates are very low and the danger of interruption of manufacturing because of fire is practically eliminated. The modern factory building provides for admitting a flood of daylight, 75 to 80 per cent of the area of the outer walls being glass. Scientifically arranged electric lights provide the illumination necessary to make night work efficient when it must be done. Ventilation by tempered air circulated by the plenum system insures the healthful and comfortable working conditions so necessary for efficient production.

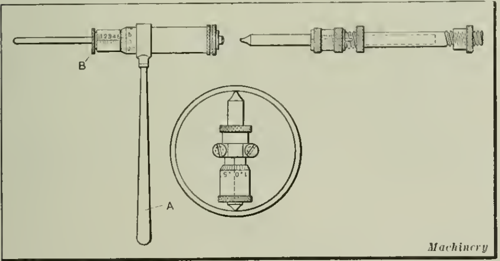


Fig. 37. The "Usher" Inside Micrometer Gage

Fig. 38. "Brown" Micrometer Pipe Gage—Prototype of Tubular Micrometers

Large production makes practicable the use of special machinery which, being designed for one purpose only, subordinates all functions to the one desired. The productive capacity of the employe attending a special machine may be increased ten-fold or even more. Manufacturing on a large scale makes possible scores of economies not worth considering in the small plant. For instance, an automobile concern in Detroit furnishes its workmen in the machine shops with coarse towels instead of waste for wiping off oil. The towels are distributed daily in the morning and collected at night for cleaning. The oil is extracted before washing, and the oil saved in a year amounts to forty barrels.

The development of special machinery for machining the metal parts making up the modern automobile and motor truck has given a tremendous impetus to the design of machine tools generally. The turning of flywheels and camshafts, the milling of cylinders and front axles, the forming of bodies, pans and rear axles from sheet metals, are operations now done with machinery unknown ten years ago.

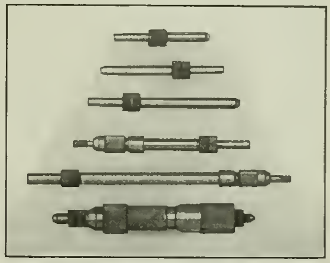


Fig. 39. An Early Type of Brown & Sharpe Inside Micrometer Caliper

Economies of manufacture are not all confined to the large plants by any means, fortunately for the smaller concerns, but the politicians and agitators who rail at all large aggregations of capital as menaces to American institutions should learn to discriminate between those engaged in legitimate production and those which seek by monopolization to make up for brains and enterprise. For these we have no use—they are brakes on progress and dangerous to public welfare—but it is evident that the costs of manufacture rising generally in all lines can be most effectively checked by the development of large and efficient manufacturing plants and their sales organizations.

* * *

A device has been designed, states the *Scientific American*, which will show if an automobile is used without the authority of the owner. The device consists of a small case containing clockwork which unwinds a strip of paper past a needle. The needle is fastened to a carefully balanced pendulum and perforates the paper when moved by the vibration of the car. The tape is marked off in divisions of time, so that the perforations indicate not only that the car has been used, but also how long.

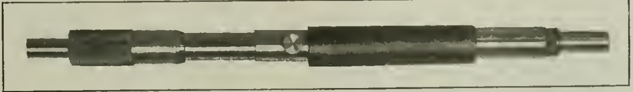


Fig. 40. The Spalding Tubular Micrometer made by the Brown & Sharpe Mfg. Co.

THREAD TOOL GAGES

BY CORRESPONDENT

During the many years that the writer has been engaged in the making of thread gages and the necessary tools for their accurate production, there have been few problems harder to solve than that of making the thread tools themselves, with which these gages were to be threaded, of the required accuracy. The limits of this accuracy are reduced to a minimum, especially when considering the soft—not hardened or ground—master gages, where the final finishing touches cannot be left to the grinding or lapping operation.

Before the advent of the thread micrometer, the art of making thread plug gages, as far as the gage-maker was concerned, was a comparatively simple one, there being hardly any accurate check on him. The means generally employed at that time in gaging thread tools consisted only of a regular bevel protractor for the measuring of the angle, and a plain micrometer for measuring the width of the flat on the tool, an equipment which, with the present high standard in gage-making, would be considered entirely inadequate and inaccurate. After the thread tool had thus been "correctly" made, the thread plug blank (being of the correct outside diameter) was generally turned down for a short distance at the point to the correct root diameter, and then threaded with the tool mentioned until the point of the thread tool "just touched" this turned down part of the plug gage, and then the gage was supposed to be of the correct size and form of thread. On the United States standard form of thread the inspector had a fairly good check on the gage-maker, as, if the gage was correctly made, the flat on the top and in the bottom of the thread of the gage should be exactly alike, an inspection which can be more accurately performed with the naked eye than anyone not acquainted with the facts would be likely to believe, and an inspection which even at the present day must not be laughed at; and it is needless to state that, even with this "crude" inspection, many a thread plug gage had to be made over, owing to incorrectly made thread tools. The procedure followed in making a Whitworth standard thread plug gage was similar, with the exception that the outside diameter of the plug gage was left slightly oversize in order to insure a perfectly round top of the thread when the point of the thread tool "just touched" the turned down part, at which time, if the tool was correctly made, the outside diameter would be correct.

It is interesting to note that, when the thread micrometers first came into use, the Whitworth plug gages were found to be of a much higher degree of accuracy than was found in the United States standard gages, a fact which can hardly be considered very surprising when taking the above procedures into consideration. What the result in accuracy would have been had gages with the United States standard form of thread been made with a sharp bottom of thread, as is now usually done—for clearance—can easily be imagined.

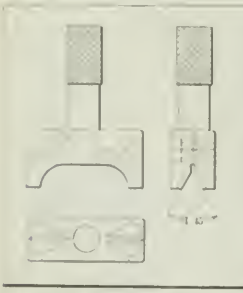


Fig. 1. Gage for measuring Angle of Thread Tools

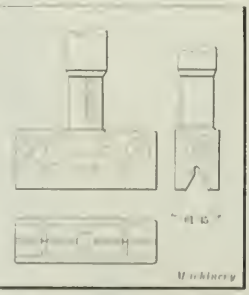


Fig. 2. Gage for determining Width of Flat or Radius on Thread Tools

The best gages for the measuring of thread tools which have come to the observation of the writer are: (1) The gage shown in Machinery's Handbook on page 1036, for measuring the width of the flat on thread tools, and (2) the vernier caliper illustrated in the Brown & Sharpe catalogue of 1913, page 492, for measuring both the width of flat and the angle of 60-degree thread tools.

When considering the *extreme* accuracy, however, necessary in the making of thread tools for gage work, both of these gages have serious drawbacks. The former, owing to its construction, is difficult to make accurately, and when made, the expenses of maintaining its accuracy are considerable. The principle of this gage, however, is excellent and has been embodied in a tool to be described. The second gage mentioned is useful and handy for ordinary thread tools, but does not give the required results when used on thread tools for gage work.

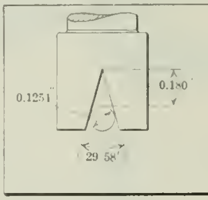


Fig. 3. V-shaped Part of Tool for Acme Thread

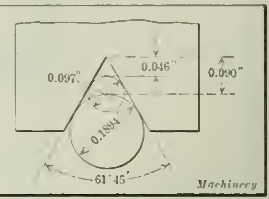


Fig. 4. Plug Gages used for inspecting Accuracy of Angle of Gages

The gages now to be described for measuring the width of the flat and the angle of thread tools can be adapted to suit thread tools of any thread angle and with any clearance angle. They have been shown as made for thread tools with 15-degree clearance angle, this clearance angle being the one most universally used by prominent makers of thread tools and thread tool-holders, as for example, the Pratt & Whitney Co., Hartford, Conn., the Western Tool & Mfg. Co., Springfield, Ohio, and others. Tables for use with these gages, figured for tools with 15-degree clearance, will be found in Machinery's Handbook, pages 1036 and 1037.

As can be seen from the illustration, both gages are made in two sections or halves, so as to be able to make them with accuracy and to maintain this accuracy. The accurate grinding or lapping of the angular sides of the gage, as well as the problem of obtaining a sharp bottom, has thus been simply solved; and when repairs are necessary, all one has to do is to take the two halves apart, grind or lap the angles and readjust the micrometer head.

Another feature of these gages is the narrow bearing surfaces of the V (see Fig. 2) these being made narrow so that any slight imperfection on the tool, such as being out of angle or out of straight, etc., will have a minimum amount of influence on the micrometer reading, and thus reduce any possible errors. It will also be noted that these V's are close together, thus still more minimizing any errors in the reading. The gage shown in Fig. 1 is used for testing the angle of thread tools, but can also be used for testing the straightness of the sides; (for this latter, however, a straightedge is equally serviceable). The testing of the angle can be done not only by the sense of feeling but also by vision, moving the tool (or the gage) back and forth once or twice and noticing the bearing surfaces. The gage shown in Fig. 2 can, of course, be used for the same purpose, but being a more expensive gage, both to make and in upkeep, it has not been found practical for this purpose. The V-part of a gage for measuring Acme thread tools is shown in Fig. 3, the angle of the V for this gage being 29 degrees 58 minutes for thread tools with 15-degree clearance. The angles of the V's for Whitworth and British Association standard threads, for tools with 15-degree clearance, are 56 degrees 38 minutes and 48 degrees 58 minutes, respectively. The micrometer heads should be adjusted to measure 0 for a theoretically sharp top of thread on the tool.

To illustrate the accuracy of the micrometer readings Y of the gages, as compared with the width X (actual) of the flat, the following may serve:

Error of Y, Inch	Kind of Thread	Error in X, Inch
0.001	U. S.	0.001195
0.001	Acme	0.000535

TABLE FOR DETERMINING FLAT AT POINT OF FRENCH AND INTERNATIONAL THREAD TOOLS

(15-degree clearance angle)

Pitch, Millimeters	Micrometer Reading of Gage, Fig. 2	Pitch, Millimeters	Micrometer Reading of Gage, Fig. 2	Pitch, Millimeters	Micrometer Reading of Gage, Fig. 2	Pitch, Millimeters	Micrometer Reading of Gage, Fig. 2
5.0	0.0206	3.75	0.0154	2.5	0.0103	1.25	0.0051
4.9	0.0201	3.7	0.0152	2.4	0.0099	1.2	0.0049
4.8	0.0197	3.6	0.0148	2.3	0.0095	1.1	0.0045
4.75	0.0195	3.5	0.0144	2.25	0.0093	1.0	0.0041
4.7	0.0193	3.4	0.0140	2.2	0.0091	0.9	0.0037
4.6	0.0189	3.3	0.0136	2.1	0.0087	0.8	0.0033
4.5	0.0185	3.25	0.0134	2.0	0.0082	0.75	0.0031
4.4	0.0181	3.2	0.0132	1.9	0.0078	0.7	0.0029
4.3	0.0177	3.1	0.0128	1.8	0.0074	0.6	0.0025
4.25	0.0175	3.0	0.0124	1.75	0.0072	0.5	0.0021
4.2	0.0173	2.9	0.0119	1.7	0.0070	0.4	0.0016
4.1	0.0169	2.8	0.0115	1.6	0.0066	0.3	0.0012
4.0	0.0165	2.75	0.0113	1.5	0.0062	0.25	0.0010
3.9	0.0161	2.7	0.0111	1.4	0.0058	0.2	0.0008
3.8	0.0156	2.6	0.0107	1.3	0.0053	...	......

Machinery

The amount of error in the width of flat X, if the amount of error in the micrometer reading Y is known, may be found by multiplying the error found in Y by 1.1954 for U. S. form of threads, and by 0.53528 for Acme form of thread.

The tables in MACHINERY'S HANDBOOK already referred to cover the United States standard thread, the Whitworth standard thread and the British Association standard thread. A table giving the value of the micrometer reading for a gage such as illustrated in Fig. 2 when measuring widths of flats of the French and International forms of thread, is not given, however, and has, therefore, been included in this article, as has also a table for the Acme form of thread.

Fig. 4 indicates how plain plug gages may be used for testing the accuracy of the angle of the gage in Fig. 2. If a plain plug gage 0.1894 inch in diameter is used in the V of a U. S. standard thread gage of the type described, the micrometer reading will be 0.090 inch. If a plug gage 0.097 inch in diameter is used, the micrometer reading will be 0.046 inch. The accuracy of the angle of the gage for Acme tools may be similarly measured; for example, if a plug gage 0.1254 inch diameter is used, the micrometer reading will be 0.180 (see Fig. 3).

TABLE FOR DETERMINING FLAT AT POINT OF ACME THREAD TOOLS

(15-degree clearance angle)

Threads per Inch	Micrometer Reading of Gage, Fig. 2	Threads per Inch	Micrometer Reading of Gage, Fig. 2	Threads per Inch	Micrometer Reading of Gage, Fig. 2
1	0.6828	5	0.1287	9	0.0674
2	0.3365	6	0.1057	10	0.0596
3	0.2210	7	0.0893	11	0.0532
4	0.1635	8	0.0768	12	0.0480

Machinery

* * *

EFFICIENCY OF FORGING HAMMERS

BY C. H. WACKERNAGEL[*]

The Heim method for determining the efficiency of drop-hammers is based on the results of numerous tests conducted by allowing an ordinary drop-hammer to fall a predetermined distance upon a pure lead cylinder, the height of which is 1.5 times its diameter. The dimensions of the cylinders which have been adopted for use in testing various sizes of hammers (with regard to their falling weight) are given in Table I.

The following formula gives the number of foot-pounds of work done by one blow of the hammer.

$$\text{Work} = 36.75\ D^3\ [8.85\ A + 13.12(A^2 + A^4)]\ \text{foot-pounds} \quad (1)$$

where D = diameter of lead cylinder;

H = original height of cylinder;

H_1 = height of cylinder after being struck by the hammer;

$$A = \frac{H - H_1}{H}.$$

If the expression inside the brackets in Formula (1) is designated by B, the formula may be expressed in the following form:

$$\text{Work} = 36.75\ D^3 B.$$

After the lead cylinder has been struck by the hammer, the value of A is calculated and the number of foot-pounds of work developed by the hammer is then obtained by taking the value of B from Table II and substituting in the formula.

Example

Suppose a 100-kilogram (220-pound) hammer striking 180 blows per minute is allowed to strike a lead cylinder, the original dimensions of which are 50 millimeters (1.97 inch) in diameter by 75 millimeters (2.95 inches) high. After the blow has been struck, the resulting height of the cylinder is 48 millimeters (1.90 inch). From the preceding formula:

$$A = \frac{H - H_1}{H} = \frac{2.95 - 1.90}{2.95} = 0.35$$

$B = 4.9$, from Table II.

Substituting the values of D and B in the formula for the work done by one blow of the hammer, we have:

$36.75 \times 1.97^3 \times 4.9 = 1376$ foot-pounds = work done by one blow.

$$\frac{1376 \times 180}{60} = 4128 \text{ foot-pounds} = \text{work done per second.}$$

TABLE I. DIMENSIONS OF LEAD PLUGS USED FOR TESTING VARIOUS SIZES OF HAMMERS

Falling Weight of Hammer		Diameter of Lead Cylinder		Height of Lead Cylinder	
Pounds	Kilograms	Inches	Millimeters	Inches	Millimeters
66	30	1.18	30	1.77	45
110	50	1.38	35	2.07	52.5
165	75	1.57	40	2.36	60
220	100	1.97	50	2.95	75
330	150	2.36	60	3.54	90
506	230	2.76	70	4.13	105
770	350	3.15	80	4.72	120
1100	500	3.54	90	5.31	135

Machinery

The maximum power required to drive the hammer is 10.3 horsepower. As 1 horsepower is equivalent to 550 foot-pounds work per second, the amount of power consumed by the hammer per second is:

$$10.3 \times 550 = 5665 \text{ foot-pounds.}$$

The efficiency of the hammer is found to be:

$$\text{Efficiency} = \frac{\text{useful work}}{\text{power supplied}} = \frac{4128}{5665} = 72 \text{ per cent.}$$

TABLE II. VALUES OF FACTORS USED IN CALCULATING POWER OF HAMMERS

A	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55	0.60
B	1.01	1.63	2.31	3.08	3.94	4.90	5.97	7.17	8.52	10.03	11.73

Machinery

The Heim formula and method of testing may be applied to all types of hammers, but when used on steam hammers the test must be made while the hammer is running continuously and not when set to deliver a single blow. The Heim method is in general use in Germany.

* * *

During the last thirty years, the proportion of factory products to farm products in the export trade of the United States has constantly increased. In 1880 the agricultural products formed about 84 per cent of the total exports, while manufactured products formed hardly 15 per cent. In 1913 the proportion of manufactures in the export trade had increased to nearly 49 per cent, while that of agricultural products was only 46 per cent of the total. This, of course, does not mean that the actual volume of agricultural products has decreased, but merely that the proportion to the manufactured products is less than formerly.

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FLUXES FOR OXY-ACETYLENE WELDING*

METHODS USED IN WELDING CAST IRON, WROUGHT IRON, STEEL, COPPER, BRASS, BRONZE AND ALUMINUM

BY S. W. MILLER†

THOSE who are familiar with oxy-acetylene welding are aware that fluxes, scaling powders, etc., are used; but it is not generally known why the use of these fluxes is necessary. They are sometimes used in the shape of powders into which the welding rod is dipped, thereby transferring the flux to the weld; or they may be incorporated in the welding rod itself. Also a special welding rod containing certain elements may be used in connection with a powdered flux. Inasmuch as each metal has different characteristics and requires different treatment during the welding process, the nature of the flux varies with the metal. Therefore, it will be well to consider each metal separately, first explaining the nature of the difficulties encountered and then describing the remedies which are applied, including, as far as possible, the materials used for making the fluxes. It should be stated here that the manufacture of satisfactory fluxes requires considerable chemical knowledge and, in the majority of cases, should not be undertaken by a welding shop because of the difficulty of getting the proper amount of the necessary elements and mixing them properly, and because it is cheaper, as a general rule, to buy the fluxes from the manufacturers than to attempt to make them.

Cast Iron

Melted cast iron has a great affinity for oxygen, which combines with it to form an oxide of iron or slag. This affinity which molten iron possesses for oxygen is well illustrated by the amount of slag produced during the cutting of steel, this slag being nothing but oxide of iron. In the case of cast iron, the oxide is lighter than the melted metal and does not melt at quite so low a temperature. Being lighter, it rises to the surface which makes it easier to dispose of. Many kinds of fluxes for cast iron are furnished by the manufacturers of welding apparatus, or by manufacturing chemists, which vary considerably in composition, but as far as the writer's experience goes, they differ but little in efficiency. The principle of all of them is to provide some chemical which, at the high temperature involved, will break up the oxide into its component parts. For cast iron the writer has found that a mixture of equal parts of carbonate of soda and bicarbonate of soda makes a very satisfactory flux. Ordinary washing soda is the name commonly given to a somewhat impure carbonate of soda. Bicarbonate of soda is ordinary baking soda. The carbonates can be obtained in a chemically pure condition from the manufacturers of chemicals, but the writer finds no particular advantage in their use. A good way to prepare the flux is to grind the washing and baking sodas together in an ordinary meat grinder, passing the material through the hopper two or three times in order to be sure of securing a thorough mixture. Somewhat more of this mixture will be used in welding than would be the case if one of the high priced fluxes was used; but as both ingredients are obtainable at any grocery store at five cents per pound, the difference in cost more than offsets the difference in the amount used. The action of the carbonates is to combine with the oxygen in the slag, reducing the iron, and allowing the oxygen to pass off in the form of carbon monoxide or carbon dioxide gas.

It will be noticed in the use of a cast iron flux that as soon as a small portion of it is put on the melted iron, the surface of the metal becomes clear and mirrorlike, and that under such conditions the union of the metal in the piece and the metal from the welding stick is easily made. The necessity of using a flux for cast iron may not be thoroughly appreciated, but if any one tries to weld cast iron without it, they will at once experience difficulty. In addition to the use of a flux, it is necessary in the case of cast iron to use a special welding rod which has a large percentage of silicon and a low percentage of manganese and sulphur in it.

When oxy-acetylene welding first became a commercial process, great difficulty was experienced in welding cast iron on account of the hardness of the welds, which prevented their being machined in any way, except by grinding. This was due to the use of ordinary cast iron for welding rods. Such cast iron has comparatively little silicon and considerable manganese and sulphur in it. Silicon promotes the formation of graphite in iron, which makes it soft, while manganese and sulphur have just the opposite effect; so that it will be seen that the use of ordinary cast iron tends to produce white iron or chilled iron containing no graphitic carbon, and which is intensely hard. The increase of silicon and the decrease of manganese in welding rods overcomes these objections and makes possible the production of a soft weld. The manufacturing of such welding sticks cannot be carried out in an ordinary foundry as the iron is not suitable. Therefore, it must be left to those who make a specialty of this work. There are several foundries in the country who do nothing else, and the material can be obtained from them, or from the manufacturers of welding apparatus.

Steel and Wrought Iron

In welding these metals, a flux is not ordinarily used, although there is a certain amount of oxide formed which may be removed by the use of a cast iron flux. The melting points of both soft steel and wrought iron are higher than the melting point of the oxide, and while the oxide is lighter than the melted metal, there is more or less tendency for it to sink into the body of the weld. The judicious use of a small amount of flux will help this difficulty. In welding steel, however, the principal thing to guard against is burning the work, which no flux will overcome, and which ruins the weld beyond repair. While it is not necessary to use a flux in making ordinary steel welds, it is absolutely necessary to use the proper kind of welding rod or wire. The higher the percentage of carbon in the steel, the greater is the danger of burning. The writer does not believe it possible to burn wrought iron, which is simply steel with an exceedingly low percentage of carbon, the only difference between the two metals being due to the method of manufacture, which, in the case of wrought iron, naturally produces a metal with less carbon. Inasmuch as the welding wire is generally of considerably smaller section than the weld, there is a greater liability of burning the wire than the weld. The proper manipulation of the torch will help to overcome trouble from this source, but the necessity of having a welding rod that is not easily burnt is obvious, and therefore iron wire is used.

Ordinary iron wire of the kind purchased in a hardware store is quite impure, containing a considerable amount of slag and other impurities which affect the strength of the weld, because phosphorus and sulphur, which are known to be objectionable impurities in steel, are not eliminated from such wire. These impurities, passing from the welding rod containing them into the weld, seriously impair its strength and ductility. The purest wire that can be found is none too good for use in welding, and wire made from pure Norway iron stock has been found to give the best results. This wire can be obtained from wire manufacturers who make a specialty of its production. Much of it is also imported from Norway, and is handled by manufacturers of welding apparatus. It is foolish to attempt to use an inferior grade of wire in welding steel, as the unsatisfactory results obtained more than offset any slight saving in the cost of the wire.

It should never be forgotten that any weld is a casting, no matter what the metal may be, and that it is impossible to produce as strong a structure in the weld as in the original metal, even with the best welding material and fluxes, unless the weld can be given the same rolling or forging treatment as that to which the original metal was subjected. In the case of alloy steels, which are largely used in automobiles, proper heat-treatment must be given in addition to forging of the steel. These results are not often possible to obtain, because the piece cannot generally be forged; nor does it contain the necessary elements for successful heat-treatment, since the joint is not a truly autogenous weld. In addition, no welding shop with which the author is familiar has facilities for conducting such heat-treatments. Therefore, in such cases, a welded piece will not give satisfactory results. This is not the fault of the welder, of the material, or of the flux, but is an inherent limitation of the process. It is, therefore, wise to avoid welding such steel pieces, except in case of emergency or for temporary purposes only.

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* For additional information on autogenous welding published in MACHINERY see "Preheating Metals to be Welded by Oxy-Acetylene Process," October, [illegible] "The Manufacture of Tubing by Autogenous Welding," January, 1912, and other articles there referred to.

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Copper

There is no necessity for using a flux for welding copper, if the surfaces are clean and if the proper welding rod is used. Ordinary copper is quite free from impurities, because traces of such impurities make it impossible to use the copper. This metal, however, has several peculiar properties. When melted it has a strong affinity for gases, such as hydrogen and carbon monoxide. Oxygen is also absorbed by the melted metal, producing copper oxide which forms a true alloy with the copper, making it brittle and worthless. When the metal solidifies, these occluded gases are given out, leaving the metal a mass of blow-holes. It is, therefore, necessary to provide something which has a greater affinity for oxygen than the copper. This is done by the use of phosphorus, which, instead of being used as a flux, is incorporated in the welding rod. Only a small percentage of phosphorus is required, as none should remain in the weld after it is made, although small traces of phosphorus in copper have no bad effect on its physical properties. It is evident that the production of such welding rods or wire is a matter which should be left in the hands of competent manufacturers. This special copper-welding material can, of course, also be obtained from apparatus manufacturers.

Copper Alloys

The alloys of copper include the various brasses and bronzes, which are exceedingly numerous and of a great variety of compositions. A brass is an alloy of copper and zinc. A bronze is an alloy of copper and tin. These alloys may have added to them lead, antimony, iron, manganese, nickel, etc., in smaller percentages than the main constituents. Inasmuch as it is impracticable in ordinary repair work to determine the percentage of the elements in copper alloys, it is manifestly impossible to make a truly autogenous weld, *i. e.*, one containing the same elements as the piece to be welded. Of course, where the process is used in manufacturing and the composition of the alloy is known, some experimenting will probably enable one to determine the most suitable mixture to use for welding rods; but in repair work it is necessary to find some one or two alloys which will apply to all of the metals that are likely to be met with. This is well taken care of by the manufacturers of welding apparatus and welding material, and suitable rods for general brass and bronze welding can best be obtained from them. The writer has found the best all-around welding material to be manganese bronze, although he has also used Tobin bronze with good results. The so-called manganese bronze is really a manganese brass, because the two principal ingredients are copper and zinc, the percentage of tin being quite small. Rolled manganese bronze rod or wire is quite fluid and makes a very good weld. Tobin bronze is somewhat more fluid, and while in many cases it works well, yet if the melting point of the piece that is being welded is high, due to the presence of a considerable percentage of copper, it may be difficult to get it to melt at the same time as the welding rod; manganese bronze not melting at quite so low a temperature is, therefore, found more satisfactory as a general rule. Tobin bronze is really a Tobin brass, as it consists mostly of copper and zinc.

It should be understood that the percentage of the various elements in both manganese bronze and Tobin bronze may vary considerably, so that they are not alloys of constant composition, the difference depending on the ideas of the manufacturers; but both contain some iron, which appears to give greatly increased strength and makes the essential difference between the properties of these metals and ordinary brass. As all brasses contain zinc, which readily volatilizes under the heat of the torch, the advisability of having a considerable percentage of zinc in the welding rod is apparent. Theoretically, the fluxes for a copper alloy should depend on the composition of the alloy, but while there are some objections to it the writer finds that for all practical purposes ordinary borax gives very good results. To prepare the borax for use, it should be melted and then allowed to cool, after which it is powdered, because in its original condition the borax does not lie quietly in the weld, but foams up and a good deal of it is wasted. It is the writer's experience that greater success is obtained by using a satisfactory welding rod for copper alloys than by varying the fluxes; and it should not be forgotten that when the composition of the piece being welded is unknown, the use of one flux may be satisfactory while another one is not. Borax seems to be the best all-around substitute. In welding brasses and bronzes, care should be taken not to heat the piece too hot. If carefully observed, it will be noticed that at a certain temperature the prepared surfaces will show little globules rising from them. This is the temperature at which the metal from the welding rod should be added. It will be found that if this is done a satisfactory weld will be made, provided the surfaces are clean and a small amount of borax is used as a flux.

Aluminum

At high temperatures aluminum has a strong affinity for oxygen. At ordinary temperatures, pure aluminum is but little affected, but all ordinary aluminum pieces, which are generally alloys of aluminum and copper or of aluminum and zinc, tarnish more rapidly. The tarnish is due to the formation of a thin film of oxide of aluminum. Unlike iron or steel, where the oxidization or rusting goes on indefinitely, the thin film of oxide on the surface of aluminum protects the metal from further attack at ordinary temperatures. However, when aluminum is melted it oxidizes freely, and as the oxide or slag is heavier than the melted metal and melts at a very much higher temperature, the tendency is for it to become mixed with the molten metal and weaken the weld. This action of the oxide makes it very troublesome for a beginner to weld aluminum.

The chemical inertia of the oxide makes it exceedingly difficult to decompose with a flux, even at the temperature of melted aluminum. Fluxes for this purpose, therefore, have to be very strong and chemically active, and one difficulty with those which the writer has used is the after-action on the aluminum, a large number of pieces having been observed in which the metal for some distance around the weld had been seriously injured by this action, although it took some time for the damage to develop. In some cases, instructions are issued that after the welding is done, the piece must be thoroughly brushed off with boiling water to remove the remnants of the flux and prevent this action. It is also the writer's experience that after a weld has been made with a flux, should a crack develop in it or near it, such a crack cannot be welded without considerable difficulty, if it can be welded at all, unless the surface is thoroughly cleaned and the metal in the old weld has been removed. Also, while it is theoretically advisable to use a flux, and while in the case of sheet aluminum it is necessary to do so, there are other reasons in the case of repairs to such castings as automobile crank cases, transmission cases, etc., why the use of a flux is difficult. The principal ones are the condition of the surface before welding, and the fact that it is not desirable in the case of thin sections of aluminum, to prepare the piece by beveling it, as is done in the case of iron and steel. There is considerable shrinkage in an aluminum weld, and it is advisable to resist this as much as possible by leaving the full thickness of the section, the thin edge of a prepared piece having less area and therefore offering less resistance. Of course, this will not stop shrinkage entirely, but it helps to do so.

Again, before any flux can be used, the surface must be

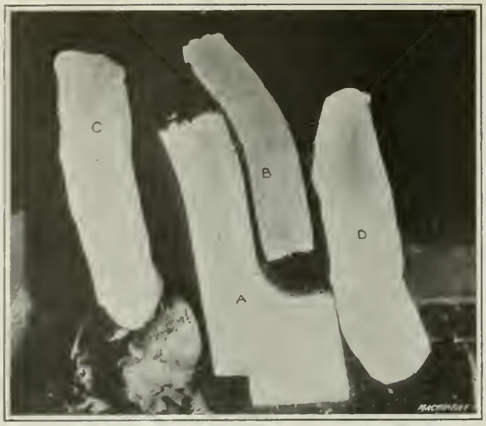


Fig. 1. Polished Aluminum Surfaces. A shows a High-grade Casting before welding; B, C and D show the Surface of another Piece of Aluminum—B before being welded, C after being welded by the Puddling Process, and D after being welded with a Flux

entirely cleaned. Frequently, it is not possible to do this, although the use of strong acid and alkali, such as hydrochloric acid and caustic soda (applied to the work separately), followed by a thorough washing and brushing in water afterward, will remove the grease and dirt from the exposed surfaces. It will not, however, remove the oxide nor, as a general rule, will it remove the grease and dirt from the crack or break, because they are more or less absorbed by the aluminum, which is porous. This absorption extends in some cases for quite a distance from the break, and unless such metal is entirely cut out the use of a flux will be found unsatisfactory. Of course, in some cases it is possible to spring a piece to allow for contraction, but in other cases this is not feasible and other remedies must be resorted to. The narrower the weld, the less the contraction and distortion of the piece, and so the less metal removed the better.

A number of fluxes are sold by the apparatus manufacturers and the chemical companies which vary in composition, and these firms should be consulted as to the best flux to use, the conditions under which it is to be applied being thoroughly explained. Sheet aluminum work is generally a manufacturing proposition, sheet aluminum being used largely for automobile and carriage bodies and similar purposes. A flux is necessary for the proper performance of the work, but as the surfaces are clean the same objections to a flux do not exist as in the case of broken parts, and a proper flux will make the weld just as tough and capable of standing as much work as the original sheet. A flux which was devised in France in the laboratory of the Autogenous Welding Association has the composition given in the accompanying table. A very small amount of this flux is all that is necessary with clean metal, but it should be remembered that it is necessary to wash the flux off carefully, as previously explained. This flux gives a bright red color to the flame when it is applied, which is characteristic of lithium salts. The writer has used this flux and finds that, as would be suspected by one familiar with the chemical properties of its ingredients, it is exceedingly active. It is, however, open to the objections mentioned above.

COMPOSITION OF FLUX FOR WELDING ALUMINUM

Ingredients	Per Cent
Lithium chloride	15
Potassium chloride	45
Sodium chloride	30
Potassium fluoride	7
Potassium bi sulphate	3

In most cases, a weld can be made without the use of a flux in the time taken to prepare the piece so that a flux can be used. Therefore, for practical purposes, the use of a flux in other than special cases is believed by the writer to be inadvisable, and a resort to the puddling of the weld with a rod made of soft steel about 3/16 inch in diameter and bent to the desired shape appears to be the best way out of the difficulty. It is true that more or less oxide is included in welds thus made, but the fact remains that they are plenty strong enough for service and tests show that they are generally stronger than the surrounding metal. This being the case, it is evidently a question whether it is advisable to resort to the use of a flux. The puddling must be thoroughly done and care must be taken to keep the metal melted while it is going on; but if the proper precautions are observed there will be no serious defects visible in the weld through an ordinary magnifying glass, and the work will last as long as the original part. Acquiring the necessary skill to enable one to make a satisfactory weld in this way takes time, and some men never become good aluminum welders. Close observation and the frequent breaking of test pieces will show whether the necessary skill is being acquired, and what is necessary to do in order to overcome any difficulties that may arise. There are two other points to be considered in connection with the use of an aluminum flux. First, there is no casting made that is not more or less porous due to the presence of oxide in it. This being the case, the writer does not see any use in trying to make the weld any better than the casting. Second, even by the use of a flux, it is not possible to make a perfectly sound weld, although it is freer from porosity than one made without a flux. Therefore, the question of the use of a flux with aluminum castings is a practical one rather than theoretical, and in the writer's mind the arguments against the use of a flux carry more weight than those in favor of it.

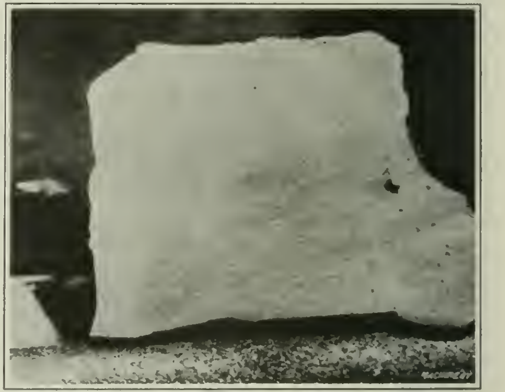


Fig. 2. Section of a Boss built up in Aluminum by Puddling

In support of the writer's contention that a flux is not necessary to get a satisfactory weld in aluminum, he would call attention to the accompanying illustrations. In Fig. 1 it will be noticed that the defects in the original pieces of metal *A* and *B* are as bad or worse than in the puddled weld *C*, while even the weld *D* in which a flux was used, is not by any means perfect. Also, after comparing Figs. 2 and 3, it will again be noticed that while the flux does remove the defects to some extent, the weld so produced is not perfect by any means. In the writer's opinion, it is almost too much to expect that in the operation of welding, a flux can be made to penetrate to all parts of the weld and to come in contact with every particle of oxide no matter how carefully the work is done. It should be stated that piece *A*, Fig. 1, was taken from the transmission case of one of the best automobiles manufactured in this country, and was selected with a view of getting as good a piece of aluminum as possible. The quality of the metal was so good, and it welded so nicely, that the man doing the work commented on it by saying "this is *aluminum*," his meaning being obvious.

The principal alloys used in this country for aluminum castings that the ordinary repair welding shop meets with are composed of about 93 per cent aluminum and 7 per cent copper; while in England and on the Continent, the general alloy appears to be about 90 per cent aluminum and 10 per cent zinc. In both cases, other elements are present in small quantities. The zinc alloy is somewhat stronger at ordinary temperatures than the copper alloy, but has the peculiar disadvantage of being very brittle at a temperature just below the solidification point. This makes it difficult to cast, particularly if the pieces are of a complicated shape; but while a welder may encounter some of these zinc alloys, particularly in parts cast a number of years ago, at the present time he will find but few of them. This is fortunate and considerably to his advantage, because it is sometimes very difficult to weld an aluminum-zinc alloy on account of the tendency of the shrinkage strains to crack the metal. The writer has frequently found it necessary in such cases to purposely cut the casting at a point where it can be sprung to compensate for the shrinkage, but in several cases has found it impossible, even by doing this, to avoid cracking. A zinc alloy can generally be readily detected by the condensation of the white oxide of zinc fumes on the colder parts of the casting. In such cases, thoroughly preheating the whole piece to the highest safe temperature undoubtedly helps to reduce the shrinkage strains. The writer finds that the welding rod for aluminum is very satisfactory if made of what is known as No. 12 mixture, containing 93 per cent of aluminum and 7 per cent of copper, and which can be obtained from the aluminum manufacturers in pigs. Any good aluminum foundry can cast from these pigs into sticks of the desired size, or they can be obtained from any of the manufacturers of welding apparatus.

Malleable Iron

This metal is a very peculiar one, and on account of its method of manufacture, but little is generally known of its peculiarities and characteristics. Cast iron contains two kinds of carbon, one of them combining with the iron and making iron carbide, which is a true alloy, and the other existing free in the state of graphite. The graphite is in the form of thin plates or flakes which break up the continuity of the iron, and its presence accounts for the comparatively low strength of cast iron. White iron or chilled iron has no free carbon in it, all of the carbon existing in the combined state as carbide of iron. Malleable iron is manufactured by packing white cast iron in boxes filled with some pulverized material as iron ore, lime or sand and subjecting it to a high temperature for several days, so that some of the combined carbon is partly removed by being oxidized; but it is mostly changed into a third condition which is called "temper carbon." This latter change cannot take place in the presence of any appreciable amount of graphite, which is the reason for using white iron in the process.

It is not necessary to go further into the metallurgy of malleable iron, except to say that the quality of a malleable iron casting depends on the material in which it is packed during the annealing process, on the time to which it is subjected to the heat, on the temperature, and on the original quality of the material from which it is made. If the casting is small, if it is packed in such a material as iron oxide, and if it is subjected for a long enough time to a sufficiently high temperature, a large percentage of the carbon may be eliminated, resulting in the formation of a crude steel. Such castings can be welded with ordinary steel welding wire and very good results obtained. In a thick casting, however, particularly if it is not packed in iron oxide or some similar material, the action is different, and the resulting metal is not a crude steel but a form of cast iron, except on the outside, where there will be a thin layer of the steel formation. A welder who observes closely, will notice that such a casting acts peculiarly. The outside skin is hard to melt and acts as steel does under the torch; while the center part acts more like cast iron, becomes full of blow-holes, and cannot be welded with steel, but will weld readily with cast iron, as in fact the whole section will do. At times such a weld is strong enough, but it has only the strength of the cast iron and will tend to be extremely hard.

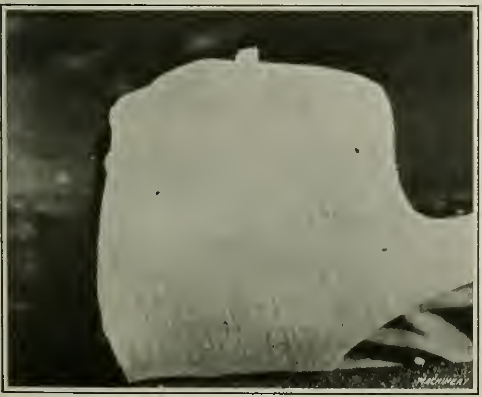


Fig. 3. Section of a Boss built up in Aluminum by welding with a Flux

A little thought will show why this is naturally the case. The original metal of which the casting was made, was cast iron of such a composition that it chills, even when poured in sand without a chill plate, so that the melting of the malleable iron tends to return it to its original condition of chilled or white cast iron, which is very hard and brittle. This accounts for the hard spots and brittleness of a malleable iron weld made with malleable iron welding rods. Of course, it is possible to eliminate these difficulties by again putting the piece through the malleabilizing process, but this is not possible in ordinary repair work, so that other means must be resorted to for joining the broken parts. It is impossible, therefore, to produce a truly autogenous weld in malleable iron without putting it through the malleabilizing process. Experience has shown that the most satisfactory and practical way of joining broken malleable iron parts is by using manganese bronze of the proper composition. Care should be taken not to heat the malleable iron too hot, and it must not be melted, but only brought to the temperature at which the bronze will alloy with it, and the weld should be somewhat reïnforced. Borax used as a flux gives very good results.

It should be remembered in all discussions of fluxes that the flux used depends upon the kind of welding material used and *vice versa*, as well as on the material which is being welded; so that no general rules can be laid down governing all cases. More or less experimenting has to be done by every welding shop, particularly by beginners, because they are not able to reproduce at will the same conditions in the use of the torch; and the variations existing from this cause frequently overshadow or entirely obliterate the results obtained by the use of certain fluxes and welding materials. The preceding outline, however, is the result of the writer's experience during the past five years in welding over 16,000 pieces of all kinds and qualities of metal. That there will be changes in the practice of oxy-acetylene welding is undoubted. That new methods will be discovered is not questioned, as it is not to be expected that any process of so recent an origin as oxy-acetylene welding is fully developed. However, the writer believes that the composition of fluxes and welding materials should be determined in laboratories equipped for accurate work, and that rough experimenting without facilities for properly checking and determining the results is a detriment rather than a benefit to the art. He therefore recommends that, except where it is specifically stated above, fluxes and welding materials be either purchased from the manufacturers or from those furnishing the apparatus, and that time and money be not wasted in making experiments that have probably been made before by others better fitted to interpret the results.

* * *

Rotary motors have not been very successful in the automobile field, although they have proved suitable in aeroplanes. The *Scientific American* mentions that an interesting motor of the rotary type, having five cylinders, is used in a new cycle car recently brought out. This motor develops twelve horsepower at 1400 R. P. M.

SECTIONAL VIEWS OF RIBS AND SYMMETRICAL PARTS

CONVENTIONAL METHODS USED IN APPROVED DRAFTING ROOM PRACTICE

BY CARL L. SVENSEN*

THE recent issues of MACHINERY have suggested the existence of a certain interest in the subject of sectioning the ribs of machine parts; and the following article has been prepared to illustrate the proper methods of representation in such cases, and also those where similar treatment is desirable. The question of symmetrical objects generally presents itself as a coordinate subject. The purpose of any drawing is to be useful; and to this end any conventions may be used which are not misleading. Just as orthographic projection cannot be strictly adhered to in all cases, so conventions are not universally applicable. Perhaps in no instances do more conventions appear than in the representing of ribs and in the sectioning of symmetrical and ribbed constructions. A number of cases are illustrated and comments are made on the various methods of representation.

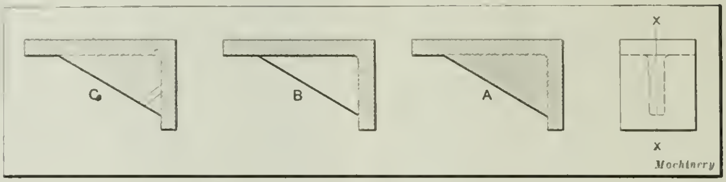


Fig. 1. Methods of showing Cross-sectional Views of Bracket on Line X-X; B and C represent Good Practice

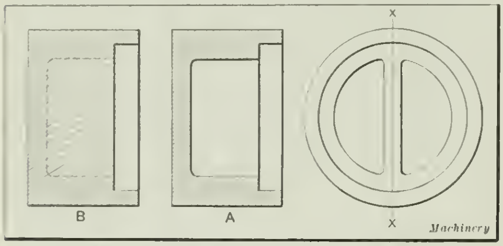


Fig. 2. Methods of showing Cross-sectional Views of Rib in Cup; Either Method is Correct

These are only types, and are not intended to cover every possible case, but simply to illustrate possible correct solutions of typical cases.

Sectional views on planes passing through ribs will be considered first. Fig. 1 shows a bracket with a section taken on the line *X-X*. The true section is shown at *A*, the dotted lines indicating the flanges, but it is hardly necessary to say that no draftsman would think of using such a representation. A generally accepted method is shown at *B*, in which the plane of the section is assumed to have been moved forward until it is in front of the rib. Another method which is sometimes used is shown at *C*, where alternate section lines are omitted from the rib. It will also be observed that in this case the flanges are shown by dotted lines instead of full lines, as the section is taken through the rib. The wider spacing indicates the presence of a rib of small thickness.

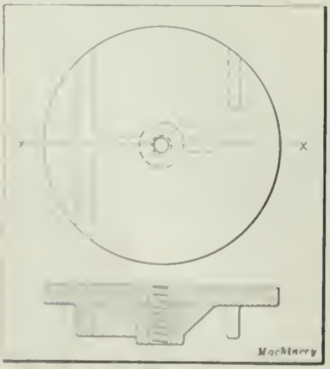
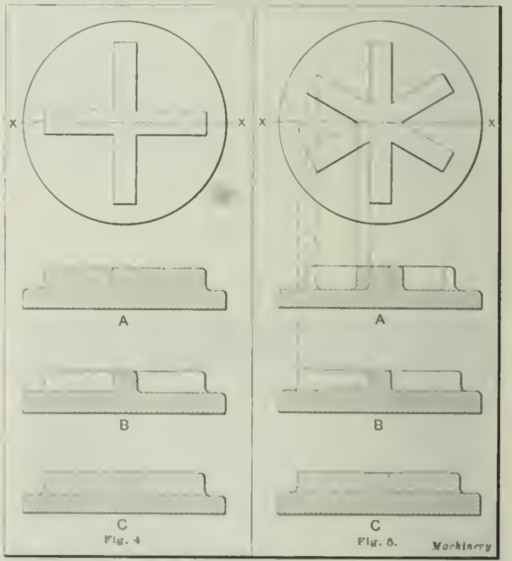


Fig 3 Correct Method of showing Cross-section of Rib and Hub

Fig. 2 represents an object having a rib as shown in the view at the right. The section on *X-X* as ordinarily represented is shown at *A*, where it will be observed that the presence of the rib is not so evident as it was at *B*, Fig. 1. The view *A*, Fig. 2, would be the same if there was no rib. It is sometimes necessary to show such an object in one view, and it is for such cases that the treatment indicated at *B* is found desirable. One view with such a representation would clearly indicate the fact that there was a rib. However, this treatment of a rib is often convenient and desirable in other cases, as shown in Fig. 3. This appeared in the February number of MACHINERY on page 494, under the title "Drafting Cross-Sections of Ribs," and it might be well to observe that Fig. 3 shows the corrected representation of the object. Note that the outline of the ribs where double sections are used is shown by dotted lines where they join the rest of the object.

Anthony's "Machine Drawing" and French's "Engineering Drawing" both treat of this method of representation, and the author of this article has frequently made use of it to good advantage. Figs. 4 and 5 show ribbed flanges. At *A*, Fig. 4, is shown the true section on *X-X*, which some draftsmen use, but the representation at *B* is more generally acceptable, and would be considered the correct one to use. The alternate method shown at *C* is also a correct representation, but is hardly necessary for such cases. At *A*, Fig. 5, is shown a cross-section on *X-X* which is projected, but it is not as evident as the representation shown at *B* which would generally be considered the correct one. In Figs. 4 and 5 the cross-sections at *B* or *C* might be used without the top views by simply giving the number of ribs in a note, and this would not be likely to lead to any misunderstanding. The representation at *A* would not be as clear. The vertical projection lines in Fig. 5 serve to show the method of obtaining



Figs. 4 and 5. Methods of cross-sectioning Ribbed Flanges; Methods B and C represent Good Practice the views *A* and *B*. The objection to the method shown at *A* is that the ribs do not appear in their true length. The objection to the representation at *A*, Fig. 4, is that it gives the impression of undue solidity.

---

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The related subject of symmetrical objects is discussed in connection with the remaining illustrations. Fig. 6 shows a section on *X-X* at *A*, in which the lugs are projected. This gives the idea of non-symmetry. The lug lying on *X-X* is treated as a rib and so is not sectioned. At *B* is shown a more desirable representation which should generally be used. Fig. 7 shows the treatment of a similar object, *A* being the true section on *X-X* and *B* the correct representation. Figs. 8 and 9 show the treatment of circular objects with ribs or arms, *A* being the incorrect and *B* the correct representation in each case. The alternate method shown at *C* is another correct representation of the object shown in Fig. 8. The projection lines show the method of obtaining the sections.

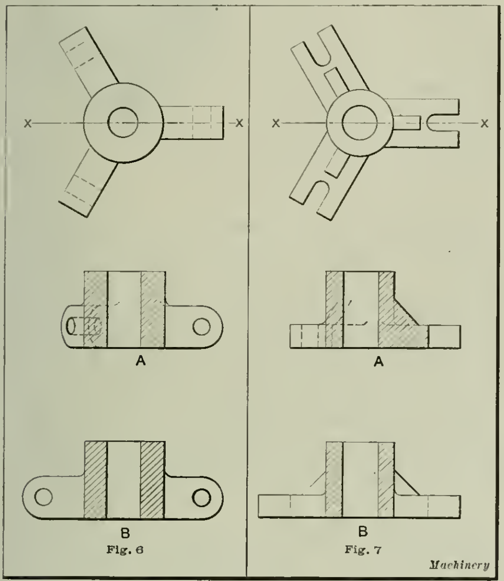

Fig. 6 Fig. 7

Figs. 6 and 7. Cross-sectional Views of Symmetrical Parts; Views shown at B represent Good Practice

A similar condition arises in representing the holes in flanges, and Fig. 10 shows the correct method in such cases at *C*, where the distance between the holes is made equal to the diameter of the circle of drilling regardless of projection. At *A* is shown the true projection, which is misleading. At *B* the holes are shown dotted, the centers of the holes being the true distance apart. This is a correct representation and is often used when none of the holes are on the plane of the section. Keyways and pins will be considered in the same manner. In Fig. 11 *A* shows the projected section of the hub with the keyway, while *B* is the representation often used to preserve symmetry. At *A*, Fig. 12, is shown the projection of a hole through a shaft for a pin, and *B* and *C* are acceptable representations of this piece, even though the end view remains the same.

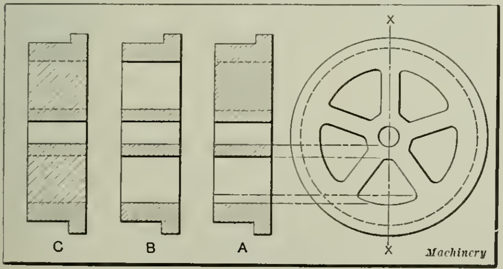

Fig. 8. Another Example of Symmetrical Cross-section; Views B and C represent Good Practice

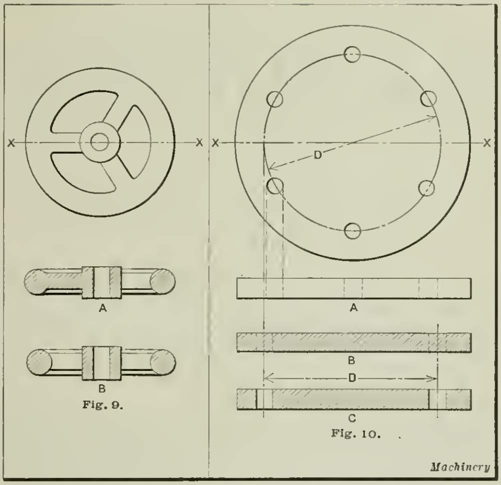

Fig. 9. Fig. 10.

Figs. 9 and 10. Cross-sections of a Wheel and a Flange with Equally Spaced Holes; Views B and C represent Good Practice in showing Holes in Flange

The object in all cases is to give a representation which will most clearly convey the idea. To this end symmetrical objects should appear symmetrical, and the true size should be shown in preference to a foreshortened one. Holes should appear round, and diameters should appear in their true length.

* * *

Advertising has effectively and cheaply solved some of the most perplexing problems of distribution. Supplying postage stamps in hotels and other places where people gather in numbers is an unprofitable and thankless job as ordinarily conducted. Coin-in-the-slot stamp machines that furnish say a two-cent stamp for three cents are failures; the public will not use them if it can be avoided, as the average person strenuously objects to paying a profit of 50 per cent on even a trifle, when he can get the same at cost elsewhere, with a little more trouble. The problem of dispensing stamps without clerical labor and without entailing an extra charge has been solved in some places by providing stamp-vending machines that supply stamps at cost in small envelopes on which local advertising is printed. The advertisers pay for the service at rates which make the installation and up-keep of the machines profitable to the promoters. The service supplies the public with stamps at all hours without troubling a clerk and without extra cost.

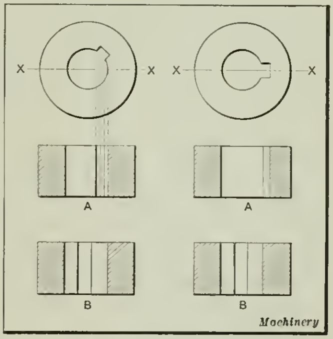

Fig. 11. Methods of showing Keyways in Cross-sectional Views; Good Practice is shown at B in Each Case

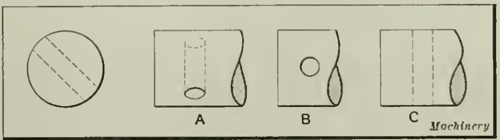

Fig. 12. Methods of showing Transverse Holes in Shaft; Good Practice is shown at B and C

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THE TIME FACTOR IN WAR

A mass of men is not necessarily an army any more than a lot of machined castings is a machine—as the Russians have discovered to their cost. The element of time, which is as necessary for the perfection of an army as of a machine, has played an important, almost a vital part in the war. Lord Kitchener has required eight months to "mold, file, equip and assemble" his army; but the big and little guns, without which the army would be only a helpless mob, and the navy little better than merchantmen, are not provided so quickly.

An arsenal capable of turning out a million rifles a year would require a force of nearly 10,000 men working eight hours a day. This estimate is based on the guarantee of the Pratt & Whitney Co. to equip an arsenal for the Australian government capable of turning out a rifle at a labor cost of twenty-three man-hours, complete from butt-plate to the scabbard for the bayonet.

The United States Government required over nine years to produce its first sixteen-inch sea-coast defense gun, not including the time spent on the plans—nine years to make the special machinery and turn out the first gun. The making of the guns, therefore, is only one of the many things that must be considered. The machinery equipment takes years to produce, because for a gun of that size the machinery is all of a special nature.

When shrapnel is being fired at the rate of 200,000 a day, the production of an enormous plant is being used. Each eighteen-pound shrapnel represents, in labor cost, about forty man-hours or five working days of eight hours each, and 200,000 shrapnel means 1,000,000 man-days labor. When we consider that in a general engagement such as is likely to develop in Europe any day the expenditure of shrapnel may be several times 200,000, we gain some idea of the tremendous cost of war and the imperative need of time as well as equipment for manufacturing munitions.

* * *

SANITARY DRINKING FOUNTAINS

Much attention is being paid by factory managers and engineers to the sanitary equipment of manufacturing buildings, especially as regards drinking water. It pays to install adequate systems for distributing drinking water throughout work rooms so that employes can quench their thirst without going far from their work, but it is not enough to merely provide taps and cups. The old-time drinking cup is being abolished from all public places, because it has been found to be a prolific means of transmitting disease.

Paper substitutes for common drinking cups are too expensive for use in shops, mills and factories where hundreds or thousands would be used daily, and it can hardly be expected that individuals will scrupulously provide cups for their own use. The bubbling drinking fountain solves the problem hygienically and cheaply. It provides for quenching thirst without recourse to the use of cups, the water bubbling up and being drunk from the stream without the drinker's lips touching anything that will retain contamination. Various forms of these fountains are now available for shop installations—some that run constantly, and others that flow only when a tap is opened by hand, foot or mouth.

The importance of providing sanitary appliances generally can hardly be overestimated. The moral effect of healthful and decent surroundings on employes is reflected in the character of the work produced. Improved conditions in manufacturing plants tend to raise the standard of living in the homes of the workers, and whatever tends to raise the standard of living tends also to raise the mental and moral level of employes.

* * *

THE WIDE-SPACE MILLING CUTTER

Several years ago A. L. DeLeeuw, at that time mechanical engineer with the Cincinnati Milling Machine Co., in a paper read before the American Society of Mechanical Engineers, described a new departure in the making of milling cutters. The difference between the new and old cutters consisted principally in the wide pitch or spacing of the teeth, which was in many cases double that of the practice at that time. In other words, the number of teeth in a cutter of the same diameter was decreased in the new type of cutter to half, or less than half the number previously used. Experiments made with these cutters proved that an equal amount of metal could be removed with considerably less expenditure of power, and that cuts could be taken that had previously been considered impracticable.

Although several years have passed since this discovery, we find today that many users of cutters tenaciously hold on to the old practice of ordering cutters with fine spacing of the teeth. It is claimed that as good a finish cannot be obtained with the wide-space cutter as with the old type. We believe, however, that for the same relation between speed and feed, this objection has been disproved by the originator of the new system; and if the speed is increased to that of which the new type of cutter is capable, as good a finish can be obtained under all circumstances. This is, in fact, admitted even by those who claim that the finish otherwise is inferior.

Here, however, a real objection to the new cutter, as applied to present-day milling machines, is discovered; or, rather, an explanation why manufacturers do not find the new cutter as valuable as might have been expected. The milling machines in use in the average shop have not the power to drive the wide-space cutter at the speed and at the feeds of which it is capable; hence, the cutter, having greater capacity than the machines in which it is used, has little chance to prove its superiority to the average practical mechanic, so that its use has been limited.

In one very large milling department in a shop of the representative type, experiments proved that only the very latest type of plain, large-size, high-power milling machine had the power to drive the wide-space cutters to their full capacity; but as the older types of machines, which do not have sufficient power and which are only a few years old in this particular shop, outnumber the latest types as twenty to one, it is easy to see why the advantages of the new cutters could not be fully utilized yet, even if they were universally used. As a matter of fact, many of the machines still marketed by reputable makers of milling machines can be stalled by the new cutters if they are used at full capacity. It is therefore evident that in spite of the constant increase in size and power of this type of machine tools, the demand is for still more powerful machines.

ALLOWABLE FRICTION VALUES[*]

EFFECT OF THE SPEED OF ROTATION ON THE OPERATION OF A FRICTION CLUTCH

BY B. D. PINKNEY[†]

B. D. Pinkney[‡]

IN the investigation of friction as it pertains to the operation of friction clutches, the generally accepted formulas contain a very uncertain element, *i.e.*, the coefficient of friction, which applies best to the surfaces of bodies that are at rest or to slowly moving bodies. As the purpose of a friction clutch is to "pick up" the load between two bodies, one of which is at rest and the other in motion, there will also be another factor to take into consideration, and that is the temperature. In the "picking up" of the static load and converting it to a rotating load, there should be a certain amount of slippage to prevent unnecessary shocks and danger of breakage; and this will cause abrasion and consequent heating of the clutch. This heating is cared for by the introduction of a lubricant in such quantities as the rubbing velocity of the friction surface necessitates.

It is a generally known fact that a lubricant decreases the friction value; also that the greater the rubbing velocity of the friction surface, the greater is the amount of oil necessary to overcome heating. Hence the higher the rubbing velocity of the friction clutch, the lower is its power in proportion to the speed of rotation. In this article, it is proposed to take the generally accepted formulas used in the design of friction clutches and introduce a factor that will make them better suited to the requirements of practical investigation, by taking into consideration the velocity of the rotating parts.

Unwin, in his "Elements of Machine Design," showed that the moment of the effort required to drive the shaft was (notation slightly changed):

$$M = P_n f r \qquad (1)$$

$$P_n = \frac{M}{fr} \qquad (2)$$

where M = moment of effort required to drive shaft, more commonly known as moment of torsion;
P_n = total normal pressure between friction surfaces, in pounds;
f = coefficient of friction;
r = mean radius of friction surface, in inches.

We get from elementary formula:

$$M = 63{,}025 \frac{H}{N} \qquad (3)$$

We may then express Formula (1) in terms of horsepower as follows:

$$H = \frac{P_n f r N}{63{,}025} \qquad (4)$$

where H = horsepower;
N = revolutions per minute.

Formula (4), therefore, is the fundamental formula for ascertaining the horsepower of friction clutches, and is identical with that given on page 511 of MACHINERY'S HANDBOOK.

VALUES OF ALLOWABLE FRICTION FOR VARIOUS RUBBING VELOCITIES

Rubbing Velocity in Feet per Minute V_f	Allowable Friction in Pounds per Square Inch F	Rubbing Velocity in Feet per Minute V_f	Allowable Friction in Pounds per Square Inch F	Rubbing Velocity in Feet per Minute V_f	Allowable Friction in Pounds per Square Inch F
1	150	150	69	1250	12
5	145	175	63	1500	10
10	140	200	58	1750	8.6
15	135	225	54	2000	7.3
20	131	250	50	2250	6.4
25	126	275	47	2500	5.5
30	122	300	44	2750	4.9
40	115	350	39	3000	4.4
50	109	400	36	3250	3.9
60	103	500	30	3500	3.5
70	98	600	25	3750	3.1
80	93	700	22	4000	2.8
90	88	800	19	4250	2.6
100	85	900	17	4500	2.3
125	76	1000	15	5000	1.9

Machinery

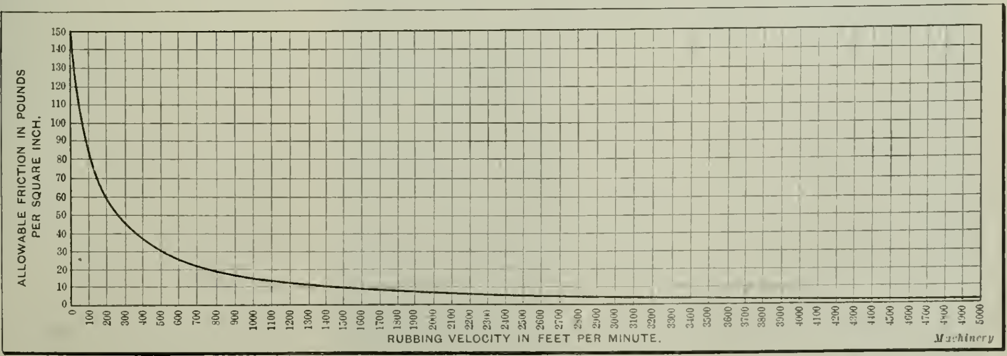
Experiments which the writer has conducted, to determine the effect of introducing oil to prevent abrasion, were for metal surfaces only; and as long as a lubricant was used, it made practically no difference of what metals the friction surfaces were made, *i.e.*, whether they were cast iron on cast iron, cast iron on steel, steel on steel, bronze on cast iron, or any metal combinations.

The following formula gives the allowable friction in pounds per square inch:

$$F = p_n f t \qquad (5)$$

where F = allowable friction in pounds per square inch;
p_n = total allowable normal friction pressure, per square inch;
t = temperature coefficient (combined with value of F) depending upon rubbing velocity of friction surfaces.

Values of F were found experimentally, and the following



Values of Allowable Friction for Cast Iron on Cast Iron, for Rubbing Velocities from 100 to 5000 Feet per Minute working formula very closely conforms to actual practical tests:

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[*] For additional information on the design of friction clutches published in MACHINERY, see also "Characteristics of Friction Clutches," August, 1913; "The Design of Clutch Release Shoes," May, 1913; "The Design of Clutch Release Shoes," January, 1913; "The Problem of Cone Friction Clutch Design," June, 1911; "The Problem of Cone Friction Clutch Design," February, 1911; "A Problem in Disk Friction," December, 1910; and "Formulas for Cone Clutches," October, 1909.

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[‡] B. D. Pinkney was born in England in 1878. He received a high-school education and an engineering education by private tuition. He has worked for the Western Electric Co., Bucyrus Co., International Harvester Co., E. Goldman & Co., Loew Mfg. Co., J. H. Day Co., holding positions of draftsman, drafting-room foreman, chief draftsman, mechanical engineer, general superintendent, etc. His specialty is machine design and mechanical standardization. He gave up executive positions five years ago to take up experimental work and machine construction, and to do consulting engineering.

$$F = \frac{19{,}900}{V_f + 130} - 2 \qquad (6)$$

where V_f = rubbing velocity of friction surface, in feet per minute.

The velocity chart which has been developed from Formula (6) shows what effect a lubricant has on the lowering of the friction efficiency due to an increase in the rubbing velocity; and the numerical values are given in the table. It will be seen that the value of the allowable friction F drops rapidly for rubbing velocities up to 200 feet per minute, after which the drop is more gradual. It has been suggested that the initial rapid decrease in the value of F is too great, and that the "tractory equation" (see "Higher Mathematics" by Merriman and Woodward, page 149) might furnish a more gradual decrease. This, however, does not agree with practice. The value of F is a maximum one. In the case of a cone clutch or of a disk clutch, the value of F must be computed for the maximum rubbing velocity and not for the mean velocity which is used to obtain the horsepower.

Expressing Formula (4) to suit these new conditions, we get:

$$H = \frac{F 2\pi r^2 WN}{63{,}025} = \frac{Fd^2 WN}{40{,}122} \qquad (7)$$

where W = width of clutch engaging surfaces, in inches;
d = diameter of a straight face clutch, or mean diameter of either a cone or disk clutch, in inches.

In the case of a multiple disk clutch of the Weston type, the mean diameter d is to be multiplied by the number of disks.

The clutch ratings of various manufacturers appear to be for low rubbing velocities of the friction surfaces, where they give good service, especially for machine tools. The manufacturer's chief claims for a good clutch are the proper leverage ratio combined with good wearing qualities. The leverage is an important feature, but the writer has found it advantageous to re-rate the horsepower to suit the conditions of Formula (7). The initial slippage due to the presence of a lubricant furnishes ample protection against abrasion of the friction surfaces and too positive an engagement of the clutch; and the allowable friction per square inch, F, is such that unnecessary wear will not result.

Maple or chemically treated wooden blocks rubbing on cast iron appear to have slightly smaller values of F for low speeds of rotation, but the values are the same for high speeds. The values of F for leather on cast iron vary considerably—possibly on account of the different grades of leather—but the writer uses a value equal to one-third that for metal on metal, and with this value the leather surface has long life. It is seldom that wood is subjected to an oil bath, so that friction clutches with wooden disks or inserts should have a lower rubbing velocity, possibly not over 2000 feet per minute. The advantage of Formula (7) over Formula (4) is the elimination of the uncertain factor f for the coefficient of friction; and the provision of means whereby a suitable working value for the allowable friction F may be obtained to suit the specific case.

* * *

CONVERTING ELECTRICAL UNITS TO HORSEPOWER

BY CHARLES S. OHRENSCHALL[*]

I have frequently been required to calculate the horsepower developed in conducting various machine tool tests in which the data was in the form of electrical units. For the purpose of facilitating such calculations I worked out the table presented in this connection, which I hope may prove of value to other readers of MACHINERY. It will be seen that the table reads from 75 to 306 volts, which will cover all average conditions under which machine tools are operated. By using the constant opposite the proper number of volts, and multiplying it by the number of amperes, the horsepower developed by the motor is obtained.

CONSTANTS FOR CONVERTING ELECTRICAL UNITS TO HORSEPOWER

Volts	Constant	Volts	Constant	Volts	Constant	Volts	Constant	Volts	Constant	Volts	Constant	Volts	Constant	Volts	Constant
75	0.1005	104	0.1392	133	0.1782	162	0.2160	191	0.2559	220	0.2948	249	0.3336	278	0.3725
76	0.1016	105	0.1407	134	0.1795	163	0.2184	192	0.2568	221	0.2961	250	0.3350	279	0.3738
77	0.1031	106	0.1420	135	0.1809	164	0.2197	193	0.2586	222	0.2974	251	0.3363	280	0.3752
78	0.1045	107	0.1433	136	0.1822	165	0.2211	194	0.2599	223	0.2988	252	0.3372	281	0.3765
79	0.1058	108	0.1447	137	0.1835	166	0.2224	195	0.2613	224	0.3000	253	0.3390	282	0.3778
80	0.1072	109	0.1460	138	0.1848	167	0.2237	196	0.2622	225	0.3015	254	0.3403	283	0.3792
81	0.1080	110	0.1474	139	0.1862	168	0.2251	197	0.2639	226	0.3028	255	0.3417	284	0.3804
82	0.1098	111	0.1487	140	0.1876	169	0.2264	198	0.2646	227	0.3041	256	0.3430	285	0.3819
83	0.1112	112	0.1500	141	0.1889	170	0.2278	199	0.2666	228	0.3048	257	0.3443	286	0.3832
84	0.1124	113	0.1514	142	0.1902	171	0.2291	200	0.2680	229	0.3068	258	0.3457	287	0.3845
85	0.1139	114	0.1527	143	0.1916	172	0.2304	201	0.2693	230	0.3082	259	0.3470	288	0.3859
86	0.1156	115	0.1541	144	0.1920	173	0.2318	202	0.2706	231	0.3095	260	0.3484	289	0.3872
87	0.1165	116	0.1554	145	0.1943	174	0.2331	203	0.2720	232	0.3108	261	0.3497	290	0.3886
88	0.1176	117	0.1567	146	0.1956	175	0.2345	204	0.2730	233	0.3122	262	0.3510	291	0.3899
89	0.1192	118	0.1581	147	0.1969	176	0.2352	205	0.2747	234	0.3135	263	0.3524	292	0.3912
90	0.1206	119	0.1594	148	0.1983	177	0.2371	206	0.2760	235	0.3149	264	0.3537	293	0.3926
91	0.1219	120	0.1608	149	0.1996	178	0.2385	207	0.2773	236	0.3162	265	0.3551	294	0.3939
92	0.1232	121	0.1621	150	0.2010	179	0.2398	208	0.2784	237	0.3175	266	0.3564	295	0.3953
93	0.1246	122	0.1634	151	0.2023	180	0.2412	209	0.2800	238	0.3189	267	0.3577	296	0.3966
94	0.1259	123	0.1648	152	0.2036	181	0.2425	210	0.2814	239	0.3202	268	0.3590	297	0.3979
95	0.1273	124	0.1660	153	0.2050	182	0.2438	211	0.2827	240	0.3216	269	0.3604	298	0.3993
96	0.1286	125	0.1675	154	0.2063	183	0.2452	212	0.2840	241	0.3229	270	0.3618	299	0.4006
97	0.1299	126	0.1686	155	0.2077	184	0.2464	213	0.2854	242	0.3242	271	0.3631	300	0.4020
98	0.1311	127	0.1701	156	0.2088	185	0.2479	214	0.2867	243	0.3256	272	0.3644	301	0.4033
99	0.1326	128	0.1712	157	0.2103	186	0.2492	215	0.2881	244	0.3268	273	0.3658	302	0.4046
100	0.1340	129	0.1728	158	0.2117	187	0.2505	216	0.2894	245	0.3283	274	0.3671	303	0.4060
101	0.1353	130	0.1740	159	0.2130	188	0.2519	217	0.2907	246	0.3296	275	0.3685	304	0.4073
102	0.1366	131	0.1755	160	0.2144	189	0.2532	218	0.2921	247	0.3309	276	0.3696	305	0.4087
103	0.1380	132	0.1764	161	0.2157	190	0.2546	219	0.2934	248	0.3320	277	0.3711	306	0.4100

Machinery

* * *

Volume IV of the transactions of the International Engineering Congress, which will be held in San Francisco, Cal., September 20-25 inclusive, 1915, will comprise an important series of papers on the general subject of railways and railway engineering. This field will be treated under seven principal topics covering relation of railways to social development; present status of railways; economic factors governing building of new lines; location; physical characteristics of road, including track and road-bed; bridges; tunnels; terminals; construction methods; signals; road equipment, including motive power other than electric; rolling stock in general; floating equipment; electric motive power in general. About twenty-seven papers are expected for this volume, which will be prepared by authors representing nine different countries. The transactions of the congress as a whole will include nine or ten other volumes, covering the various fields of engineering work.

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[*] Address, Care of Detrick & Harvey Machine Co., Baltimore, Md.

PRODUCTION AND PREMIUM SYSTEM

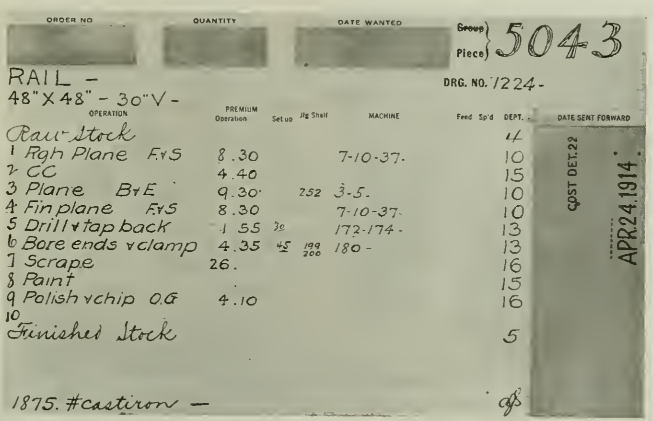
USE OF DIFFERENT COLORED TAGS TO DISTINGUISH VARIOUS CLASSES OF ORDERS

BY A. J. SCHNEIDER*

A. J. Schneider†

THE following article, explaining the system used by the Cincinnati Planer Co., Oakley, Cincinnati, Ohio, should be of interest to many readers of MACHINERY. Production orders are divided into three distinct classes and a combination color scheme and order number system has been adopted to avoid confusion. The salmon color stock order, designated by the letter S, is issued for all standard details which can be manufactured and carried in stock, and order numbers in this class were started at 4000. The yellow lot L order is issued for one or more complete planers and calls for making all parts which are not carried in stock, and for all assembling, erecting and painting. Order numbers in this class were started at 1. The green job J order is issued for anything that cannot be done on a stock or lot order, *i.e.*, repair work, shop work, tools, jigs or any special work. Order numbers in this class were started at 1500.

The new piece number is assigned by the drafting-room, placed on the drawing and sent to the planning and routing department. Here, the master sheet shown in Fig. 1, which is 5 by 8 inches in size, is made out giving the routing that is to be followed, the premium allowed on each operation, the number of the shelf where the proper jig will be found, the machine on which the work is to be done, the proper speed and feed to use, and the numbers of the successive departments through which the work passes. This master sheet is made out on tracing paper and sent to the blueprint room where five prints are made from it. Of these, one copy goes to the planning and routing department to be filed, and another is sent to the superintendent's desk in the shop, where a printed "sticker" is placed over one end of it and the sheet is then ready to be used as a location record, as shown in Fig. 2. The purpose of this location record is to afford an immediate index of the exact location and method of finding all production orders which are in the shop. The columns on the "sticker" are kept up-to-date by the time-keeper, who stamps the date of completion of each operation as taken from the finished time card, after making the rounds of the shop. The three remaining blueprints from the master sheet are sent to the cost department and filed, awaiting an order. The original master sheet is used every morning by the cost department for the purpose of figuring the premium time cards.



ORDER NO	QUANTITY	DATE WANTED	Group / Piece
			5043

RAIL -
48"X48" - 30"V -

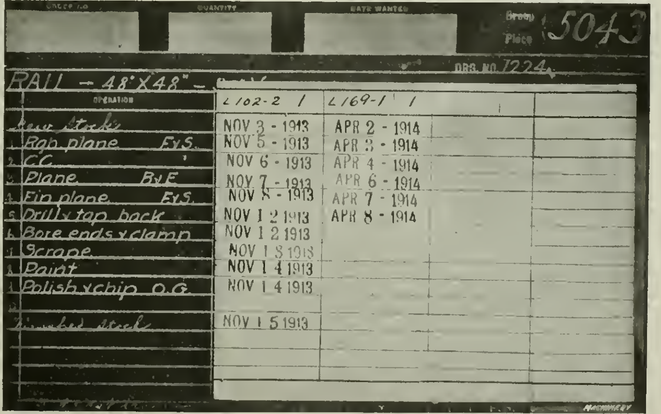
DRG. NO. 1224 -

OPERATION	PREMIUM Operation	Set up	Jig Shelf	MACHINE	Feed	Sp'd	DEPT.	DATE SENT FORWARD
Raw Stock							4	COST DET. 22 APR.24.1914
1 Rgh Plane F&S	8.30			7-10-37-			10	
2 CC	4.40						15	
3 Plane B&E	9.30		252	3-5.			10	
4 Fin plane F&S	8.30			7-10-37-			10	
5 Drill & tap back	1.55	30		172-174-			13	
6 Bore ends & clamp	4.35	45	199 200	180-			13	
7 Scrape	26.						16	
8 Paint							15	
9 Polish & chip O.G	4.10						16	
10								
Finished Stock							5	

1875. #castiron -

Fig. 1. Master Sheet which gives Detailed Information in regard to handling Each Order

When an order for one or more pieces is received, two blueprints of the master sheet are taken from the cost department's file and the spaces at the top are filled out with the order number, quantity and date wanted, after which they are sent to the stock room to be filed until the raw material for the order is at hand. A colored "sticker" and double wire are then attached to one print as shown in Fig. 3, thereby making a tag of it. The stickers used for attaching the wire are salmon colored for stock orders, yellow for lot orders and green for job orders, thus indicating the class of order that is being dealt with. The second blueprint which was filled out and sent to the stock room is known as the foreman's order. This order, together with the blueprint which has been converted into a tag, and the necessary material for filling the order, are sent to the department where the first operation is to be performed. Each foreman has a file at his desk for filing the orders for work which is in process in his department. As soon as an operation is completed and the "date sent forward" has been stamped on the order by the foreman, the material, order and tag are transferred to the next department. The last operation on all tags calls for the finished material to be delivered to the stock room, and when this is done the stock-keeper puts his O. K. on the order and it is then returned to the cost department. The return of the order thus serves as a notice to the cost department that the order has been completed so that the cost may be figured.



ORDER NO	QUANTITY	DATE WANTED	Group / Piece
			5043

DRG. NO. 1224

RAIL - 48"X48" -

OPERATION	L102-2 1	L169-1 1		
Raw Stock	NOV 3 - 1913	APR 2 - 1914		
1 Rgh plane F&S.	NOV 5 - 1913	APR 3 - 1914		
2 CC	NOV 6 - 1913	APR 4 - 1914		
3 Plane B&E	NOV 7 - 1913	APR 6 - 1914		
4 Fin plane F&S.	NOV 8 - 1913	APR 7 - 1914		
5 Drill & tap back	NOV 12 1913	APR 8 - 1914		
6 Bore ends & clamp	NOV 12 1913			
7 Scrape	NOV 13 1913			
8 Paint	NOV 14 1913			
9 Polish & chip O.G	NOV 14 1913			
10				
Finished Stock	NOV 15 1913			

Fig. 2. Blueprint from Master Sheet, which is sent to Superintendent's Desk and provided with "Sticker" for Use in maintaining Location Record

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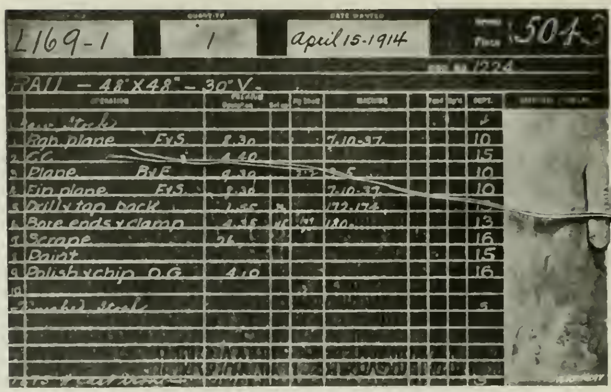
* Address: Care of Cincinnati Planer Co., Cincinnati, Ohio.

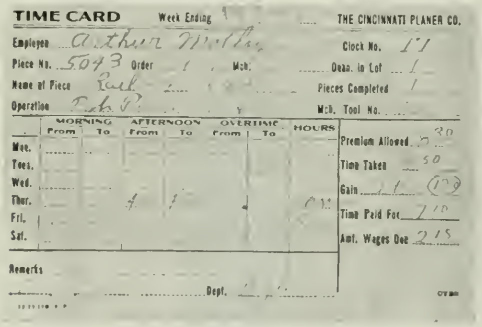
† A. J. Schneider was born in 1886. He received a high school education and special courses in bookkeeping and corporation accounting. He has worked for the Wirthlin Bros., American Fire Engine Co., J. H. Day Co., Bullock Electric Mfg. Co., and Cincinnati Planer Co. His specialty is cost accounting.



L169-1	1	April 15-1914	Piece 5043	
RAIL - 48"X48" - 30° V.			1224	
	Raw Stock			
1	Rgh plane E+S	8.30	7.10-37	10
2	CC	4.40		15
3	Plane B+E	9.30		10
4	Fin plane E+S	8.30	7.10-37	10
5	Drill+tap back	1.55	172.174	
6	Bore ends+clamp	4.35	180	13
7	Scrape			16
8	Paint			15
9	Polish+chip O.G.	4.10		16

Fig. 3. Blueprint from Master Sheet, which is filled out and sent to Stock Room to be used as Tag

The half premium plan of paying labor is employed in the plant of the Cincinnati Planer Co. Under this plan, the employe is given a guaranteed hourly rate and will automatically increase his wages in proportion to his ability. All premium pay earned is held back one week in order to afford time for the inspection of the work. The time card shown in Fig. 4, which is 4 by 6 inches in size, is made out by the time-keeper when a man starts work on a new job, information for this purpose being obtained from the tag shown in Fig. 3, which is always attached to the work. Referring to Fig. 4, it will be seen that the time-keeper made out this card at 4 P. M. on Thursday and closed it at 12 o'clock on Friday, when the operation was finished and the workman was ready for his next job. It will be noticed that the premium allowance on this job was 8½ hours and the time taken was 5 hours and 50 minutes, showing a gain of 2 hours and 40 minutes. One-half of this premium is paid to the workman as a reward for the extra effort, in addition to the guaranteed hourly rate.



TIME CARD Week Ending — THE CINCINNATI PLANER CO.

Employee Arthur Miller — Clock No. 17

Piece No. 5043 Order 1 Mch. — Quan. in Lot 1

Name of Piece Rail — Pieces Completed 1

Operation — Mch. Tool No.

	MORNING From	MORNING To	AFTERNOON From	AFTERNOON To	OVERTIME From	OVERTIME To	HOURS
Mon.							
Tues.							
Wed.							
Thur.			4				
Fri.							
Sat.							

Premium Allowed 8 30

Time Taken 5 50

Gain 2 40

Time Paid For 7 10

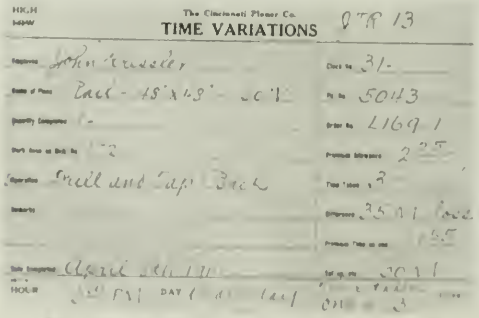
Amt. Wages Due 2 15

Remarks

Dept.

Fig. 4. Form of Time Card used

The purpose of the time variation sheet shown in Fig. 5 is to give immediate notice of any variation or irregularity in the time taken on an operation. This exposes everything which is abnormal, and will "show up" the incapable employe, foreman, or time-keeper; or the purchasing department in cases where the castings or bar stock was defective, or where the tools gave poor service. These sheets are made out every morning by the cost department, while the premium time cards are being checked; and in cases where the time taken is higher than the premium allowance or when it is one-half or less than one-half of the premium allowance, the time variation sheet is at once sent to the foreman who gives an explanation of the cause on the form provided on the back of this sheet, as shown in Fig. 6. The sheet is then sent to the superintendent, the purchasing department and finally to the cost department, where it is filed. A correct premium allowance and efficient organization call for sending out very few of these time variation sheets. Fully 95 per cent of the clerical work of this system is done in the office, where it can be handled to the best advantage, without hindering the shop work.



The Cincinnati Planer Co.

TIME VARIATIONS

Clock No. 31

Pc. No. 5043

Order No. L169 1

Operation Drill and Tap Back

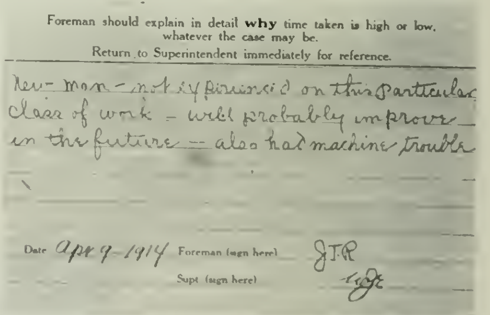
HOUR — DAY

Fig. 5. Time Variation Sheet which shows Irregularities in Time taken on Any Operation

* * *

NON-RUSTING OR STAINLESS STEEL

The fact was lately mentioned in a consular report from Sheffield, England, that a firm in that city had introduced a steel which is claimed to be non-rusting, unstainable and untarnishable. The steel is especially adapted for table cutlery, as the original polish is maintained after use, even when brought in contact with most acid foods. It is an interesting fact that the steel was not made with a view to producing cutlery, however. The investigator was endeavoring to produce a steel for pump rods used in collieries, where a damp atmosphere had to be resisted. The application of the steel to cutlery was but a natural sequence, and no doubt a multitude of other uses will be found for it. In a tempered condition, the steel has a maximum strength of 50 to 55 tons per square inch, an elongation of 20 per cent, and a reduction of area approaching 60 per cent. In the hardened condition, the tensile strength is raised to about 100 tons. It is claimed that the steel retains a keen edge, much the same as the best double-shear steel.



Foreman should explain in detail **why** time taken is high or low, whatever the case may be.

Return to Superintendent immediately for reference.

New man - not experienced on this particular class of work - will probably improve in the future - also had machine trouble

Date Apr 9-1914 Foreman (sign here) J.T.R.

Supt (sign here)

Fig. 6. Form used by Foremen in explaining Irregularities in Time on Operations in Their Department

The Firth-Sterling Steel Co., McKeesport, Pa., recently concluded an arrangement with Messrs. Thos. Firth & Son, Ltd., of Sheffield, whereby it will manufacture this "stainless" steel for the American market. Obviously there are many situations where a non-tarnishable steel would be much more satisfactory than the present steels.

* * *

The growth of the automobile industry is to some extent indicated by the growth of the Society of Automobile Engineers. At the end of 1912 this society had a membership of 1252; at the end of 1913, 1611; and at the end of 1914, 1804.

TURRET INDEXING MECHANISMS

CONSTRUCTION AND OPERATION OF DIFFERENT TYPES OF INDEXING MECHANISMS AS APPLIED TO MODERN MACHINE TOOLS

BY ALBERT A. DOWD[*]

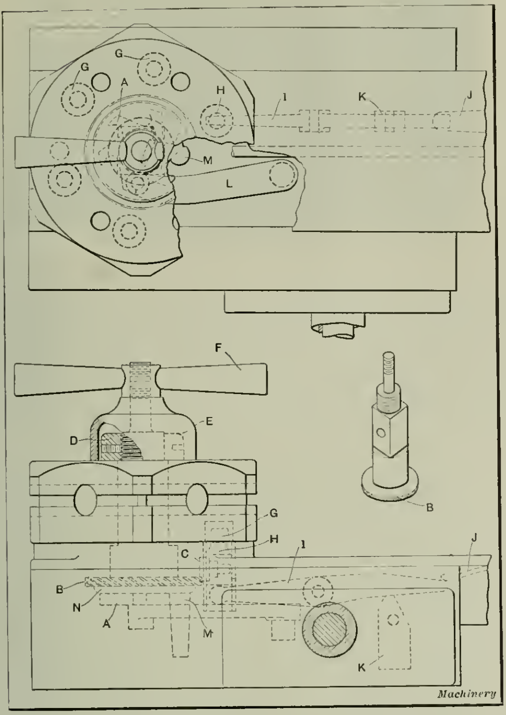


Fig. 1. Side Elevation and Plan of Garvin Turret

INDEXING mechanisms of various kinds may be used on nearly every variety of machine tool, but with the exception of the planer or shaper, the milling machine or gear-cutter and horizontal and vertical turret lathes, their application is of rare occurrence. When an indexing device is applied to a planer or shaper, it is usually a special fixture which may be used for holding a piece of cylindrical work to be grooved or serrated in a longitudinal direction. Sometimes the indexing or dividing head is used for cases of this kind, but it is obvious that when this is done the operator's careful attention is required at all times during the progress of the work, and it is necessary to stop the machine frequently while the indexing is being done. When a special fixture is used, however, it is possible to perform the indexing automatically by means of a projecting block which can be so arranged that it will push over a pawl at the end of the stroke, thus indexing the fixture. As the use of special indexing mechanisms on these machines is somewhat rare, it is not necessary to discuss the matter in this article.

The indexing mechanism of a gear-cutter is so simple that it does not require description, and it is further so well known that everyone is familiar with its action.

Applications to the milling machine are of frequent occurrence in the use of the index head, with which every toolmaker is familiar. This machine, however, is frequently furnished with special fixtures for a variety of work, the indexing being done by hand after each cut has been completed. Sometimes a hand milling machine is used, and when this is the case it is easily possible to so arrange it as to make the indexing automatic. Several years ago the writer designed and built a fixture for cutting the ratchet teeth on an automobile finger lever sector, the machine to which it was applied being a hand milling machine. In this instance both the feed and the indexing were accomplished automatically, and the cost of rigging up the machine was not great. A small special countershaft running at slow speed was hung above the machine and an overhanging end of the shaft was furnished with a disk. The face of the disk had a T-slot cut diametrically across it, which contained a shouldered T-bolt acting as a support for a long rod whose lower end was connected to the feed lever handle of the machine. An angular block was attached to the bed of the machine close to the table and this performed the indexing as the table moved back after each cut. The action took place through a roller on the end of a lever, to the other end of which a pawl was attached engaging with teeth on the revolving portion of the fixture. It was a very simple arrangement but one which gave excellent results. Adaptations of this were afterward made for two other jobs.

On turret lathes the highest development of indexing mechanisms is shown in the turret arrangements, because of the great demand for these machines and the necessity for rapid and accurate indexing. The requirements have been very carefully studied and have been developed year after year with a view to making the mechanisms as nearly perfect as possible. Accuracy has been the goal for which all the designers have striven and every known refinement has been employed to attain this end. In order to insure accuracy it is not sufficient to have the locating points or surfaces properly located when the machine is first built. The upkeep and proper provision for adjustments for wear must be carefully looked after and abuse must be considered as a large factor. In addition to this, the entrance of dirt or foreign matter of any kind must be carefully guarded against so that faulty indexing cannot be caused by imperfect contact of the locating points. It is evident that any variation at the locating points will be multiplied greatly at the end of a long boring-bar, so it is readily seen why so much care is necessary to secure accuracy in the indexing. Another point which has received a great deal of careful consideration is that of firmly clamping the turret after it has been indexed, so that no vibration will be apparent in the cutting tools due to a lack of rigidity in the turret. The arrangement for

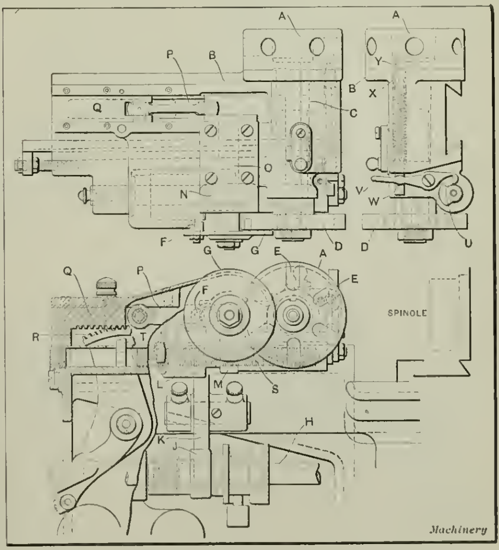


Fig. 2. Brown & Sharpe Automatic Indexing Mechanism

revolving the turret is subject to a great deal of abuse and it must therefore be of sufficient strength to withstand the maximum strains which may be put upon it without danger to the parts involved. We shall now consider several varieties of indexing mechanisms for the horizontal type of turret lathe.

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[*] Address: 221 Grove St., Bridgeport, Conn.

Indexing Mechanism for the Garvin Turret Lathe

Fig. 1 shows a side view and plan of the turret and slide used on the Garvin turret lathe. The turret mounting is somewhat exceptional in that a square post is used as a driver (see perspective detail above the side elevation in the illustration) and the star wheel *A* is integral with it. This construction prevents any chance for lost motion between the turret and the star wheel and avoids all troubles which might be caused by parts jarring loose, due to the constant shock of indexing the turret. The stud itself is of steel and is hardened and ground to an accurate fit in the turret. It will be noted also that the individual stop shaft wheel *B* is a part of the same piece of steel, and controls the action of the stops by means of the spiral gear *C*. The turret is held in position by the collar *D* which is threaded onto the shank and is secured by a headless set-screw. A binding collar *E* clamps the turret down on the slide when the handle *F* is tightened. The lock pin bushings *G* on this turret are off at at one side of the center (see plan view), and the lock pin *H* is slotted at its lower end to receive the end of the lock pin lever *I* which is rounded on the end. The action of the spring *J* is self-evident. The tumbler *K* is the means by which the lock pin lever is operated, and its action will be described later. The turret rotator lever *L* is shown in the plan view, and carries at its forward end a hardened pin which engages with the star wheel.

The operation of the mechanism is as follows: As the turret slide is pulled back on the return stroke, the lock pin lever *I* rides up on the tumbler *K* and pulls out the lock pin *H* from the lock pin bushing *G*, in the under side of the turret. Just as this action is completed the star wheel *A* reaches a position where it engages the star wheel lever *L*. As the backward movement continues, the star wheel is turned around one division and the combined movements bring one of the star wheel teeth up against the stop-pin *M*. This takes the shock of the momentum and prevents any further movement. While this has been taking place, the under side of the lever *I* has been sliding along over the top of the tumbler *K*.

On the beginning of the forward stroke, the drag of the lever tips over the tumbler *K*, and the lock pin shoots into place as it is forced to do by the flat spring *J*. This arrangement prevents all rubbing of the pin against the under side of the turret while indexing from one position to another, and it will be further noted that the turret has been previously indexed to the correct position to receive this pin so that all wear on the end of the lock pin and lock bushing is avoided. The star wheel is shrouded by a flange *N* which also serves to hold the turret down.

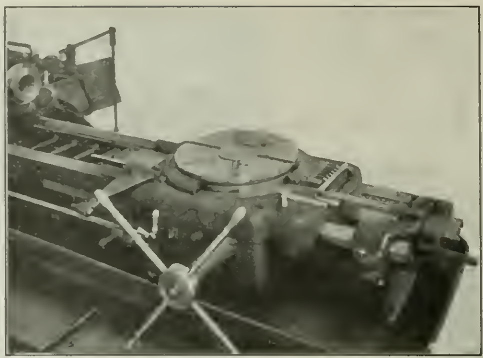
Fig. 4. Turret of Hartness Flat Turret Lathe

Steinle Turret Mechanism

The Steinle turret lathe is one of the heavier types, the turret being 20 inches in diameter and fitted with arrangements for carrying heavy tool equipment. A longitudinal section through the turret and slide and a transverse section and end view are shown in Fig. 3. It will be noted that the turret is fitted both on the bevel *A* (which makes it self-centering), and on the wide surface *B* as well, while it also has a supplementary central pin *C* which extends down through the slide and is held in place by a nut on the under side. The large adjusting nut *D* is screwed to the turret ring and acts as a thrust collar against which the binding ring makes up. The stop-operating ring *E* is cut in the form of a progressive cam on its lower side and controls the sector lever *F* which, in turn, revolves the stop rod *G*. A collar *H* is fixed to the end of this rod and the stops are held in place in any desired position by means of set-screws. The adjustable abutment for the stops is shown at *I*. The under side of the turret is fitted with taper bushings in which the taper locating pin *J* seats itself. Attention is called to the fact that this pin is 8⅝ inches from the center of the turret and this assists greatly in giving accurate turret locations. The pin is operated in one direction by the spring and in the other by the segmental wedge shaped block *K*. The supper surface of the clamping ring *L* is cut in the form of a three-point cam having a shallow rise, and the under side of the turret slide is cut to correspond. An extremely powerful clamping action of the turret is therefore attained by means of the lever *M*. It will be readily seen that as this lever is forced over by the hand of the operator, the cams work against each other and the turret is drawn down on the slide in such a way that the two form practically a solid unit. Provision is made for lubricating the moving surfaces by an oil-well and roller.

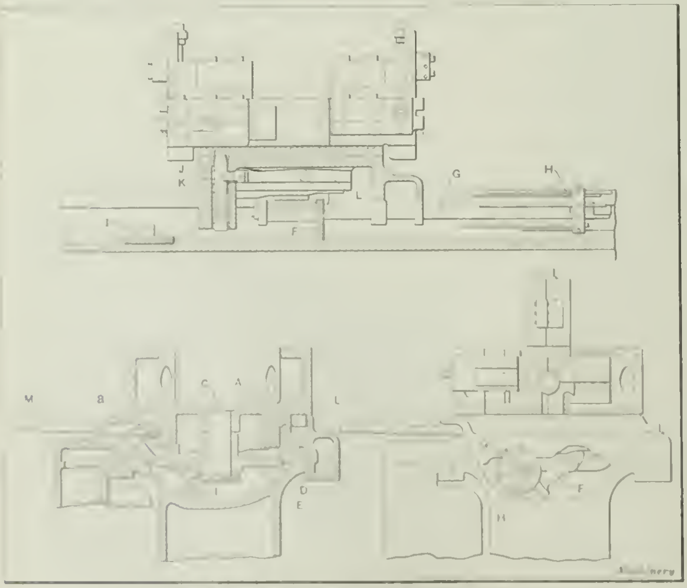

Fig. 3. End and Sectional Views of Steinle Turret

Brown & Sharpe Automatic Index Mechanism

We now come to an entirely different arrangement, in that the machine itself is of the automatic type and therefore all

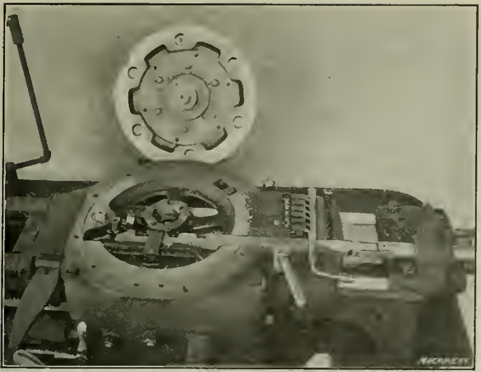

Fig. 5. Hartness Flat Turret raised from Seat to expose Mechanism

indexing movements must be performed automatically. The upper view in Fig. 2 shows the turret *A* mounted on the slide *B*. The turret itself is of steel and is made with a cylindrical shank *C* which passes through the bearing and is fitted on the other end with the index plate *D*. This plate has six slots *E* on its outer surface, these being spaced 60 degrees apart. A roller *F* is secured to the back face of the disk *G* in such a position that it will engage with the slots *E* as the disk is revolved. The feed shaft *H* (shown in the lower view) is at the rear of the machine and operates the train of gears *J*, *K*, *L*, *M*, the last of which is a spiral gear meshing with the gear *N* (upper view) on the shaft *O*. An intermittent clutch on the feed shaft is thrown into engagement at the proper time by means of a trip lever operated by a cam. (This is not shown in the illustration.) On the other end of the shaft *O* the crank *P* is pivoted. Its other end is connected to the block *Q*, which is free to move independently of the slide itself except when restrained by the crank's locking action when in the position shown. The sector *R* carries the turret forward by the action of the cam that controls it. The coil spring *S* forces the turret slide back after a machining operation has been performed. The pin *T* is fixed in the slide and the spring acts against it through the medium of an annular grooved plunger, the groove engaging with the pin. The upper end of the pin is shown broken away.

The turret itself is fitted with taper bushings *Y* in which the end of the index pin *X* locates. The action of the latter is controlled by the cam *U* and the coil spring shown. This cam is on the end of the shaft that contains the spiral gear operating the indexing mechanism. It will be noted that the lever *V* works in a slot *W* in the side of the bolt. The action of the mechanism is as follows: At the completion of an operation the trip mechanism throws in the intermittent clutch on the feed shaft. This motion is transferred through the train of gears to the index disk *G*, which starts to revolve and pulls the crank *P* forward as it rotates, thus allowing this spring *S* to gradually force the turret slide back and thereby remove the tool from the work. The cam *U* now operates the lever and pulls out the lock bolt, immediately after which the roller *F* has reached a point where it engages with one of the slots *E*, and as it continues to revolve the turret is rapidly indexed. At the proper time (the cam having released the lever) the lock bolt snaps into place but the crank continues to move until it reaches the position shown in the illustration, at which time the intermittent clutch is thrown out of engagement, thereby leaving the whole slide tied together through the medium of the link. The turret is now carried forward by the toothed sector *R* for the next operation, the sector engaging a rack affixed to the turret slide.

It will be noted that the link motion and floating action between the block *Q* and the slide, is of great value, in that it permits the withdrawal of the tools from the work just as soon as the end of the stroke is reached without waiting for the roll to drop off the end of the cam. The result is a considerable saving in time over other methods.

Hartness Flat Turret Lathe Indexing Mechanism

Fig. 4 shows the turret of a Hartness flat turret lathe, with a portion of the annular gib removed to show the construction. Fig. 5 shows the turret tipped up and the internal mechanism exposed to view. Fig. 6 (upper view) is an isometric drawing of the turret and slide, broken away to show the construction, while the lower view is a plan.

The turret construction, indexing mechanism, and system of stops for this machine show many novel features which are well worth studying. Figs. 4 and 5 show the general appearance of the turret and slide, and attention is especially directed to the clean appearance of the design as a whole and the freedom from dirt- and chip-catching projections. The accessibility of the various levers is also an important feature. Referring to Fig. 6, the turret itself is of cast iron and is located on a central steel stud *A* and gibbed down by four annular gibs around its periphery. A ratchet gear *B* engages with the spring ratchet pin *C* and is used to revolve the turret (see small section in upper left-hand corner of illustration). The turret turning rack-bar *D* is of rectangular section and has at its forward end three notches which engage with teeth in the ratchet gear. The spring taper locating pin *E* is set well out from the center of the turret and directly underneath the cutting tool. This insures great accuracy. The upper end of the pin enters one of the hardened bushings in the under side of the turret. The pin itself is also carried in a bushing and a coil spring underneath forces it into place. The locking pin lever *F* pivots on the pin *G* and is controlled by the rocker *H* which is fastened to it. The latch *I* (see section *Y-Y*) keeps the lock pin lever down while the turret is being indexed, and the screws *J* trip it and allow the lock pin to swing into place at the termination of the indexing movement. An oiling roll *K* furnishes lubrication for the turret. The lever *L* locks the slide firmly in any desired position on the ways.

The stop mechanism on this machine is very efficient and

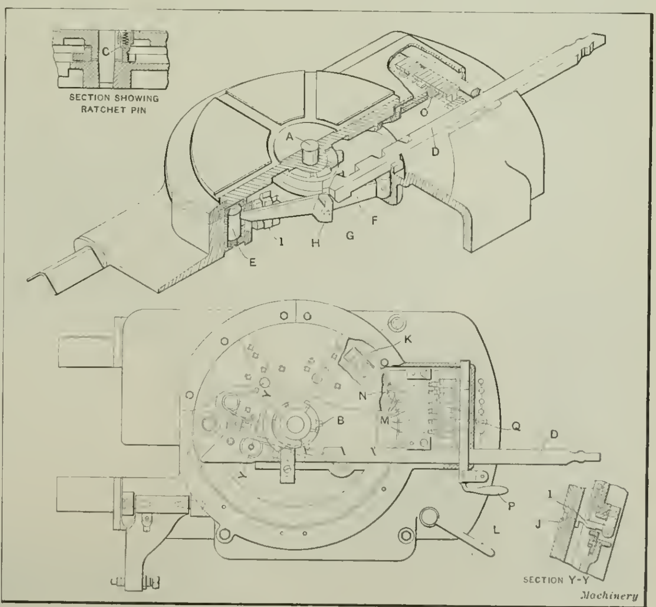

Fig. 6. Indexing and Stop Mechanism of Hartness Flat Turret Lathe

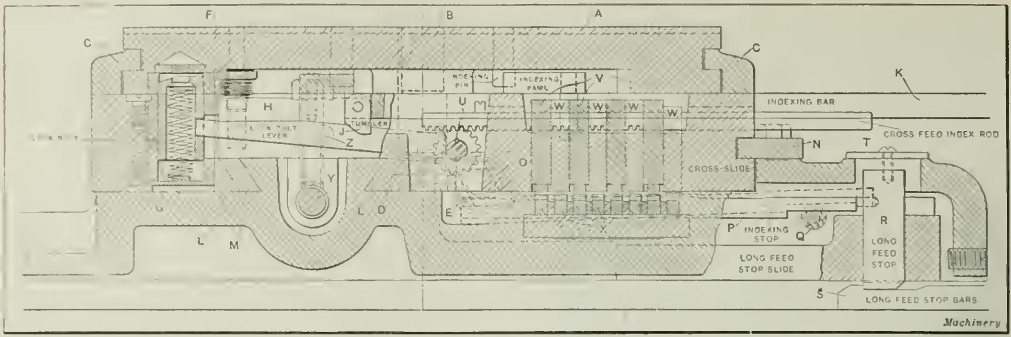

Fig. 7. Longitudinal Section of Acme Flat Turret

quite unusual, there being twelve stops in all—two for each position of the turret. The main stop bars are of rectangular section and about four feet long; they lie directly under the carriage saddle and are snugly nested together in the top of the bed casting. Each bar has a notch cut in it on its upper edge and this notch is square on the front end but beveled on the rear. Into these notches the supplementary bolts in the turret drop, thereby arresting the forward movement of the slide. The supplementary bolts are nested in a vertical pocket in the carriage, and are controlled by the turret through the medium of the tappet rods shown at *M* in the plan view. These tappet rods snap into the semicircular pockets in the turret at *N* and make contact with six small lifting cranks *O* which hold the vertical stop bolts out of engagement except when the tappet rod enters the pocket. The bolt for this particular rod is then allowed to drop below the others, and therefore as the turret slide moves forward, it engages the notch in the lower bar and arrests the forward motion of the slide. In this connection it is well to note that a slip mechanism is provided on the turret feed so that it does not spring back after coming to the stop but remains there until moved back by the operator. In coming up to a shoulder it will be seen that this "dwell" serves to smooth up the shoulder. The lever *P* is so arranged that either half of the stops may be lifted at one time, or alternate stops, and by turning the lever to a central position, all of the stops may be lifted out of engagement.

By placing an auxiliary stop pin *Q* in any one of the six holes shown, it is possible to secure an extra stop position by inserting the pin in one of the holes not in use on that particular job. In fact, seven longitudinal positions of the turret may be obtained by using the regular stop for one position and the alternate six extra stops for the remainder. A more adaptable arrangement would be hard to find.

In operating the index mechanism after a turning or boring operation has been completed, the turret is run back until the back stop is struck by the turret turning rack bar, and as the retrograde movement continues, this bar slides over the rocker *H* and depresses the lever, thereby pulling out the turret locking pin; the latch *I* snaps over the lever and holds it down. The notches in the bar now engage with the ratchet gear and revolve the turret until the end of the trip screw *J* disengages the latch *I*. This releases the locking pin lever *F* which permits the turret locking pin to spring up into position, thereby positively locating the turret. A valuable feature of this design is that any one of the trip screws can be screwed up so that the turret can be indexed past any position not needed, thus saving time.

When the indexing takes place, the tappet rod corresponding to the turret face in use snaps into the semicircular pocket *N* in the turret and allows the proper stop bar to drop down to its correct position. As the turret slide is run forward again, the bar *D* is held at the rear by the spring fingers on the back stop (see also Fig. 4), with sufficient pressure to pull back the ratchet gear to its normal position.

Bullard and Pratt & Whitney Indexing Mechanisms

On the Bullard vertical turret lathe the turret is at an angle to give more clearance when swinging tools over the slide. The indexing mechanism is hand actuated by means of a crank and pinion, after the turret has been drawn forward away from the locating pins. The action is simple and efficient, but does not require a lengthy description. The method of locating is, however, somewhat extraordinary. There is a double set of pins which are slabbed off on the sides to a shallow taper, and firmly fixed in the slide at the upper part of the turret bearing seat. On the back of the turret at each of the five turret positions another set of pins with opposing tapers is fixed, these being very carefully fitted so that the tapers make up snugly at the same time that the turret is drawn back onto its seat. The advantage derived from an indexing position that is away from the turret seat is that, as there

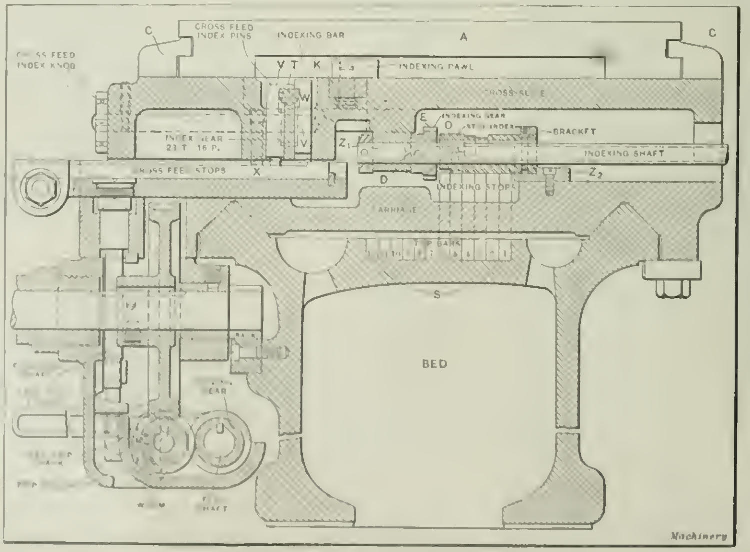

Fig. 8. Transverse Section of Acme Flat Turret

is no friction on the seat while indexing, there can be no wear, and alignment is therefore more absolute.

The new Pratt & Whitney side-head boring mill also uses a turret set on an angle. It is located on a large central stud but does not leave its seat when indexing. A hand lever connected by internal gearing is used to revolve the turret. Two lock bolts are used to locate this turret, these being wedge shaped on the ends to fit angular slots in the index ring, which is of large diameter, thus insuring great accuracy. All these working parts are hardened and ground to a fit. The lock bolts are supported on each side by taper gibs easily adjusted to take up wear. The mechanism is operated by a lever-controlled pinion which engages the rack portion of the bolts and forces them into their seats. This lever is also so arranged that it binds the turret securely to its seat on the slide, making practically a solid unit.

Acme Flat Turret Lathe Mechanism

This machine has a cross-sliding turret in addition to its regular longitudinal movement. Fig. 7 shows a longitudinal section through the turret, while Fig. 8 gives a transverse section. The turret *A* in Fig. 7 is centered by the plug *B* and is held down by the annular gibs *C*. As the slide is run back the indexing bar *K* strikes the stop arranged for that purpose on the ways of the machine. The bar moves forward in its relation to the turret until the tumbler *J* strikes the roll *Z* on the lock bolt lever *H*, depressing it and pulling over lock bolt *G*, after which the indexing pawl revolves the turret by means of the pins on its under side, and the lock bolt snaps into place in the tapered bushing *F*.

The cross-slide of the turret is of the dovetail type, as shown at *L*, and it is provided with adjustment in the gib *M*. The stops for the cross-slide are eight in number and are controlled by a knob at the front of the slide, which permits the revolution of the rod *U* on which a spur gear is mounted. This gear moves the cross-feed index rod in either direction and allows any of the stop pins *V* or *W* to drop into the angular slot in the rod. As the cross-slide is fed forward, the end of the pin which has dropped brings up against one of the stop rods *X* which are nested together in the base. It will be seen that any or all of the eight stops may be used for any one position of the turret, thus making possible a great range of stops for intricate shoulder work. Reference to Fig. 8 will make this construction perfectly clear. The longitudinal turret stops are twelve in number, six of these being controlled by the indexing of the turret while the other six are operated independently by a knob on the front of the turret slide.

As the turret is indexed, the spiral gear *D* on the turret center stud meshes with the gear *E*, causing it to revolve one-sixth of a turn. By referring to Fig. 8 it will be seen that the stop index *O* is slabbed off in six places and that the shaft which carries it has a bearing at Z_1 and Z_2. As the shaft revolves, the indexing stop levers are operated so that one of the longitudinal feed stops *R* (Fig. 7) is allowed to drop down below the rest so that it eventually brings up against the shoulder on the longitudinal feed stop bar *S*. These bars are nested in the bed as shown in Fig. 8 and they are protected from dirt and chips by the slide itself which covers them. As all the mechanism of the stops is internally located there is very little danger of inaccuracies resulting from imperfect contact due to dirt or chips.

The six independent stops for the turret longitudinal feed are operated by a knob at the front of the slide, which controls the rod *Q* that is flattened off in six places. Its operation is the same as the mechanically controlled stop index, except that it is controlled by hand and is so arranged that all six stops can be used for any one turret face, if desired, in addition to the regular stop. This makes possible the production of longitudinal shoulder distances with great accuracy.

Other designs of turret indexing mechanisms could be cited but they would do no more than elaborate the subject without serving any useful purpose. The examples given are as widely different as it was possible for the writer to select, no attempt being made to illustrate every turret mechanism on the market, as this would take too much space.

VERTICAL DRILLING OF DRILL ROD BILLETS

A new method of producing hollow steel bars used for rock drill rods was described in the October, 1914, number. It consists essentially of drilling a billet, filling the hole with a special composition, plugging the ends and then heating and rolling to the diameter of drill rod required. The composition with which the hole is filled elongates with the rolling but holds the circular shape. By this process, it is possible to produce, say, a ¾-inch drill rod 30 feet long with a ¼-inch axial hole extending from end to end. While the hole is not mathematically exact, it is sufficiently true to the axis and uniform in diameter to answer the purpose desired, which is to convey water to the point of the drill when drilling holes in stone. The water forcing out the chips and cooling the point of the drill, greatly increases the speed at which holes can be drilled.

The manufacture of this type of rock drill rod having been licensed in the United States by Dunford & Elliott, Ltd., Attercliffe Wharf, Sheffield, England, by whom it was originated, some interesting American machines have been designed for its manufacture. One of these, recently built by the Foote-Burt Co., Cleveland, Ohio, is an inverted drilling machine for drilling the billets. The method of forming the hole in the billet first employed by Dunford & Elliott was the well-known Mannesmann process by which a pointed mandrel is forced axially through the billet while being rolled hot with hyperboloidal rolls. This process was found to be objectionable because it caused minute radial cracks which later extended and caused failure of the drill rod.

The Foote-Burt drilling machine holds the square billet, about 5 by 5 inches and 20 inches long, in a frame mounted on a slide on the vertical face of the drill column, jaws being provided for centering it over the drill which stands beneath. With this machine, a 1¼-inch hole can be drilled in 90-point carbon steel 20 inches deep in 20 minutes, the feed being one inch per minute. Oil-tube drills with straight flutes or with flutes having less than half the usual angle with the drill axis are used.

The advantages claimed for the internal drilling machine are rigid support for the drill spindle because of being mounted in the base close to the floor, and the inverted position of the drill which permits chips to fall by gravity. The fact that the chips fall from the hole by gravity, the clearing being aided by the lubricant forced in under pressure, permits the use of a type of drill that breaks the chip instead of curling it. This reduces the heat generated and tends to produce more effective cutting.

The efficiency of inverted drilling in this case is indicated by the fact that 26 billets were drilled in ten hours, the hole in each being 20 inches deep and 1¼ inch in diameter. The peripheral speed of the drill used was 50 feet per minute and the feed, as stated, was one inch per minute or 0.0065 inch per revolution. In the foregoing it was stated that the billets drilled are 5 inches square, but the size depends on the diameter of the drill rod to be rolled, the diameter of hole required and the length to be rolled.

* * *

Piping of various kinds such as gas, water, steam-heating, vacuum cleaning or compressed air, is often concealed within walls, generally under plaster, and when it comes to making repairs or replacing such pipes, their exact position cannot always be found without doing considerable damage to the wall. A recently patented electric method for locating the pipes is simply a special application of the well-known induction balance principle. As described in the *Scientific American*, a convenient apparatus is made up of two sets of coils placed on the ends of a magnet bar. One set of coils receives alternating or vibratory current from a suitable source, and the other is connected to a telephone. The balance is first established so that no sound is heard in the telephone. When the device comes near the metal piping, this disturbs the balance and a sound is heard. It is thus an easy matter to find the exact position of the pipes and to reach them with less damage to the wall.

USE OF CONTINUED FRACTIONS IN MECHANICAL PROBLEMS*

THE THEORY OF CONTINUED FRACTIONS AND THEIR APPLICATION TO CHANGE GEAR PROBLEMS

BY WILLIAM W. JOHNSON†

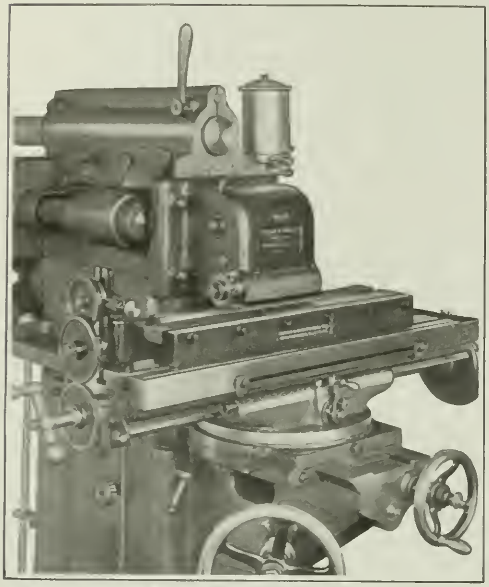

Fig. 1. Rack Cutting Indexing Attachment of Brown & Sharpe Milling Machine

QUITE often in the operation of machine tools, the problem arises of selecting the required change gears for handling some specific operation. A typical example of this kind is where the rack cutting indexing attachment is to be used to obtain some fractional spacing that is not given in the index table; and it is the purpose of this article to show by the solution of a few examples how accurate results can be obtained by employing continued fractions in selecting suitable change gears for the rack cutting indexing attachment of the Brown & Sharpe milling machine. This attachment is shown in Fig. 1 set up for milling a rack, accurate spacing being obtained by means of a locking disk connected to the feed-screw of the milling machine by two change gears and two equal gears, which connect the indexing attachment with the feed-screw. The ratio of the change gears determines the distance that the milling machine table moves for each turn of the locking disk. The change gears furnished with a Brown & Sharpe indexing attachment are two with 56 teeth and one each of 28, 35, 42, 44, 49, 63, 70, 77, 84, 88, 91, 98, 105 and 112 teeth. These gears will be referred to again in the examples which follow.

Before proceeding to work out an example we will consider briefly some of the properties of continued fractions which are useful in reducing fractions with large terms to approximate fractions with smaller terms. Any common fraction $\frac{N}{D}$ in its lowest terms may be converted into a simple terminating continued fraction of the form:

$$Q_1 + \cfrac{1}{Q_2 + \cfrac{1}{Q_3 +}}$$

The preceding form of fraction is commonly written:

$$Q_1 + \frac{1}{Q_2 +}\ \frac{1}{Q_3 +}$$

where Q_1, Q_2, Q_3, etc., are the successive quotients in the operation of finding the greatest common divisor of N and D.

When $\frac{N}{D}$ is a proper fraction the first quotient Q_1 is zero.

In the continued fraction $Q_1 + \frac{1}{Q_2 +}\ \frac{1}{Q_3 +}\ \frac{1}{Q_4 +} \cdots$ the fractions formed by taking one, two, etc., of the quotients are called "converging fractions," or the "principal convergents" to the continued fraction. Each convergent is nearer in value to the continued fraction than any preceding convergent. Let $\frac{N_1}{D_1}, \frac{N_2}{D_2}, \frac{N_3}{D_3}, \cdots \frac{N_n}{D_n}$ represent the successive convergents, which will be fractions in their lowest terms.

Then we have:

$$\text{1st convergent} = \frac{N_1}{D_1} = Q_1 \text{ or } \frac{Q_1}{1}; \qquad (1)$$

$$\text{2nd convergent} = \frac{N_2}{D_2} = Q_1 + \frac{1}{Q_2} = \frac{Q_2Q_1 + 1}{Q_2}; \qquad (2)$$

$$\text{3rd convergent} = \frac{N_3}{D_3} = Q_1 + \frac{1}{Q_2 +}\ \frac{1}{Q_3} = \frac{Q_3(Q_2Q_1 + 1) + Q_1}{Q_3Q_2 + 1} = \frac{Q_3N_2 + N_1}{Q_3D_2 + D_1} \text{ [from (1) and (2)];}$$

In general, we find:

$$\text{nth convergent} = \frac{N_n}{D_n} = \frac{Q_nN_{n-1} + N_{n-2}}{Q_nD_{n-1} + D_{n-2}} \qquad (3)$$

Formula (3) expresses the law of formation of the successive convergents to a continued fraction, each convergent after the second being obtained from the two convergents immediately preceding it. The last convergent is always equal to the common fraction from which the continued fraction is obtained; and any convergent that immediately precedes a large quotient is a near approximation to the value of the continued fraction.

Example 1

Suppose, for example, that a rack is required with a distance between adjacent teeth of 0.268 inch. Then we have the following:

$$\text{Ratio of change gears} = \frac{\text{pitch required}}{\text{lead of feed-screw}} = \frac{0.268}{0.250} = \frac{\text{number of teeth in gear on locking disk}}{\text{number of teeth in gear on feed-screw}} = \frac{134}{125}.$$

As we have no gears with so large a number of teeth, we will have to content ourselves with an approximation of this ratio. To obtain the best possible approximation we convert

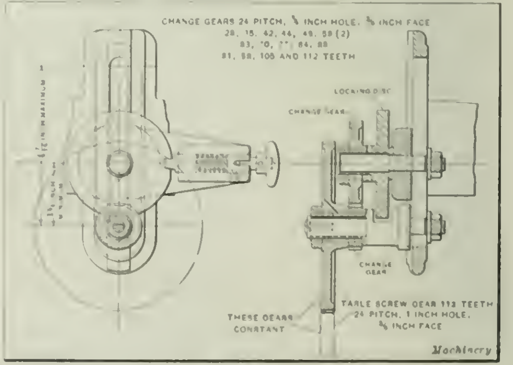

Fig. 2. Diagram showing Arrangement of Gears on B. & S. Rack Cutting Indexing Attachment

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* For other articles on this subject published in MACHINERY see "Selecting the Number of Teeth for Gears and Sprockets," by G. M. Bartlett, September, 1912 and "How to Obtain Approximate Fractions by the Method of Continued Fractions," by Mitchell Dawes, August, 1908.

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$\frac{134}{125}$ into a continued fraction and calculate the principal convergents as follows:

$125)134(1 = \text{1st quotient} = Q_1$
$\quad 125$
$\quad 9)125(13 = \text{2nd quotient} = Q_2$
$\qquad 117$
$\qquad 8)9(1 = \text{3rd quotient} = Q_3$
$\qquad\quad 8$
$\qquad\quad 1)8(8 = \text{4th quotient} = Q_4$
$\qquad\qquad 8$
$\qquad\qquad 0$

From the successive quotients just found we can calculate the principal convergents by means of Formulas (1), (2), (3), and arrange them for convenience in calculating, as shown in Table I.

TABLE I. VALUES OF PRINCIPAL CONVERGENTS OBTAINED IN SOLVING PROBLEM 1

Number of quotient = n	1	2	3	4
Quotient = Q	1	13	1	8
Numerator of convergent = N	1	14	15	134
Denominator of convergent = D	1	13	14	125

Machinery

Since the third convergent precedes a large quotient we select $\frac{15}{14}$ as a near approximation to the value of the fraction $\frac{134}{125}$. Then:

$$\frac{\text{Number of teeth in gear on locking disk}}{\text{Number of teeth in gear on feed-screw}} = \frac{15 \times 7}{14 \times 7} = \frac{105}{98}.$$

Referring to the list of change gears we find that we have gears with 105 and 98 teeth. For checking to find the error resulting from the use of this approximation we have the formula:

$$\text{Distance work moves} = \frac{PLT}{S} \qquad (4)$$

where P = number of teeth in gear on locking disk stud;
L = lead of feed-screw (¼ inch on B. & S. milling machine);
T = number of turns of locking disk;
S = number of teeth in first gear on stud (connected directly to feed-screw by means of equal gears).

The sum of the number of teeth P and S should be not greater than 213; nor less than 84, due to the maximum and minimum gear centers on the B. & S. indexing attachment. For the B. & S. milling machine, Formula (4) becomes:

$$\text{Distance work moves} = \frac{TP}{4S} \qquad (5)$$

Example 2

Given a rack with a pitch of 0.2585 inch, to find the necessary change gears:

$$\text{Ratio of change gears} = \frac{0.2585}{0.2500} = \frac{517}{500}.$$

We will again try, by employing continued fractions, to find a fraction that will enable us to use the gears at hand. Calculating the principal convergents as before, we have:

$500)517(1 = Q_1$
$\quad 500$
$\quad 17)500(29 = Q_2$
$\qquad 493$
$\qquad 7)17(2 = Q_3$
$\qquad\quad 14$
$\qquad\quad 3)7(2 = Q_4$
$\qquad\qquad 6$
$\qquad\qquad 1)3(3 = Q_5$
$\qquad\qquad\quad 3$
$\qquad\qquad\quad 0$

TABLE II. VALUES OF PRINCIPAL CONVERGENTS OBTAINED IN SOLVING PROBLEM 2

Number of quotient = n	1	2	3	4	5
Quotient = Q	1	29	2	2	3
Numerator of convergent = N	1	30	61	152	517
Denominator of convergent = D	1	29	59	147	500

Machinery

It would appear that the method of continued fractions fails to give a suitable ratio in this case. We may, however, find another series of convergents, intermediate between any two principal convergents, if the quotient Q_n from which the last one of the two principal convergents was derived is greater than 1. The number by which this quotient exceeds 1 will be the number of intermediate convergents we can find between any two consecutive principal convergents. In the present case, we can find one more convergent between $\frac{N_3}{D_3} = \frac{61}{59}$ and $\frac{N_4}{D_4} = \frac{152}{147}$, because $Q_4 = 2$, which is one in excess of 1. The intermediate convergents between Q_n and Q_{n-1} are found by the formula:

$$\frac{N_{n-2} + kN_{n-1}}{D_{n-2} + kD_{n-1}}. \qquad (6)$$

where k is given successively the values 1, 2, 3 ..... Q_n.

TABLE III. VALUES OF INTERMEDIATE CONVERGENTS OBTAINED IN SOLVING PROBLEM 2

Multiplier k			1	2
Numerator of convergent = N	30	61	91	152
Denominator of convergent = D	29	59	88	147

Machinery

For convenience in calculating intermediate convergents, we arrange the work as shown in Table III. We find we have gears for the ratio $\frac{91}{88}$; and computing the error obtained by using these gears, we have by Formula (5):

$$\text{Distance work moves} = \frac{1 \times 91}{4 \times 88} = 0.25852 \text{ inch.}$$

This is a very close approximation to the required pitch and allows us to use the regular gears.

Example 3

Given the problem of setting up the machine to cut a rack with a pitch of 0.479 inch, to find the necessary change gears. Using the method of calculation already employed, we get:

$250)479(1 = Q_1$
$\quad 250$
$\quad 229)250(1 = Q_2$
$\qquad 229$
$\qquad 21)229(10 = Q_3$
$\qquad\quad 210$
$\qquad\quad 19)21(1 = Q_4$
$\qquad\qquad 19$
$\qquad\qquad 2)19(9 = Q_5$
$\qquad\qquad\quad 18$
$\qquad\qquad\quad 1)2(2 = Q_6$
$\qquad\qquad\qquad 2$
$\qquad\qquad\qquad 0$

TABLE IV. VALUES OF PRINCIPAL CONVERGENTS OBTAINED IN SOLVING PROBLEM 3

Number of quotient = n	1	2	3	4	5	6
Quotient = Q	1	1	10	1	9	2
Numerator of convergent = N	1	2	21	23	228	479
Denominator of convergent = D	1	1	11	12	119	250

Machinery

We have gears for the ratio $\frac{21}{11} = \frac{84}{44}$.

$$\text{Distance work moves} = \frac{1 \times 84}{4 \times 44} = 0.47727 \text{ inch.}$$

The use of these gears introduces an error of 0.0017 inch. If we need a closer approximation, we will again try to find a suitable ratio by calculating the intermediate convergents between $\frac{23}{12}$ and $\frac{228}{119}$. In making this calculation, we have the values presented in Table V. Either of the ratios $\frac{44}{23}$, $\frac{67}{35}$,

TABLE V VALUES OF INTERMEDIATE CONVERGENTS OBTAINED IN SOLVING PROBLEM 3

k			1	2	3	4	5	6	7	8	9
Numerator of convergent = *N*	21	23	44	67	90	113	136	159	182	205	228
Denominator of convergent = *D*	11	12	23	35	47	59	71	83	95	107	119

Machinery

and $\frac{182}{95}$ would give a close approximation, but each would require one special gear. Selecting $\frac{182}{95}$ as the nearest approximation, we have, making $T = 2$ in Formula (5):

$$\text{Distance work moves} = \frac{2 \times 91}{4 \times 95} = 0.47894 \text{ inch.}$$

This would require a special gear with 95 teeth, and two turns of the locking disk. The preceding method of finding one or more series of fractions intermediate between two principal convergents is quite simple, and often it is the only solution for obtaining a suitable ratio, *i.e.*, a ratio for which we have the gears, when the principal convergents fail. If this method does not give a suitable ratio, it will at least give the best approximation to the true ratio, from which it is easy to determine what special gear, or gears, will be required.

The change gears of the Brown & Sharpe rack cutting indexing attachment were selected as the basis of the examples presented in this article. Those who are familiar with this equipment will know that an index table (reproduced in Table VI) is provided that gives the necessary change gears for cutting all standard pitches for which the attachment is adapted, and it is needless to say that no mechanic would think of figuring out the change gears which are given in this table. The use of continued fractions is also valuable for cases where it is desired to determine the number of teeth in a pair of gears to give a certain ratio, where the numbers of teeth in the gear and pinion must be within certain specified limits. In general, continued fractions are employed to obtain approximate fractions, the values of which are very close to the value of the fraction from which they are derived.

TABLE VI. INDEX TABLE FOR USE WITH RACK CUTTING INDEXING ATTACHMENT ON BROWN & SHARPE MILLING MACHINES

Diametral Pitch						Circular Pitch					
Pitch	Gear on Index Disk	1st Gear on Stud	No. of Turns of Index	Work Moves	Correct Pitch	Pitch	Teeth Per Inch	Diametral Pitch	Gear on Index Disk	1st Gear on Stud	No. of Turns of Index
3	88	42	2	1.047619	1.047194	1	1	3.1416	112	28	1
3½	88	49	2	0.897958	0.897598	15/16	1 1/15	3.3510	105	28	1
4	88	28	1	0.785714	0.785398	7/8	1 1/7	3.5904	98	28	1
4½	88	63	2	0.698413	0.698132	13/16	1 3/13	3.8666	91	28	1
5	88	35	1	0.628571	0.628318	4/5	1 1/4	3.9270	112	35	1
5½	112	49	1	0.571428	0.571198	3/4	1 1/3	4.1888	84	28	1
6	88	42	1	0.523809	0.523597	11/16	1 5/11	4.5696	77	28	1
7	88	49	1	0.448979	0.448799	2/3	1 1/2	4.7124	112	42	1
8	88	56	1	0.392857	0.392699	5/8	1 3/5	5.0265	70	28	1
9	88	63	1	0.349206	0.349066	3/5	1 2/3	5.2360	84	35	1
10	88	70	1	0.314285	0.314159	4/7	1 3/4	5.4978	112	49	1
11	88	77	1	0.285714	0.285599	9/16	1 7/9	5.5851	63	28	1
12	88	84	1	0.261904	0.261799	1/2	2	6.2832	56	28	1
13	88	91	1	0.241758	0.241661	4/9	2 1/4	7.0686	112	63	1
14	88	98	1	0.224489	0.224396	7/16	2 2/7	7.1808	98	56	1
15	88	105	1	0.209523	0.209439	3/7	2 1/3	7.3304	84	49	1
16	88	112	1	0.196428	0.196349	2/5	2 1/2	7.8540	56	35	1
18	44	63	1	0.174603	0.174533	3/8	2 2/3	8.3776	84	56	1
20	44	70	1	0.157142	0.157080	4/11	2 3/4	8.6394	112	77	1
22	44	77	1	0.142857	0.142799	1/3	3	9.4248	56	42	1
24	44	84	1	0.130952	0.130899	5/16	3 1/5	10.0531	70	56	1
26	44	91	1	0.120879	0.120831	3/10	3 1/3	10.4720	84	70	1
28	44	98	1	0.112245	0.112198	2/7	3 1/2	10.9956	56	49	1
30	44	105	1	0.104762	0.104719	1/4	4	12.5664	56	56	1
32	44	112	1	0.098214	0.098179	2/9	4 1/2	14.1372	56	63	1
						1/5	5	15.7080	56	70	1
						3/16	5 1/3	16.7552	42	56	1
						2/11	5 1/2	17.2788	56	77	1
						1/6	6	18.8496	56	84	1
						2/13	6 1/2	20.4204	56	91	1
						1/7	7	21.9911	56	98	1
						2/15	7 1/2	23.5620	56	105	1
						1/8	8	25.1327	56	112	1
						1/9	9	28.2743	28	63	1
						1/10	10	31.4159	28	70	1
						1/12	12	37.6992	28	84	1
						1/14	14	43.9823	28	98	1
						1/16	16	50.2656	28	112	1

Machinery

Note.—It is not necessary to change gear on screw or second gear on stud when changing for the different pitches.

* * *

Prof. James F. Kemp, of Columbia University, emphasized in his address to the graduating class of the Michigan College of Mines the fact that the mining engineer is a man whose measure of responsibility is not limited to engineering work alone, but upon whom, in a remote community, the welfare of hundreds or thousands of families often depends. As an example was mentioned Hjalmar Lundbohm at Kiruna, Sweden, who, far beyond the Arctic Circle, in a land where under ordinary conditions only the Laplanders, with their herds of reindeer, could eke out a scanty subsistence, has built up a community of from 8000 to 10,000 men, women and children. Here schools of the very best character have been established, comfortable homes have been built, and careful attention has been given to all matters connected with the welfare of the inhabitants, much of which is due to the ability and the generous spirit of Mr. Lundbohm; hence, there are many other sides to the mining engineering profession than ore and rocks, concentration and smelting. In more than any other branch of engineering the conditions under which the workers and their families live depend upon those in charge of the operations. It is of vastly more importance to a mining community than to an ordinary town of varied industries whether the men in power are considerate, just and sympathetic, or whether they are unscrupulous and selfish.

* * *

The specific heat of steatite, which is the essential ingredient of soapstone, is 0.21.

A STUDY OF BELT DRIVES

BY MILES SAMPSON*

In a large manufacturing establishment in which the writer was employed, there was constant trouble with large belts which were found to wear out rapidly and to require constant attention in order to have them operate at a reasonable efficiency. Many of these drives had been designed too small for economical operation, while others had gradually become overloaded through the speeding up of machinery, the introduction of heavier work or the addition of new machinery in the plant. To overcome the difficulty and to determine standards for future reference it was decided to make an individual study of each belt over 15 inches in width, and to make a careful record of the results of these investigations. The data obtained were tabulated on the form which is presented herewith. The results shown in columns 1 to 11 were obtained by direct observation and measurement. The maximum load given in column 12 was obtained by either calculation or test. Knowing the pulley diameter and the shaft speed, the speeds tabulated in column 13 were obtained by direct calculation. The results in column 14 are calculated as follows:

$$\text{Feet per minute, per inch of belt, per horsepower} = \frac{S \times W}{\text{H.P.}}.$$

where S = actual speed of belt per minute;

W = width of belt in inches;

H.P. = horsepower transmitted by belt.

The results obtained by this calculation show the speed at which a belt 1 inch in width and transmitting 1 horsepower, would be loaded equally with the belt under consideration. Then by assuming a standard speed for a belt in the particular class of drive under consideration, the results presented in columns 15 to 20 are obtained, these values being given the arbitrary name "ratio of loading." The values of this ratio were obtained as follows:

FORM USED TO TABULATE BELT DATA

	Location				Description							Load	Speed		Ratios of Loading						
Drive No.	Mill No.	Floors Driven	Motor		Double or Triple Belt	Width in Inches	Thickness in Inches	Net Length	Center to Center of Shafts	Tight Side, Top or Bottom	Angle with Horizontal, Degrees	Maximum H.P.	Actual in Feet per Minute	Per H.P. per Inch of Belt in Feet per Minute	One Inch of Belt to carry One H. P. at Speed assumed as Standard for Each Case (Feet per Minute)						Remarks
			No.	H.P.											400	450	500	550	600	650	
1	1	1 and 2	....	....	D	14½	$\frac{11}{32}$	....	....	B	Hor.	90	2100	340	....	....	....	....	1.76	....	
2	5	All	....	....	D	23½	$\frac{3}{8}$	....	....	Binders		360	3300	225	....	....	....	2.22	....	....	
3	6	5	....	....	D	19½	$\frac{3}{8}$	....	....	B	75	85	4900	1125	....	....	....	....	....	0.58	
4	8	2 and 3	36	150	D	17¼	$\frac{3}{8}$	....	....	B	35	174	3825	380	....	....	....	1.58	....	....	
5	10	1 and 3	....	....	T	24⅛	$\frac{7}{16}$	....	...	Binders		285	3650	285	1.40	....	....	....	....	....	Water wheel
Column No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

Machinery

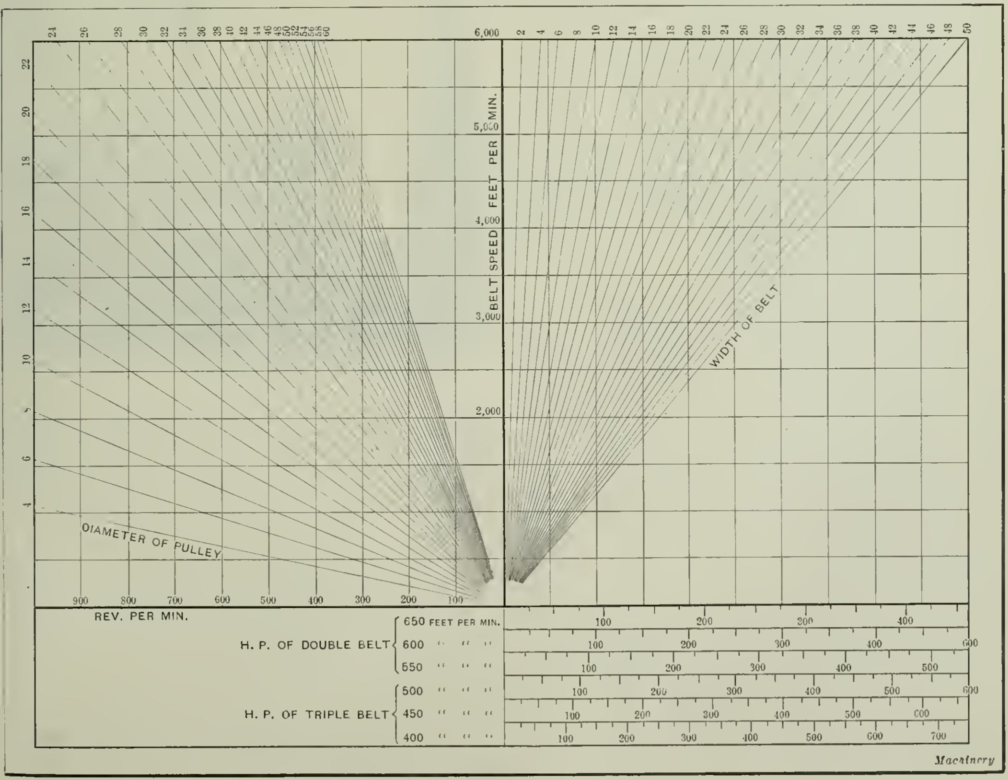

Diagram for Quick Solution of Problems dealing with Transmission of Power by Belts

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* Address: 430 Manchester St., Manchester, N. H.

$$\text{Ratio of loading} = \frac{\text{Standard speed to transmit 1 H.P.}}{\text{Actual speed to transmit 1 H.P.}}.$$

With the data obtained from these investigations we proceeded to establish standards suited to the particular requirements of our own plant. These standards are given by the following: (1) For double belts 5/16 to 3/8 inch in thickness, a belt 1 inch in width should transmit 1 horsepower when running at a speed of 600 feet per minute. (2) For triple belts 7/16 to 9/16 inch in thickness a belt 1 inch in width should transmit 1 horsepower when running at 450 feet per minute. (3) A speed of 650 feet per minute for double belts and 500 feet per minute for triple belts should be allowed where conditions are bad, *i.e.*, for drives on short centers, drives in hot or dusty rooms, or drives where the belt runs over small pulleys. (4) A speed of 550 feet per minute for double belts and 400 feet per minute for triple belts should be allowed where the conditions are exceptionally good. (5) The allowances given under heads (3) and (4) should be increased or decreased, as the case may be, where the conditions are exceptionally good or particularly bad.

Having established these standards, a simple and accurate method of figuring problems in the transmission of power by belts became imperative; and after giving the subject some thought, the chart which accompanies this article was worked out and has been found exceptionally useful. In order to explain its use, assume that the number of revolutions per minute of a pulley is known and also the size of the pulley, it being required to determine the belt speed in feet per minute. The vertical line through the given number of revolutions per minute is followed to the diagonal line corresponding to the diameter of the pulley in inches; then by following the horizontal line over to the vertical scale, the belt speed in feet per minute is obtained. Having proceeded to this point and knowing the horsepower which is to be transmitted by a given belt, it will be required to determine the necessary width for the belt. The vertical line on the right-hand side of the diagram, running through the power at any required scale, is found and followed up to the horizontal line through the belt speed—which was previously determined from the diagram—and the intersection of these two lines locates the diagonal which gives the required width for the belt.

By way of conclusion it may be mentioned that in making a study of the different belts in our factory, some belts were discovered which were carrying as much as 100 per cent overload, and many belts were found to be overloaded 50 per cent. Triple belts 30 inches in width, which cost as much as $1200, were found to have been worn out and replaced after being in service for only four or five years. The results of our investigation will doubtless help to prevent such unnecessary expenses being incurred in the future.

* * *

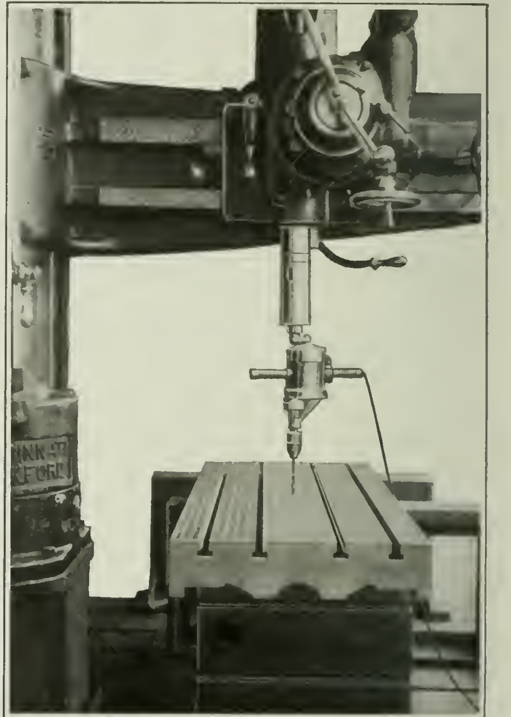
MINNEAPOLIS INDUSTRIAL EDUCATION SURVEY

For the purpose of determining just what kinds of industrial education will best meet the needs of her present and future workers, the city of Minneapolis has begun an exhaustive analysis of both her trade and school conditions, which it is expected will take about seven months to complete. In the analysis which is being made, industries are reduced to occupations and occupations to operations. The investigation seeks to find (1) to what extent the worker can "get on" in his job; (2) to what extent the city's industries may give special training which they do not now provide; (3) to what extent the schools can be a factor. It is estimated that the cost of the survey which is under the direction of a committee from the National Society for the Promotion of Industrial Education will be not less than $15,000. The findings and recommendations will furnish the basis for a large part of the discussion at the annual meeting of the National Society, which will hold its next convention in Minneapolis in January, 1916. Out of the findings of this survey and the recommendations which will come as a result of the work, Minneapolis expects to develop a program of vocational education which will put it in the fore front of American cities in the development of a comprehensive program of industrial education.

ELECTRIC SPEED DRILL FOR RADIAL DRILLING MACHINES

It is a matter of common experience to find machine parts of such size that they must be drilled under a radial drilling machine, but which have some holes that are too small to be efficiently drilled with the speeds available. The Lucas Machine Tool Co., Cleveland, Ohio, has overcome the difficulty very simply and effectively with an electric hand drill which has been converted into a drill speeder attachment. The part to be drilled under the radial drilling machine is handled in the usual way until the small holes are reached and then the main spindle is stopped and an electric drill inserted as shown in the accompanying illustration. A taper tang fitting the spindle socket has been attached to the electric drill, taking the place of the handle. The tang is provided with an off-set foot so as to bring it directly in line with the electric drill spindle.

This attachment enables the operator to drill small holes rapidly, and saves the wear and tear incident to driving a large radial at top speed. The regular hand feed is used for feeding the drill to the work. Electric hand drills can be used thus in many places to save time and expense in drilling large castings which must be done under radial drilling machines not provided with the spindle speeds that enable them to drive small drills at the proper drilling speeds.



Electric Hand Drill converted into a Drill Speeder for Radial Drilling Machine

* * *

The fiftieth anniversary of the Worcester Polytechnic Institute will be celebrated June 6 to June 10. The main exercises will take place June 8 and 9. It is expected that on the latter day President Wilson, who was the commencement orator twenty-five years ago, will be present, provided the pressure of public business permits him to leave Washington at that time. General George W. Goethals has already accepted an invitation to be present. In connection with the celebration, there will be a special meeting of the American Society of Mechanical Engineers at 2.00 P. M., June 9, to be held at the works of the Norton Co., at which meeting papers will be read and discussed.

PERCUSSIVE ELECTRIC WELDING*†

PROCESS AND MACHINES FOR UNITING SIMILAR OR DISSIMILAR METALS BY PERCUSSIVE ENGAGEMENT

BY DOUGLAS T. HAMILTON‡

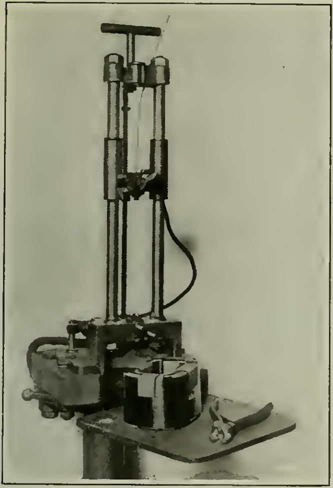


Fig. 1. Portable Percussive Electric Welding Machine

PERCUSSIVE electric welding which is one of the latest developments in the electric welding art, was originated by L. W. Chubb of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. During the year 1905, while Mr. Chubb was experimenting with electrolytic condensers and rectifiers in the research department of this company, he noticed that the wires could be connected to the aluminum plate by the condenser spark when the cells were discharged. It was also noticed that copper wires could be attached to aluminum or that two pieces of aluminum could be joined by the condenser spark. The joint thus made, however, was not strong, but after a careful consideration of the results of these early tests, it was decided to try out this method of welding with a greater condenser discharge.

This method of electric welding was first applied to the welding of aluminum, because this metal had given such trouble in soldering, especially when joining small wires. With the substitution of aluminum wire for copper wire, which has taken place in the last few years, the need for a good means of joining aluminum has become urgent, and the percussive electric method was developed primarily for this purpose after a thorough investigation of the methods available. In addition to the welding of wire, several other special applications have been successfully made, so that a general review of some of the more important points should be of interest. Percussive electric welding differs from the resistance method chiefly in the nature of the current used. For resistance electric welding, alternating current is used, whereas for percussive welding direct current is employed. It is possible to weld any two metals, whether alike or different, of high or low melting points or of an unequal thermal conductivity. With aluminum, the oxide which covers the surface of the pieces being welded prevents the metals from flowing together after the ends have been melted in the usual way. Large wires and rods of aluminum can be welded by melting the metal under the oxide film and then suddenly pushing the ends of the pieces together, breaking the oxide film and allowing the clean metal to flow together, but on small wire this practice is not feasible.

Development of Percussive Electric Welding Apparatus

Following up the experiments made in 1905, Mr. Chubb designed a condenser giving a discharge on a larger scale, and employing the same principle of simultaneous condenser discharge and percussive engagement that had been used in the original experiments. During the test and development of the welding apparatus, however, it was found that the best results depended upon several variables, such as the condenser capacity, the velocity and force of impact, the voltage and the resistance and induction in the circuit. The first apparatus consisted of two hinged arms with wire grips in their ends. Wires placed in the grips were connected to the terminals of a charged electrolytic condenser. Upon being released, these arms were drawn together and at the instant of contact of the wires, the explosive condenser discharged and the force of impact welded the ends together. This apparatus was not very satisfactory, as it did not allow of a separate study of the effect of the variations in velocity, momentum, kinetic energy, etc. A second apparatus similar in construction to a pile driver on a small scale was then built. This was provided with one stationary and one movable wire grip or chuck. In this apparatus the "forge effect" and velocity could be varied independently by a separate adjustment of the length of drop and mass of the moving parts. Other welding tools have been designed in which springs have been used to shoot the wire holders together horizontally, but this type of device has not been as satisfactory as the "drop-hammer" type.

Construction of Percussive Electric Welding Apparatus

A percussive electric welding device of the portable type is shown in Figs. 1, 2 and 3. Fig. 1 shows this device set up for welding a copper lead wire to a coil of aluminum wire, and Fig. 2 shows plan and sectional elevations of the device.

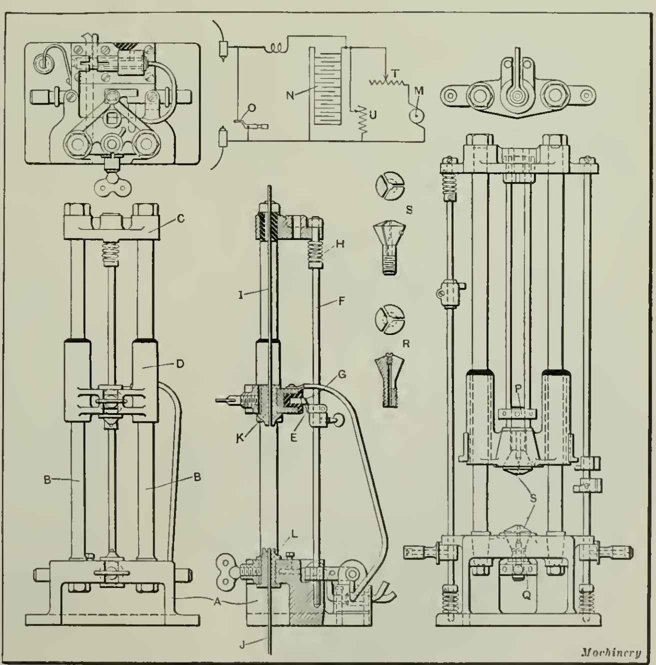


Fig. 2. Front Plan and Sectional Elevation of Portable Percussive Electric Welding Machine and its Connections—Two Types of Machines illustrated

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* For additional information on electric welding see "Special Electric Butt-welding Machines," published in the May number of MACHINERY, and other articles there referred to.

† Illustrations Figs. 1, 3, 5, 6, 7, 8, 9, 11, 12 and 13 used through courtesy of "The Electric Journal."

‡ Associate Editor of MACHINERY.

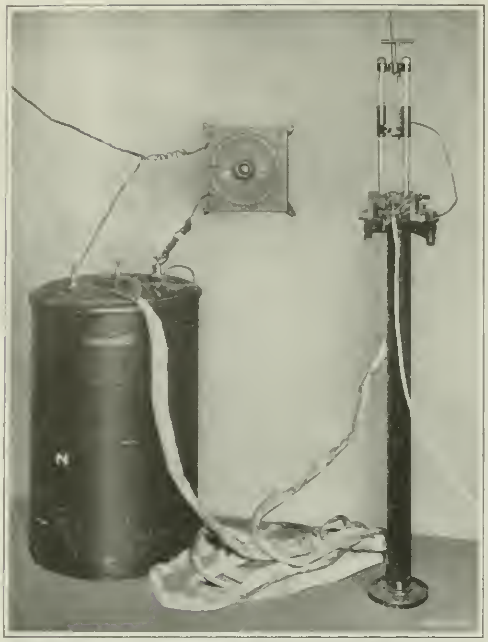

Fig. 3. Complete Percussive Electric Welding Outfit, comprising Electric Welding Machine, Rheostat, Electrolytic Condenser and Connections

Referring to Fig. 2, it will be seen that this machine has a base *A* carrying two parallel uprights *B*, which are held together at the top by stationary head *C*. Sliding on these guides *B* is a carriage or head *D* which carries a clamping chuck for holding one of the pieces of wire to be welded.

In order to support carriage *D* in a raised position, adjustable trip *E* held on the rod *F* is provided. Trip *E* contacts with trip *G*, held in the sliding head *D*, and is insulated from it. Rod *F* is so located in its bearings that it can be rotated to bring trips *E* and *G* into alignment with each other. Both trips *E* and *G* are beveled, enabling carriage *D* to be raised, but not lowered until trip *E* is released by a slight rotative movement of the rod *F*, which is again returned to its operative position by means of spring *H*. The wires *I* and *J* to be welded are held in chucks *K* and *L*. Clamping chuck *L* has the general form of a spool or flanged cylinder, and is split longitudinally into two parts which are grooved to receive one of the wires to be welded. The chuck is mounted in a slot in the base of the machine and is held in position and also caused to grip the wire by a thumb-nut. The clamping chuck *K* is similar to *L*, and is held in the same manner. The other wire *I* to be welded is conducted down through the top cap of the machine as illustrated, passing through an insulating bushing.

The electrical energy (see Figs. 2 and 3) is supplied from a generator *M*, or any source of direct current, which charges the electrolytic condenser *N*. There is a high resistance *T* in the circuit, and the condenser charge can be varied by resistors *T* and *U* In operation, the pieces of wire *I* and *J* to be welded are secured in the chucks *K* and *L* so as to project out from the chuck for a short distance The carriage *D* is then raised to the desired height, which is determined by the setting of the trip *E*. The position of trip *E* is governed by the diameter and composition of the wire to be welded After the wire has been clamped in position and trip *F* properly set, switch *O* is opened to permit generator *M* to charge condenser *N*. Trip *E* is then released from trip *G*, allowing the carriage to drop and carry the end of the wire *I* into percussive engagement with the end of wire *J*. At the instant of contact, the condenser *N* is discharged, and the energy thus concentrated at the point of contact is sufficiently great to produce a perfect weld between the wires. The weld is then complete, and after being removed from the machine the wire will be found to have the same strength at the joint as anywhere else.

A percussive electric welding machine embodying the general principles just described, but of slightly different construction, is shown to the right of Fig. 2. In this machine the tripping mechanism is guided by two rods instead of one, and it is also provided with a different type of work-holding chuck, which is shaped similarly to that used on a screw machine and is also split to allow for expansion and contraction. The chuck body is tapered to fit into a correspondingly shaped hole in the base and sliding head of the machine, and is tightened on the work by means of nuts *P* and *Q*. The jaws of these chucks may be threaded as shown at *R* to adapt them to receive small screws if desired. By supporting a small screw in this manner in the chuck and holding a section of platinum wire in the upper chuck, the screw may be easily provided with a platinum tip. Each of the chucks has a pin projection which engages a notch in the holder for the purpose of preventing the chuck from rotating when the nut is being tightened.

Description of Percussive Electric Welding Process

The action that takes place when the wires are percussively engaged covers such a short period of time that it is practically impossible to see it with the naked eye. The only possible way of analyzing the action is to consider it from a theoretical standpoint. From careful observation of a large number of welds and the study of oscillogram records, the theoretical action that takes place between the engaging terminals of the rods to be welded has been graphically set forth as shown in Fig. 4. At *A* the wires to be joined are shown close together as they appear when approaching each other. It will be noticed here that the ends of the wire have been provided with chisel-shaped edges, arranged at right angles to each other. This is done so that the first engagement between the two wires is at a small point. These chisel-shaped edges require no particular care in making, and in fact the thin edge usually produced when wires or rods are cut off with an ordinary pair of pliers or shearing device is satisfactory.

At the instant of contact *B*, the voltage of the circuit falls away as shown by the curve *a*. The current and power, on the other hand, increase rapidly as indicated by curves *b* and *c*. In this particular case, the voltage drops from approximately 207 volts to 160 volts in 0.0001 second and reaches zero at the end of 0.00035 second. The power expended in the circuit rises from zero to 23,000 watts in 0.0001 second,

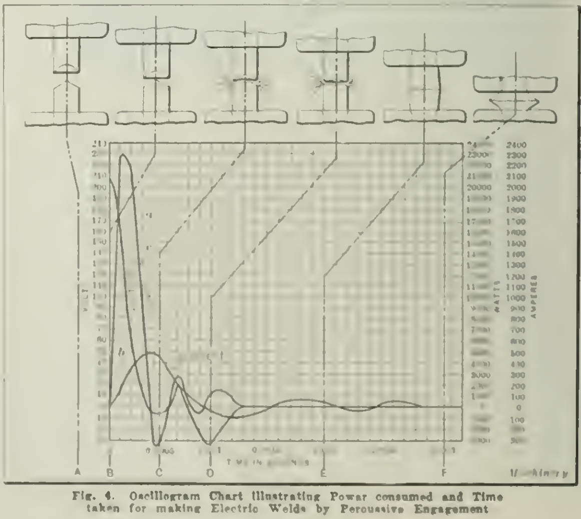

Fig. 4. Oscillogram Chart illustrating Power consumed and Time taken for making Electric Welds by Percussive Engagement

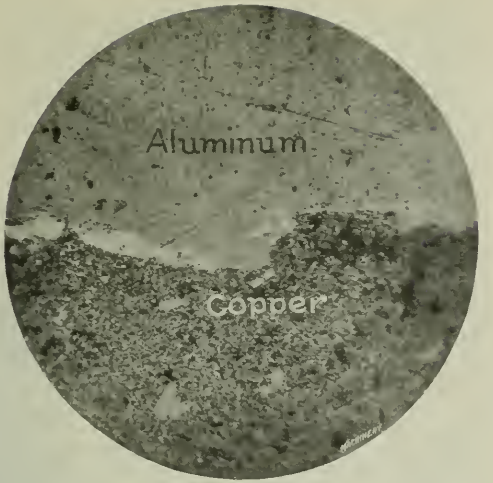

Fig. 5. Microphotograph of Copper and Aluminum Wire electrically welded showing Intermingling of Metals—magnified 850 Times

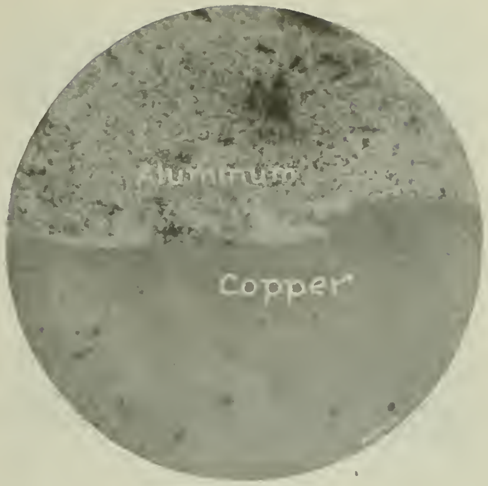

Fig. 6. Microphotograph of a Copper-aluminum Weld—magnified 850 Times

and then almost as suddenly decreases crossing the zero line with the voltage. The weld in this case is completed electrically, that is, so far as a perfect junction of the two metals is concerned, in 0.0012 second, although the upsetting action still continues to forge the metals together until the upper chuck is brought to rest. Although 23 kilowatts is being dissipated between the ends of the wire at a certain instant, the total energy used at the weld is only 0.00000123 kilowatt hour, or enough to light an ordinary 50-watt 16-candlepower lamp for 0.09 second. The cost of this amount of energy at ten cents per kilowatt hour would be twelve-millionths of a cent. Referring to Fig. 4, it will be noticed that the watt curve *c* is oscillatory and that the negative value would indicate a return of stored energy. Such an action would be impossible from a metallic arc, but can be explained by the fact that the voltage was measured above and below instead of between the wire chucks, so that the storage and return of energy is from the magnetic flux produced in the steel chuck set up by the current of 500 amperes flowing through them.

The time between the first contact and the finished weld is of such short duration that the exact action cannot be recorded, but is supposed to be about as shown in Fig. 4. At *A* the wires are approaching each other at a velocity of about 65 to 200 centimeters per second (25.59 to 78.74 inches). At *B* the first contact is made, at which time the current begins to build up and heat the small section of metal carrying the current. At *C* the ends of the wire have separated, not by any appreciable retarding or reversing of the motion of the upper wire but by the melting and vaporizing of the metal which first came into contact. At *D* the wire chucks are closer together, but the arc is still burning between the wires. At *E* the second contact has been made, the arc extinguished and the upsetting of the metal has begun. At *F* the complete weld is shown after the upper chuck has come to rest and the upsetting is completed.

The generation of heat is so localized, so sudden, and so intense that there is no time for unequal heat conduction through the shanks of the wire, and the ends will be melted and even vaporized whether the melting point of the metal is high or low. For this reason various metals and alloys can be welded together independently of their electrical resistance, melting point or heat conductance. All the combinations of metals or alloys that have been tried will weld together, but the joints will not be permanent with such combinations as aluminum and tin or lead and iron.

Interesting Phenomena in Percussive Electric Welding of Metals

Although the action of percussive welding is complex, as indicated by the chart, Fig. 4, it is not necessary to construct the welding apparatus or to adjust its parts with more than an ordinary degree of accuracy. Furthermore, it is not neces-

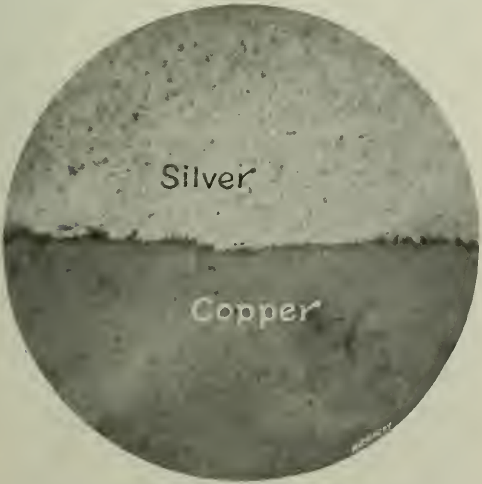

Fig. 7. Microphotograph of a Copper-silver Joint showing Sharp Line of Demarkation at Point of Weld—magnified 1000 Times

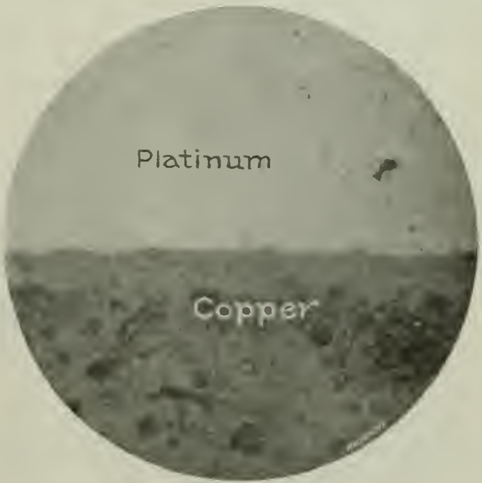

Fig. 8. Microphotograph of a Copper-platinum Weld—magnified 1000 Times

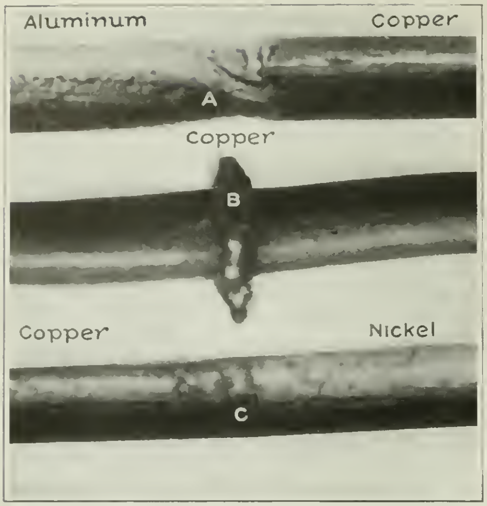

Fig. 9. Nickel, Copper and Aluminum Wires united by Percussive Electric Welding, showing Condition of Metal at Welded Joint

sary to be very careful about determining the capacity of the condenser, the voltage of the charging circuit, or the inductance of the welding circuit. As an example, perfect welds have been made on the first trial between such metals as tin and platinum, platinum and nickel, and copper and aluminum, without special precautions, calculations or adjustments. While the machine is relatively light, a sufficient compression is obtained to forge the terminals of the metals to be welded, and by the use of a condenser of suitable design and capacity a sufficiently intense heat is supplied for a fraction of a second to melt the engaging surfaces and weld such metals as platinum and tin without injury to either metal.

It is believed that such a tremendous amount of energy relative to the size of the conductors not only fuses the engaging surfaces but vaporizes them, producing a small explosion and actually separating the solid portion of the wires for an instant as shown at *C* in Fig. 4. At this stage of the welding action the terminals of the wire being welded are surrounded by a metal vapor. That this is true is abundantly proved by deposits of metal particles found on the chucks of the welding machine after a number of welding operations have been performed. It is believed that metal vapor surrounds the terminals before they are brought into permanent engagement, and that this is one of the reasons why successful joints have been secured between such unlike metals as aluminum and copper and between two aluminum conductors, the surfaces of which become oxidized with extreme rapidity when exposed to the air under ordinary welding conditions. It is thought that the small explosion previously referred to actually blows out a certain portion of the terminals in the form of vapor and consumes such a short time that the mechanical energy produced by the dropping of the chucks is still effective in welding the "wetted" terminals. The terminals are not permitted to cool after the explosion and previous to their percussive engagement because the current in the welding circuit as indicated by the curve *b*, does not die out immediately, but continues to oscillate for several thousandths of a second.

Nature of the Work Produced by Percussion Welding

It has been found that on account of the intense heat that can be concentrated at the desired point for a short period of time the electric percussive method is particularly effective in making a satisfactory joint. The effect of the concentration of energy referred to on an aluminum wire is to vaporize a small quantity of the aluminum on the engaging surfaces, thereby blowing out laterally in all directions the vaporized material, and carrying off, or at least breaking up, the oxide film which has hitherto prevented the welding of aluminum successfully. In the welding of copper to aluminum by the percussive method it would be expected that the joint would be unsatisfactory, owing to the fact that certain combinations of these metals form a brittle alloy. This, however, is not the case, as welds between these two metals are so ductile that they may be worked in a die, forged or rolled into thin foil. Any alloy that is formed at the junction of the aluminum and copper wires must range from 100 per cent copper on one side to 100 per cent aluminum on the other, but possibly the brittle combinations are so thin that the joint as a whole is flexible and ductile. The possibility of making satisfactory joints between aluminum and copper is of great commercial importance, as copper feed wires which solder easily can be welded to aluminum coils. It was thought at first that a diffusion of the two metals in service would result in a brittle joint, but tests show that after four years the joint is apparently as strong and ductile as when first made. Similar ductility has been noted in almost every combination of metals when first welded, but diffusion, disintegration and loss of ductility eventually result in such welds as silver to tin or aluminum to tin; the welds are effected by what is known in the trade as "tin disease" or "tin-pest"—a disintegration of the molecules.

Metals which are either hardened or softened with heat and sudden cooling can be welded together without appreciable change in the physical properties of the material. Tempered spring steel wire welded and reduced to uniform diameter and tested has shown equal or greater strength at or near the weld without any noticeable change in temper. Metals such as hard drawn copper, silver, aluminum, etc., can be welded without causing any local annealing, and these metals, as well as soft steel, can be welded together without detrimental local hardening. In welding unlike metals by the ordinary method of electric welding a brittle alloy is sometimes formed between the joints of the metal. In percussion welding this is not the case, as the energy and heat are so concentrated, and continue for such a short interval, that there is no appreciable flowing of one metal into the other, the line of demarkation being very sharp, even when the welded pieces are rolled out into a thin sheet or foil. If a film of alloy is produced at the joint, the film is so thin that it is flexible. This is true of various combinations of metals, as will be described later.

Explanation of Supposed Lack of Change in Molecular Structure in Parts Electro-Percussively Welded

Several explanations are given for the mechanical properties of various metals before and after welding; some of these are: First, such a sudden heating and cooling may not allow change in molecular structure; second, with hard steel, the heated metal at the weld is so suddenly cooled by conduction of heat into the adjacent cold metal that it is again hardened; third, with hard copper, silver, aluminum, etc., the heating and sudden cooling would ordinarily soften the metal, but the cold upsetting of the blow in welding possibly hardens it again; fourth, the metal is subjected to the sudden heating and cooling so that it may be hardened or annealed (depending upon the characteristics of the material welded), but the amount of material affected may be too small to be detected.

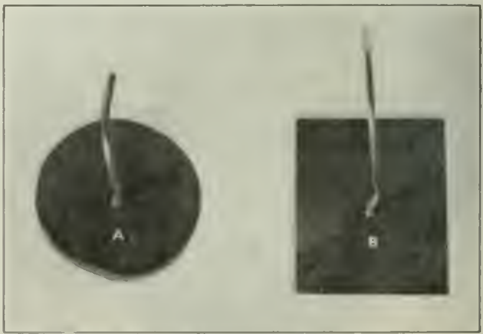

Fig. 10. Examples of Butt-welding Operations performed by Percussive Electric Welding Apparatus

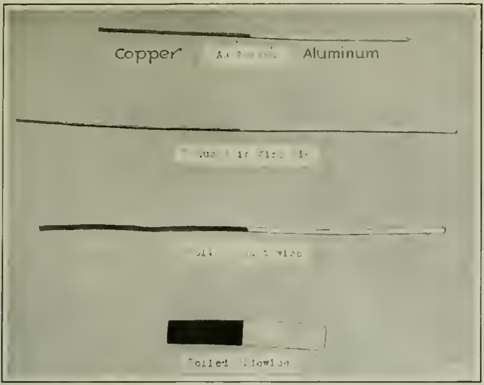

Fig. 11. Examples of Aluminum-Copper Welds on Wire manipulated to show Ductility and Malleability of Weld

As an example, in welding No. 18 (0.043 inch diameter) hard-drawn aluminum wire, 0.00123 watt-hour or 1.06 small calories are dissipated at the weld. Assuming that none of the energy is lost in noise, radiation or metallic vapor and that one-half of the total is propagated in a heat wave in each direction along the wire, it can be shown mathematically that an annealing temperature will not be reached more than 0.05 millimeter (0.002 inch) from the weld. The total amount of metal softened would be a disk 0.1 millimeter (0.0039 inch) long and 1.02 millimeter (0.0403 inch) in diameter. A soft insertion of such proportions could hardly be detected.

In welds between some metals diffusion takes place, but in any of the useful combinations the change is too slight to affect the ductility of the weld. The welds, as a rule, show only a sharp dividing line between the metals, but there is often an intermingling of the two at or near the center for a short distance. Figs. 5 and 6 show a new weld and a three-year old weld between aluminum and copper. The microphotographs, which are enlarged 850 times, were taken at the irregular point in the weld; elsewhere the line of division is sharp and rather straight. In addition to the small irregularity of the dividing line, some spots of bright material, possibly aluminum-copper alloy, are present at this point, but do not appear at other points in the weld. Both of these welds are so malleable that they are capable of being rolled into thin foil. Wire having such welds was used in actual service at a temperature over 100 degrees C. (212 degrees F.) carrying a heavy direct current, and failed to show sufficient diffusion to affect its mechanical properties. The heating current was maintained for weeks and tests were made with the current flowing in both directions. At higher temperatures (red heat) there was a rapid diffusion of the metals, and in a few minutes the metals were diffused for a distance of two or three inches. A percussive electric weld offers a very convenient specimen for the study of the diffusion of different metals at different temperatures and under various conditions. The microphotographs Figs. 7 and 8 show copper-silver and copper-platinum welds, respectively. Both of these welds show a sharp dividing line when enlarged to 1000 diameters. The weld, Fig. 8, is three years old.

It has been found that the electrical resistance of two wires welded together is not appreciably increased by the small film of high resistance alloy at the joint formed in welding. Tests on eighty-five alternate pieces of aluminum and copper wire joined with eighty-four welds, making a total length of 23.5 centimeters (9.254 inches) showed an increase of 0.56 per cent in resistance in three years. This test was made to determine whether or not diffusion at the joints would occur. The increase is small and may be due to a change in the joints, or error in observation or oxidization. This sample was recently rolled and showed no change in malleability.

Metals that can be Electro-Percussively Welded

Thus far, no difficulty has been experienced in welding together any metal or alloys of metals, nor in fact, any combination of metals or alloys. The following are a few of the combinations that have been welded. Tin to aluminum, copper and platinum; lead to tin; tin to platinum; tin to copper; nickel to platinum; steel of various alloys and carbon contents. The chief advantage of the electro-percussive method of welding at present is in the uniting of copper and aluminum, since it is almost impossible to make this weld with the other well-known methods, and when made by the resistance method the joints are as brittle as glass. Another interesting feature of the joint made in wires of different materials by percussion welding is the fact that the metal is just as ductile at the weld as it is any other place along the surface. Fig. 9 shows various combinations of metals that have been electro-percussively welded. At *A* is shown a piece of aluminum wire welded to a piece of copper and subsequently reduced by drawing the wire through a die. It will be noticed that the aluminum wire has "disintegrated" to a certain extent at the joint but is still firm. This wire has been magnified eighteen times. At *B* is shown a joint of copper to copper with a slight flash. When this flash is removed it will be possible to draw out the wire without showing any change in shape or reduction in diameter at the joint. The reason for this is assumed to be that the action of welding is of such a nature that the fused or volatilized metal is completely expelled and the cold metals come together to form the joint with a very thin film between them. At *C* is shown a piece of copper wire welded to nickel. Upon looking closely at this illustration it will be noticed that when the wire was drawn out there was practically no difference in diameter at the joint between the copper and nickel wire. This has been magnified eighteen times.

Examples of Electro-Percussive Welding

While the development of this method of electric welding was brought about primarily to secure successful joints between aluminum and copper wires, it is evident that it possesses wide application. Metals varying widely in characteristics, such as platinum and tin, may easily be welded, from which it follows that almost any metal can be joined where the joint is within the capacity of the machine. The apparatus up to this time has only been made for welding wires 0.072 inch in diameter and smaller, but there is no reason why, with a larger machine and suitable apparatus, wires much larger than this could not be welded as well as other classes of work. Sufficient experimenting has been done to show that the welding of wires to plates or blocks can be successfully accomplished. Fig. 10 shows two examples along this line. At *B* a piece of 1/32-inch copper wire has been electrically butt-welded to a piece of copper 3/16 inch thick; whereas at *A* a piece of 1/32-inch copper wire has been butt-welded to a piece of 1/32-inch sheet brass. In the ordinary method of electric welding, it would be practically impossible to join these two pieces for the simple reason that the area of one is so much greater than the other that the wire would fuse and melt away before any perfect junction could be secured. By means of percussive welding, this operation is comparatively simple and a joint is made that is as homogeneous and strong as the metal itself.

In order to determine just what effect manipulation of the stock would have on the welded section, copper and aluminum wires, as shown in Fig. 11, have been welded, drawn and rolled. The first view shows copper and aluminum wires welded together; in the second view these two pieces of wire have been reduced in diameter by drawing; in the third

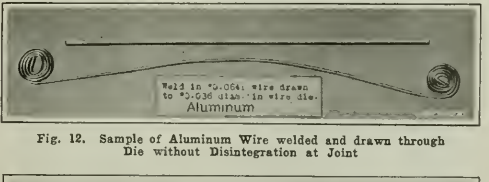

Fig. 12. Sample of Aluminum Wire welded and drawn through Die without Disintegration at Joint

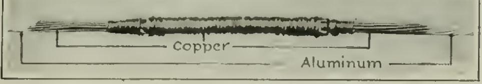

Fig. 13. Method of splicing Aluminum Cables

view the wire has been rolled out lengthwise; and in the fourth view a section of this wire is shown rolled out sideways. A study of these metals under different manipulating processes is interesting. It will be noticed in the first view that the joint is almost straight across the wire, but after drawing, the aluminum wire, which is slightly softer than the copper wire, has been reduced a little at the joint, and the copper wire has overlapped the aluminum wire in one place. This same condition is shown in the third view where the copper has rolled into the aluminum. Probably the most interesting condition is shown in the fourth view where the wire has been rolled sideways. Here it will be seen that the line of demarkation between the aluminum and the copper wire is extremely sharp and that it is practically straight across the section, showing that the two metals came together when practically in a cold state and that the film of fused metal between them must have been extremely thin.

In order to show the ductility of metals when percussively welded, two pieces of aluminum wire were joined as shown in Fig. 12. This piece of aluminum wire, which was 0.0641 inch in diameter after welding, was then drawn down to 0.036 inch in diameter through a wire die. The point at which the weld was made could not be determined even under a microscope, which showed that there was no physical change in the wire due to welding and that as far as ductility was concerned the metal was just as ductile at the weld as it was any other place along the section. Another interesting use of this art is shown in Fig. 13. This illustrates a method of splicing aluminum cables. This is done by welding a short length of copper to each strand of the aluminum cable, and then twisting or wrapping the copper wire around the joint, and soldering the ends. After the joint is soldered, an aluminum tube is placed over the joints to prevent any electrolytic action between the copper and aluminum wires.

There are also many uses of the electro-percussive method, especially in the jewelry trade, where it can be employed for joining platinum without showing any solder line; welding sterling tips to table forks without annealing; welding pins to badges; and many other similar applications. The attaching of contact points of platinum, tungsten, silver, etc., for various electrical purposes is also readily accomplished.

* * *

A SIMPLE MAGAZINE ATTACHMENT

BY E. WHITNEY

A magazine for automatic screw machines consisting of a rod, a tube and a special feed finger is described in the following. In order that automatic screw machines may sometimes handle a larger diameter of stock than usual, the spindle tube is removed and a feed finger *A* is constructed, as shown in Fig. 1. This feed finger is used backward and is located outside the spindle instead of inside. The groove *B* is provided to receive the latch key which is regularly latched in the back of the spindle tube. This style of feed finger affords a practical means of automatically handling washers of the form shown at *C*, and similar parts on which it is required to have a second operation performed. In the case of the washers *C*, the second operation for which the magazine is used consists of countersinking them as shown by the dotted lines. The magazine consists of the rod *D* which is loaded with washers and inserted in the spindle. As many washers may be carried in one loading as will fill the spindle and feed finger. The tube *E* is used as a "shover" to push the washers into the chuck, and after one washer has been finished, the next one coming into place will eject it as shown in Fig. 2. It will be necessary, of course, to keep the rod immovable, and this can easily be done by making use of one of the stands provided for supporting the stock.

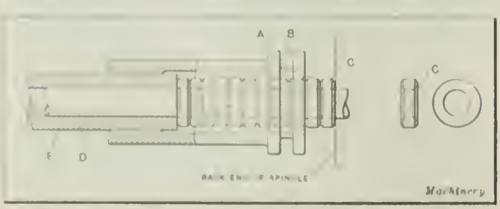

Fig. 1. Magazine Attachment for Automatic Screw Machine and Class of Work for which it is used

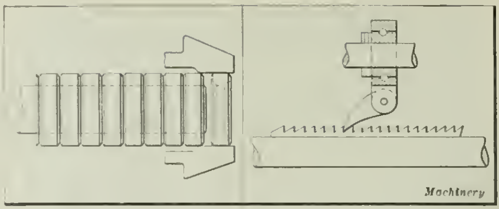

Fig. 2. How the Work is ejected from the Chuck, and Means of holding the "Shover" Tube Stationary

The question may arise as to how the tube *E* is held stationary while the feed finger slides back over it the distance required for feeding out a new piece. In ordinary work, the chuck grips the end of the bar while the feed finger slides over it, but, when using the feed finger shown in Fig. 1 for short bars or for magazine purposes, a special clutch device is required. The simplest means of providing for this is to fasten a collar to the stock as shown in Fig. 2; this collar has a ball bearing, the inside of which is fastened to the stock with a set-screw, while the outside carries the pawl which engages in the rack. This rack is carried by a rod mounted to the stock supporting stands. Another method of supporting the stock while the feed finger is taking hold is shown in Fig. 3. Clutch fingers *G* are held against the stock by the coiled springs, and these fingers are set ahead of the center so that the stock will slide freely in one direction and be prevented from sliding in the opposite direction. The method of using this device for stock was to use up all the 10-foot bars as far as possible, after which the clutch was attached for the short bars. At *H* is seen a cap which, engaging the ends of the fingers *I*, will release the clutch fingers the moment the last piece has ben cut off from the bar. This prevents unnecessary wear on the feed fingers.

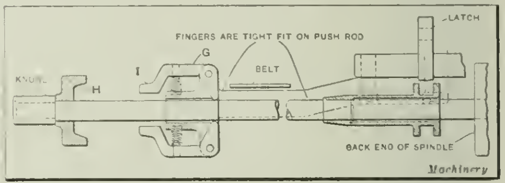

Fig. 3. Another Method of supporting the Stock while the Feed Finger is taking hold

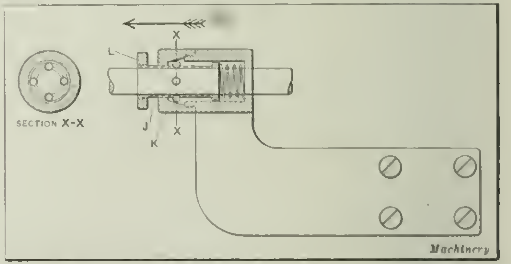

Fig. 4. Ball Clutch Device to replace Mechanisms shown in Figs. 2 and 3

Fig. 4 shows another device which is used for the same purpose. Many small shops will find it convenient in performing light operations on steel and brass stock over 1 inch in diameter on the No. 2 Brown & Sharpe machines, and up to 7/16 inch diameter on the No. 00 machine made by the same company. On the device shown in Fig. 4, four balls are used as a clutch. It will be noticed that these balls are carried in small pockets in the tube *J* so that the coiled spring will keep the balls in contact with the tapered interior of the cap *K*. The balls will prevent the shoving-rod from sliding in the direction of the arrow, but will allow the feed finger to move it in the opposite direction. By pushing the knob *L*, the clutch may be released so that the rod can be moved by hand.

MACHINING FLYWHEELS

TOOLING AND METHOD OF OPERATION AS APPLIED TO THE CONRADSON MULTIPLE-SPINDLE AUTOMATIC

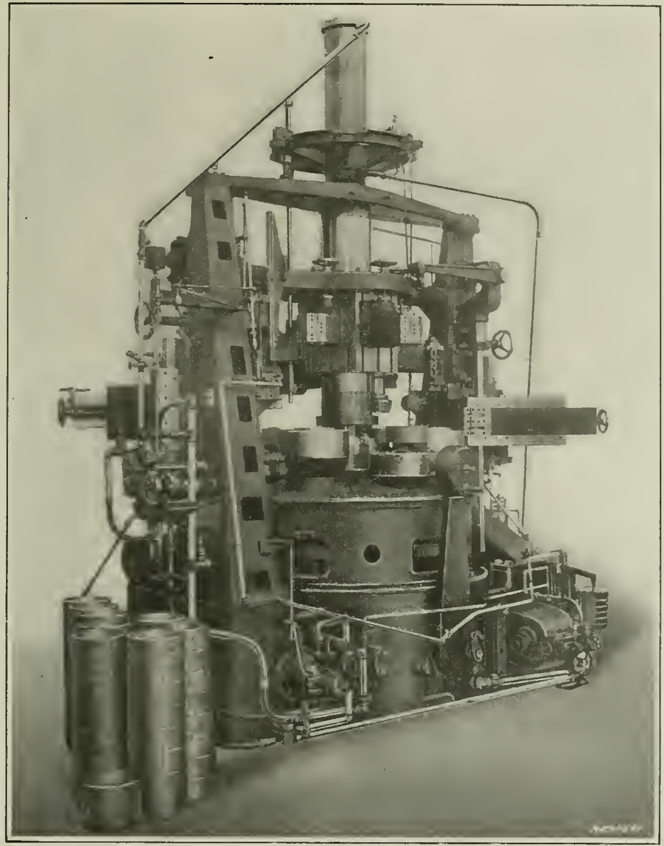
Fig. 1. Conradson Multiple-spindle Automatic tooled up for machining Flywheels

THE Conradson multiple-spindle automatic, which is built by the Giddings & Lewis Mfg. Co., Fond du Lac, Wis., is well adapted for handling those classes of work which require a succession of operations to complete them. The machining of flywheels is a case in point, and it is the purpose of the present article to describe the method of procedure in handling this work. One of the No. 0 machines tooled up for machining flywheels is illustrated in Fig. 1; and Fig. 4 shows details of the type of flywheel to be machined. In handling these parts, the work is passed through the machine along the path shown diagrammatically in Fig. 5. Reference to this illustration will show that the table is indexed through two stations at a time. The chucks are loaded at station No. 1, after which the table is indexed twice to bring the work to station No. 3, where the first operation is performed; the next indexing brings the work to station No. 5 where the second operation is performed. The second operation completes the machining of one side of the flywheel and the work is then indexed back to the starting point at station No. 1, where the work is removed from the chuck and re-set in the chuck under station No. 2 ready to have the necessary operations performed on the opposite side of the wheel. After setting up the work, the table is again indexed through two stations, bringing it first to station No. 4 where the first operation on the back of the wheel is performed, and then to station No. 6 where the final operation is conducted. The flywheel is now finished and is indexed back to station No. 2, where it is removed from the chuck. Fig. 2 shows a view of station No. 1 at *A*, station No. 2 at *B*, and station No. 6 at *C;* station No. 4 is shown at *D* in Fig. 3, and station No. 5 at *E;* Fig. 6 shows station No. 3 at *F* and station No. 4 at *G*.

Having briefly described the method by which the machining of flywheels is conducted on the Conradson automatic, we are now in a position to give a more detailed description of the individual operations involved. Station No. 3 is shown at *F* in Fig. 6, and it will be remembered that this is the station where the first operation on the flywheels is performed. This operation includes turning the outside of the blank, facing the two edges, boring the taper on the inside of the rim, boring the center hole, and facing the hub. The tools employed for this purpose are shown in Fig. 7; and in this illustration, the dotted lines indicate the rough-

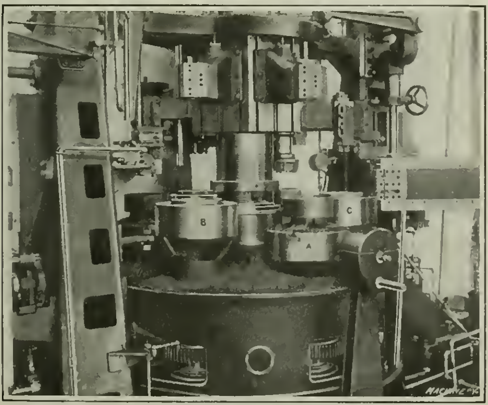

Fig. 2. View of Machine Stations Nos. 1, 2 and 6

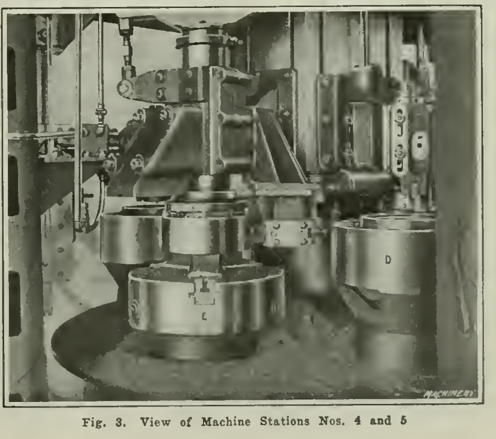

Fig. 3. View of Machine Stations Nos. 4 and 5

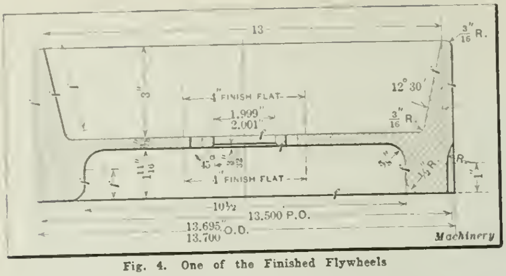

Fig. 4. One of the Finished Flywheels

ing cuts which are taken. After the first operation has been completed, the work is indexed to station No. 5, which is shown at *E* in Fig. 3. Here the second operation is performed which consists of finishing the surfaces from which a roughing cut was taken in the first operation. The tools provided at station No. 5 are shown in detail in Fig. 8, and reference to this illustration will show that the work performed consists of reaming the central hole in the hub, finishing the tapered clutch surface on the inside of the rim with a conical reamer, taking a finishing cut over the outside face of the wheel with a suitable turning tool, and finishing the top edge of the flywheel with a form tool. After these operations have been performed, the work is carried on to station No. 1, shown at *A* in Fig. 2, where it is removed from the chuck.

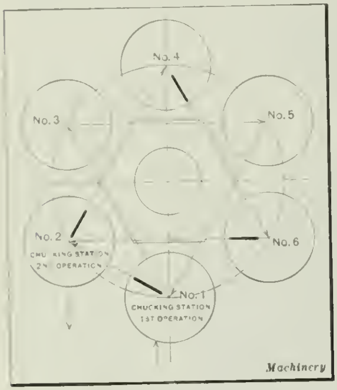

Fig. 5. Diagram showing Passage of Work through Machine

It has already been stated that for performing the necessary operations on the back side of the flywheel, the work is set up at station No. 2, shown at *B* in Fig. 2; and for this purpose, it is held in the collet chuck shown in operation in Fig. 2, and in detail in Fig. 9. The work is now indexed to station No. 4, shown at *D* in Fig. 3; the work is shown in this position at *G* in Fig. 6, and the tools provided for taking the roughing cuts are shown in detail in Fig. 10. Reference to the latter illustration will show that the work consists of taking a roughing cut over the edge and inside of the rim of the wheel. The work is then indexed to station No. 6, shown at *C* in Fig. 2, where finishing cuts are taken over those surfaces which were roughed out by the preceding operation; and the edge of the central hole in the wheel is also chamfered off to an angle of 45 degrees. The tools provided at station No. 6 are shown in detail in Fig. 11. After this has been done, the flywheel is completed and it is merely necessary to carry it on to station No. 2, where the finished work is removed from the chuck and replaced by a new blank. The total time required to finish one of these flywheels is said to be only 4½ minutes.

E. K. H.

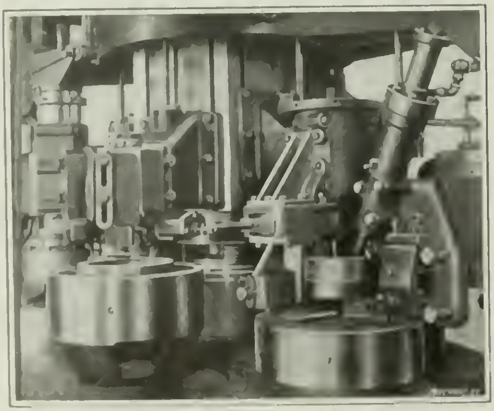

Fig. 6. First Operation performed at Station No. 3

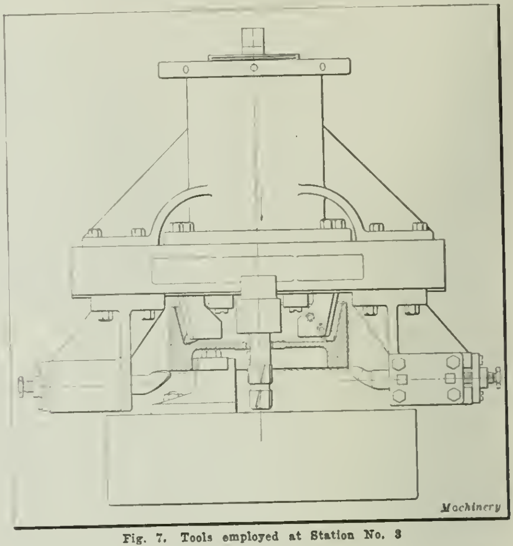

Fig. 7. Tools employed at Station No. 3

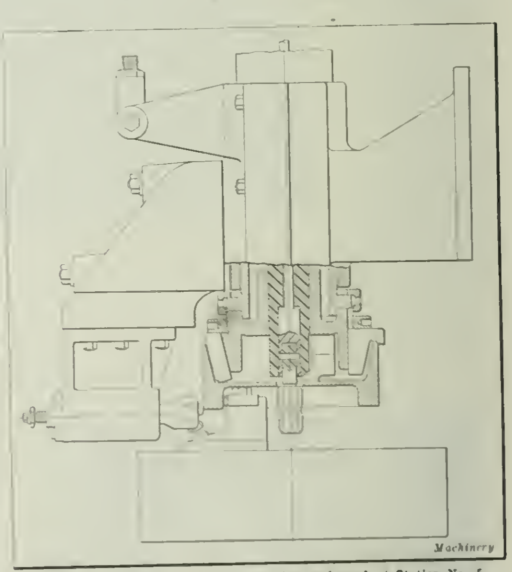

Fig. 8. Tools used for Second Operation performed at Station No. 5

* * *

The offices and exhibits of the American Museum of Safety have been moved from the Engineering Societies Bldg., 29 West 39th St., New York City, to 16-18 West 24th St., New York City. The new premises were formally opened to the public May 4. They are on the ground floor and afford much better facilities for showing the exhibits than the old quarters. The public is invited to inspect the museum and see the devices shown for protecting life and limb in industrial occupations. Dr. William H. Tolman is the director

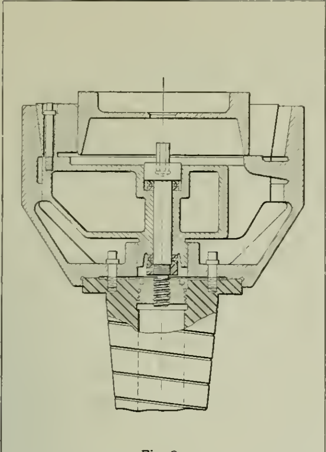

Fig. 9.

Fig. 9. Collet Chuck in which Wheel is re-set for Final Operations

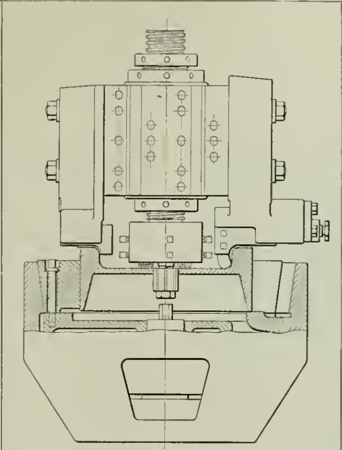

Fig. 10.

Fig. 10. First Operation on Back of Flywheel performed at Station No. 4

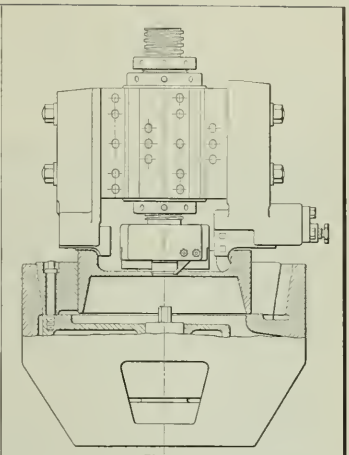

Fig. 11.

Machinery

Fig. 11. Final Operation on Back of Flywheel performed at Station No. 6

A USEFUL FILING SYSTEM

BY HENRY R. GILSON*

In the design and development of machinery it has been the writer's custom for a number of years to preserve all calculations, sketches, and suggestions that are made, having them properly dated before they are filed away. For this purpose brown paper folders are used 9¼ by 11¾ inches in size, which have projecting tabs ½ by 4½ inches, on which is written the subject matter of the contents of the folder. These folders are kept properly arranged in a four-drawer vertical filing cabinet. When a new problem in design comes up, the first step is to make sketches of the parts or an assembly drawing of the complete machine, and these drawings are used as a basis in making calculations. Each drawing and each sheet of calculations are marked with the date on which they were made, and assembly drawings also have a brief description of the functions of the machine attached to them. As the design of the machine progresses and changes are made from the original, new sketches are made and dated, so that when subsequent reference is made to the file the date will show the design that was ultimately employed.

When the first machine is complete and experimental work started, a careful record is kept of every change that is made and the results of each change are properly noted. Many ideas will present themselves of which crude sketches are made, and these may or may not be adopted; but in any case the drawings are preserved, for if an idea is worth putting on paper it is worth preserving. It may be of value when least expected. All correspondence relating to prices of parts of the machine, and the results of all physical, electrical, or other tests which were made to determine certain features are also filed, so that when the machine is completed and turned over to the manufacturing end of the business, the folder in the file will contain an accurate chronological record of the various steps in its invention and development. The advantages of this method are obvious, for if the experimental work extends over a long period of time reference to the records preserved in the file prevents the same change being duplicated. This record also furnishes data which enables any engineer to continue the development intelligently should the necessity arise for so doing. And if at any time a larger or smaller machine of the same type is to be made, a complete set of data on the original machine is at hand, which is of great value for purpose of reference. The value of such a file of information in determining priority of invention in patent litigation has also been demonstrated in certain cases.

FREAK ADVERTISEMENTS

BY W. F. S.

Manufacturers are often tempted to run "freak" advertisements in the hope of attracting attention. It might interest such advertisers to know that publicity experts are unanimous in condemning this kind of advertising. The principal argument against this practice is its utter lack of dignity. In preparing advertising copy don't arrange pictures upside down or entire advertisements upside down; and don't run advertisments the wrong way of the page unless it is absolutely necessary. Avoid the use of ugly or foolish illustrations. It is all right and generally good practice to "ring in" a little humor once in a while, but don't carry it too far. Nothing is more effective in advertising than the use of good illustrations which show the product you are selling as clearly as possible. Such illustrations are best used in connection with a description that is made as terse and interesting as possible. Make your advertisement one that will sell the product on its merits, and not one that merely attracts attention. Freak advertisements may catch the reader's eye, but it is doubtful if they help in selling.

* * *

The Commission on Industrial Relations, in its first annual report to Congress, deals with the subject of industrial unrest and gives the following reasons for the unrest in labor circles, as seen by the employers and by the employes.

Reasons Given by the Employers

Normal and healthy desire for better living conditions.

Misunderstanding and prejudice; lack of conception that interests of both labor and capital are identical.

Agitation by politicians and irresponsible agitators.

Unemployment.

Unreasonable demands arising from strength of organization.

Labor leaders who stir up trouble to keep themselves in office and to graft on employers.

Inefficiency of workers, resulting in ever-increasing cost of living.

Rapidly-increasing complexity of industry.

Sudden transition of a large number of foreigners from repression to freedom, which makes them an easy prey to labor agitators.

Universal craze to get rich quickly. Decay of old ideas of honesty and thrift. Misinformation in newspapers.

Too much organization for combative purposes, instead of for cooperation.

Violence in labor troubles; sympathetic strikes; boycotting and picketing. Meddlesome and burdensome legislation.

The "closed shop," which makes for labor monopoly; financial irresponsibility of labor unions.

Reasons Given by the Employes

Normal and healthy desire for better living conditions.

Protest against low wages, long hours, and unsanitary and dangerous conditions existing in many industries.

Demand for industrial democracy and revolt against the suppression of organization.

Unemployment.

Unjust distribution of the products of industry.

Unjust attitude of police and courts.

One law for the rich, another for the poor.

Immigration, and the consequent over-supply of labor.

Disregard of grievances.

Unfair competition from prison and other exploited labor.

The rapid pace of modern industry.

Arbitrary discharge of employes.

Black-listing of individual employes.

Exploitation of women and children in industry.

Promotion of violence by the use of "gunmen," spies, and provokers hired by employers.

Attempt to destroy unionism by the pretence of the "open shop."

Monopolization of land and natural resources.

Suppression of free speech and right of peaceful assembly.

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* Address: National Metal Molding Co., Ambridge, Pa.

RECENT LEGAL DECISIONS INVOLVING MACHINERY

Implied Warranty of Fitness of Machine for Particular Use

(Federal.) Where automatic nut-tapping machines, sold by defendant to plaintiff, had been on the market a comparatively short time, plaintiff had never seen or had an opportunity to inspect such a machine, and defendant's circulars stated that they would automatically tap hot or cold pressed nuts and any style of thread or pitch in hexagon or square nuts of iron, steel, brass, or any usual material from which nuts were made, and directed that samples of blank and tapped nuts should accompany inquiries, and the machines were purchased for use on the kind of stock regularly used by plaintiff, with defendant's knowledge of such intended use, there was an implied warranty that they would suitably work such stock; the rule that, when a known, described, and definite article is ordered and supplied, there is no warranty that it shall answer the particular purpose intended by the buyer, though stated by him, did not apply, and it was error for the lower court to charge that defendant did not warrant that the machines were fit for any particular purpose, or for tapping any special kind of nuts, that plaintiff could recover only by showing that the machines were unsuitable to perform the ordinary work which they were made to do in tapping ordinary nuts, and that evidence of plaintiff's reliance upon the alleged warranty should be disregarded.

Where, though a machine was sold on thirty days' trial to enable the buyer to determine whether it would want other similar machines, the buyer was in such urgent need of the machines that, without waiting for the first machine, it asked the seller to build eight machines with the utmost dispatch and ship them to it, and the subject of thirty days' trial was not then or thereafter referred to, it was apparent that the buyer was content to rely upon the situation as disclosed by the seller's circulars and the correspondence with the seller, and not upon a trial of the machines, and instructions on the theory that the sale was a sale on thirty days' trial were improper. *(Kansas City Bolt & Nut Co. v. Rodd, 220 Fed. 751.)*

Patent of Coal Conveying Apparatus Void by the United States Circuit Court of Appeals

(Federal.) The Simmons, Forgham & Bennett patent, for a coal unloading and distributing apparatus for use in ballast burning, held void for prior commercial use of the apparatus in substantially its patented form for more than two years prior to the application.

Where a patented machine was publicly and commercially used for more than two years before the filing of the application, experiments made during that time for the purpose of strengthening and otherwise improving the machine as an operative device must be deemed merely incidental, and not as dominating the character of the use.

Assignment of Patent

(Massachusetts.) The owner of a patent cannot sell and assign his rights thereunder to another, and by means of a suit for infringement of an older and broader patent, subsequently acquired by him and covering the same invention, deprive his assignee of the full benefit of what he purchased. *(United Printing Machinery Co. v. Cross Paper Feeder Co., 220 Fed. 313.)*

Instructions as to Operation of Machinery

(Indiana.) Plaintiff, a common laborer, had on several occasions operated a boom on a steam derrick, holding the rope taut or paying it over the winch head. At these times the rope used was soft and pliable. Plaintiff did not know that it was necessary to make more wraps when a new stiff rope was being used. Held, that it was negligence for the master to direct him to operate the machine with a new rope without giving him instructions.

That the plaintiff attempted to hold the rope with his right hand while he used his left to straighten it does not, though he only had five or six wraps around the winch, show him to be guilty of contributory negligence as a matter of law, in view of the fact that in the past he had been able to hold soft pliable ropes in that manner. *(Indiana Bridge Co. v. Shepp, 108 N. E. 107.)*

Sale of Machinery on Approval

(New Jersey.) On the sale of a machine on approval for one month, and the rejection of the same within the month as not satisfactory, the title to the machine does not pass to the buyer. *(George A. Ohl & Co. v. Barnet Leather Co., 93 A. 714.)*

Assumption of Risk by Machine Operator

(Illinois.) The rule that where an employer promises to repair within a fixed time or within a reasonable time, and neglects to do so, the employe thereafter continuing the employment, and using defective machinery without further complaint and assurance that the same will be repaired, assumes the risk, is not controlling, where no definite time was fixed in which repairs were to be made, and where the employe not only relied on the promise to repair but on the assurance that repairs had been made, and did not discover until after his injury that they had not been made.

An employe presumptively contracts to assume the risk incident to the employment, and he also assumes an "extraordinary risk," which is a risk which may be obviated by the exercise of reasonable care by the employer, if he knows and appreciates the dangers.

An employe, performing dangerous work in obedience to the employer's command does not assume the risk; but he may be guilty of contributory negligence, depending on whether the danger was so great that a person of ordinary prudence would not have incurred it, for "negligence" consists in conduct which common experience or special knowledge of the actor shows to be so likely to produce the result complained of under the circumstances known to him that he is answerable for that result, though it was not certain, intended or foreseen. *(Wheeler v. Chicago & W. I. R. Co., 108 N. E. 332.)*

Machinery Guard Statutes

(Illinois.) Under Illinois laws, providing that all power-driven machinery, including saws, shall be so located as not to be dangerous to employes, or shall be properly enclosed, fenced, or otherwise protected, a circular saw should be guarded to prevent it from throwing off slivers, as it is not the only purpose of the act, as evidenced by "otherwise protected," to prevent actual contact with the saw.

Within Illinois Workmen's compensation act providing that, when the injury to an employe is caused by the intentional omission of the employer to comply with safety regulations, the act shall not affect the civil liability of the employer, the failure to guard a circular saw to prevent it from throwing off slivers, construed to be within the terms of the law and is an "intentional omission."

In the construction of statutes, the intent is to be ascertained, and effect given to it, though it may not be entirely consistent with the strict letter of the statute. *(Forrest v. Roper Furniture Co., 108 N. E. 328.)*

* * *

PROPOSED STANDARDIZATION OF TAP DRILL SIZES BY S. A. E.

The Society of Automobile Engineers has under consideration a subject of considerable importance to manufacturers generally, in the metal working industries. The research division of the standing committee of the S. A. E. has taken up the matter of tap-drill sizes. It is notorious that more taps break than wear out in service; in fact, it is asserted that ninety per cent break instead of wearing out. This not only means heavy tap expense, but what is of greater moment, serious delays in getting new taps, resetting machines and the expense of removing broken taps from the parts being machined. In many cases, it is more costly to remove the broken tap than to scrap the work and to make a new part complete. The belief is that this waste is almost wholly unnecessary and could be avoided by using properly designed taps and specifying correct sizes of tap drills. The research division will investigate the matter with the idea of recommending a tap drill list that can be applied in automobile practice generally, and which will greatly reduce the number of tap drills and taps required.

THE MANUFACTURE OF CHAIN—2

MACHINES AND METHODS USED IN MAKING ELECTRICALLY WELDED CHAIN

BY FRANK H. MAYOH*

IT is the purpose of this article to describe some of the machines and methods used in the manufacture of machine-made chain in which the links are electrically welded. In this work, as in the making of all types of chain, the well-known axiom holds true that a chain is no stronger than its weakest link. Consequently, the chain manufacturer who produces a high-grade product must use material of uniform quality, and the finished chain must be tested to discover any weakness due to improperly welded links, burnt links, or other defects in material or workmanship. In making such tests a load equal to about one-half the ultimate strength of the chain is applied; and as the specified safe working strength of the chain is about one-half the load applied in making the test, it will be seen that the factor of safety allowed is approximately 4. In some cases the specified strength of the chain is made one-third the ultimate strength, making the factor of safety only 3.

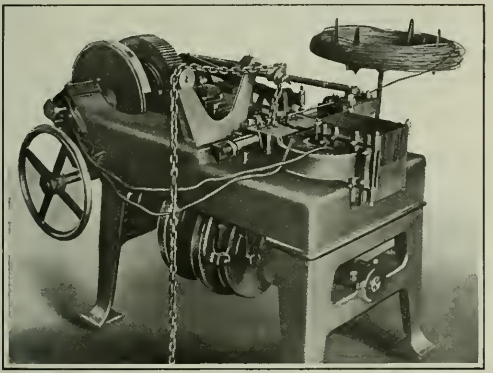

Fig. 1. Machine used for Manufacture of Electrically Welded Plain-link Chain, showing Welding Apparatus

The Manufacture of Plain-Link Chain

Aside from the provision of the welding apparatus and the necessary mechanism to form the links of the chain, probably the most important requirement of chain making machines is that they be built very rigid so that they can stand up under the strains incident to the constant hammering and twisting which takes place while they are in operation. It is also important for the heat supplied by the welding apparatus to be localized so that it will not affect the different members of the machine. Figs. 1 and 2 illustrate one type of machine used for making plain-link welded chain, and these illustrations show the rigid form of construction that is adopted, both as regards the weight of the machine members and the compact way in which they are mounted on the bed. In operation, this type of machine receives the wire from a coil carried by a reel of the form shown in Fig. 1, straightens it, cuts off a blank of the required length for the size of link that is being made, forms the link and makes a scarf weld, each link being connected with the one previously made, so that a continuous chain making process is attained. When working on ¼-inch wire, the rate of production on this machine is from ten to twelve links per minute.

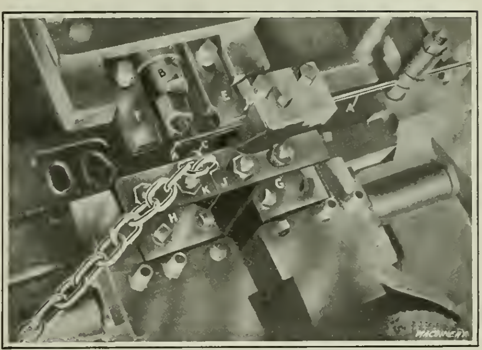

Fig. 3. Link Forming and Welding Mechanisms

The steps involved in the manufacture of chain on this machine are illustrated in Figs. 3, 4 and 9, which show plan views of the forming and welding mechanisms while in operation. Referring to Fig. 3, the wire *A* is fed up to a stop, which regulates the length of the blank, while the forming plunger *B* is returning from the preceding operation. The arbor about which the links are formed is in the position indicated by *C*, but this arbor is hidden by the chain. As the wire is fed forward, the arbor rises to its upper position, and when it reaches the top of its travel the wire is cut off by a knife carried on the outside of one of the forming slides, the position of the cut-off blade being indicated at *D*. After the blank has been cut off, it is held between the forming slides and the arbor, and the forming slides *E* and *F* continue their forward movement and bend the ends of the blank around the base of the arbor. The arbor then drops to its central position and the forming plunger *B* moves forward and completes bending the blank around the smaller part of

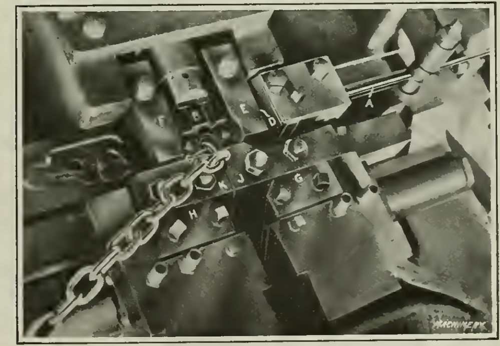

Fig. 4. Mechanism at End of Forming Operation

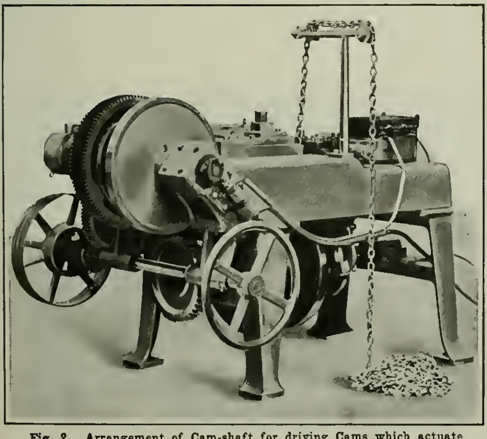

Fig. 2. Arrangement of Cam-shaft for driving Cams which actuate Mechanism of Plain-link Chain Making Machine

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* Address: 700 Weeden St., Pawtucket, R. I.

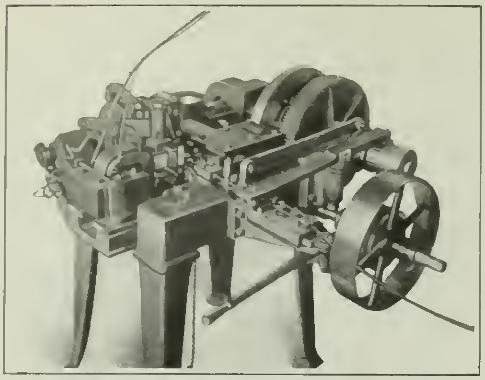

Fig. 5. Form of Wire-straightener used on Machine shown in Fig. 7

the arbor. As the scarfed ends of the blank come together, they pass through the link of the chain which was formed by the previous operation, and are laid over each other ready to be welded. At this stage of the operation the position of the different members of the machine is shown in Fig. 4. The link is still retained in the forming plunger *B* which now makes one-fourth of a revolution to bring the link into position for welding, and at the same time is advanced to the welding jaws *G* and *H* where the link is electrically welded. Before the plunger moves forward to the welding jaws, the arbor *C* must drop to its lowest position, in order to free the link.

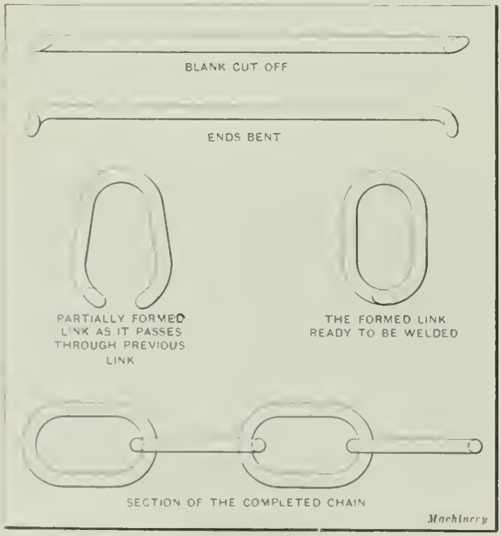
BLANK CUT OFF
ENDS BENT
PARTIALLY FORMED LINK AS IT PASSES THROUGH PREVIOUS LINK
THE FORMED LINK READY TO BE WELDED
SECTION OF THE COMPLETED CHAIN
Machinery

Fig. 6. Condition of Work after Each Step in Cycle of Operations

In the manufacture of electrically welded chain, the speed of production is limited by the time required for welding the links, as the various forming operations require very little time. After each link is welded it is drawn back to the trimming jaws *J* and *K*. In making the weld there is generally a surplus amount of metal left at the joint and while the link is still hot it is drawn back to the trimming jaws which consist of a pair of dies shaped to press the joint into the required form. While this final operation is being performed, the blank for the next link is being fed into the machine and the forming plunger *B* is moving back. During this backward motion, the plunger turns through one-quarter revolution in order to return to its original position. It will be remembered that the plunger *B* made a quarter turn during the operation of producing the link, which was for the purpose of having the finished link still held by the trimming jaws *J* and *K* in position to have the next link passed through it. In order to avoid twisting the chain into kinks, the plunger *B* is arranged to turn alternately through a quarter revolution in the right- and left-hand directions. The operations of the various members of the machine are controlled by cams carried on a camshaft beneath the bed, this shaft being shown in Figs. 1 and 2. The camshaft runs at one-half the speed of the main driving shaft, the drive being through a train of spur gears and a worm and worm-wheel.

The preceding description of the method of producing chain on this type of machine may be briefly summarized as follows: (1) The wire is fed through to the stop; (2) the blank is cut off and has its ends bent by the side forming jaws *E* and *F*; (3) the forming of the link is completed by the forward movement of the plunger *B*, which closes in the ends of the blank through the preceding link; (4) the plunger *B* turns the link through one-fourth revolution and carries it forward to the welding jaws; and (5) the link is returned to the trimming jaws which grip it and squeeze the excess metal from the weld. The condition of the work after each successive operation is shown in Fig. 6. This sequence of operations is repeated indefinitely until the required length of chain has been produced.

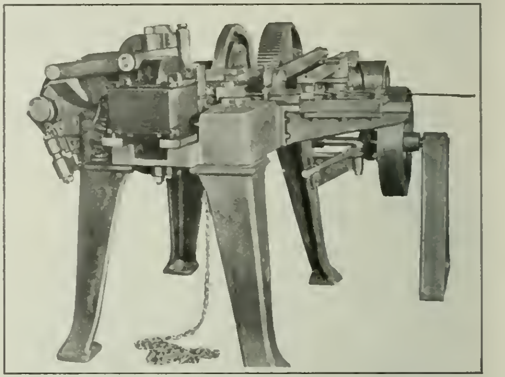

Fig. 7. Machine for Manufacture of Electrically Welded Twisted-link Chain

The Manufacture of Twisted-Link Chain

Machines for the manufacture of twisted-link chain, which are equipped with electric welding apparatus, are shown in Figs. 5, 7, and 8. As in the case of the machine used for the manufacture of plain-link chain, the wire is taken from a coil carried by a suitable reel and enters the machine through a straightener which removes all kinks in the wire. The design of the straightener on this machine is somewhat unusual in that it slides backward over the wire while the wire is held by a clamp on the machine. Those who are familiar with

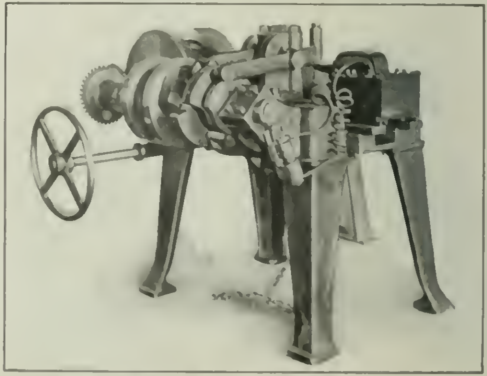

Fig. 8. Arrangement of Cam-shaft of Machine shown in Fig. 7

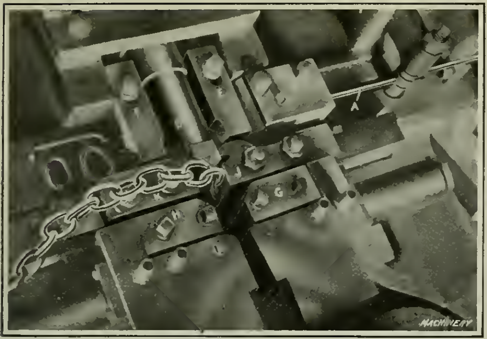

Fig. 9. Position of Mechanism shown in Fig. 4 after Welding Operation

wire forming machinery will recall that in most wire straighteners the wire is pulled through the straightener. A good view of the wire straightener is shown in Figs. 5 and 7.

In describing the operation of this machine reference is made to Figs. 10 to 14, inclusive. The wire is first fed forward and cut off preparatory to having the ends of the blank bent by the auxiliary forming slides *A* and *B* which act in conjunction with the two pins *C* and *D* on the extreme ends of arbor support, Fig. 10. After this has been done the arbor *E* moves to its second position in front of the forming plunger *F*, which then moves forward to complete forming the link as shown at *G* in Fig. 11. In the course of this forming operation the scarfed ends of the wire are lapped over each other, the ends of the link being closed in through the link which was produced during the preceding cycle of operations. The link is now ready to be welded, and in order to convey it to the welding dies, the arbor *E* drops down to allow the plunger *F* to carry the link forward to the welding dies *H*.

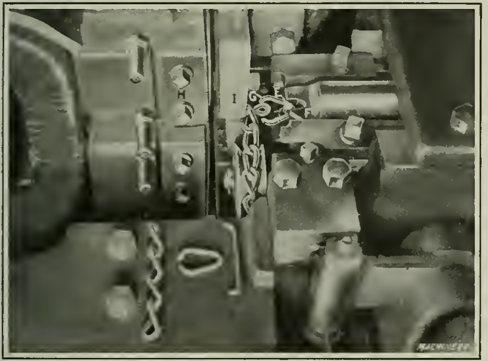

Fig. 11. Completing Bending of Link

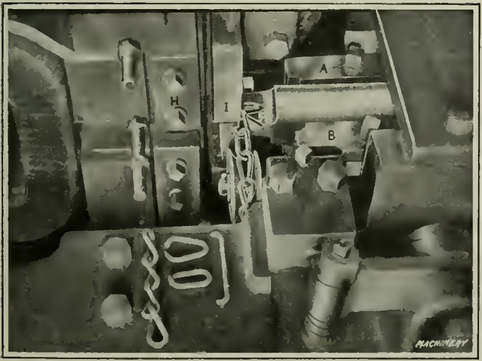

Fig. 13. Trimming and twisting Link

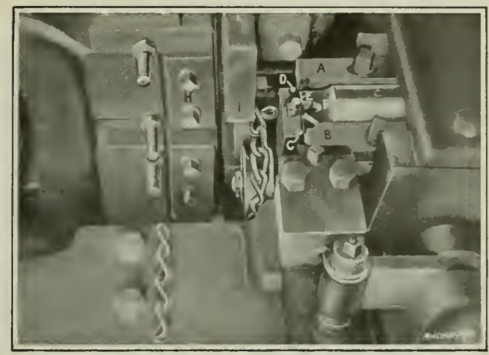

Fig. 10. Starting Point in making a Twisted Link

In order to provide the necessary clearance, the trimming dies *I* have also opened. As the plunger *F* moves forward it turns through a quarter revolution to bring the link into the welding position; and after the link has been welded, the plunger *F* moves back conveying the link to the trimming dies *I* where the weld is shaped to the required form. These trimming dies grip the link as shown in Fig. 13 and the plunger *F* still retains its grip on the end of the link while it rotates through one-fourth revolution, thus producing the required twist in the link, which is the final operation of the cycle. The plunger *F* now releases its hold and moves back, as shown in Fig. 14, until it reaches its position ready for the beginning of the succeeding cycle of operations, this position of plunger *F* being shown in Fig. 10. The finished link is still held in the trimming dies ready to have the next link passed through it. The operation of the forming plunger on this machine is controlled by a cam on the main driving shaft, and the rotation of the plunger is effected by a segment

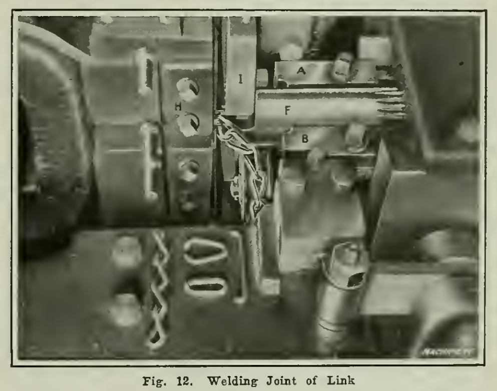

Fig. 12. Welding Joint of Link

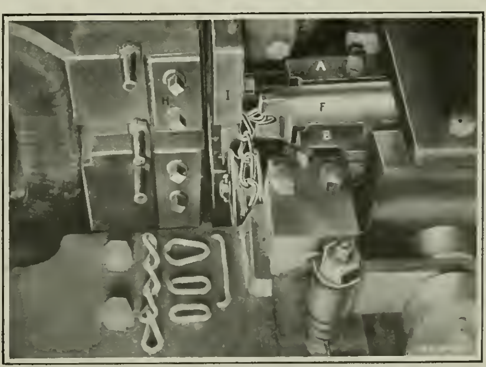

Fig. 14. Return of Bending Plunger

gear which meshes with teeth cut in the plunger; these teeth can be seen in Fig. 12.

The preceding description of the cycle of operations involved in the manufacture of twisted chain on the machine shown in Figs. 5, 7, and 8 may be briefly summarized as follows: (1) Feed the wire through to stop; (2) cut off the blank; (3) bend the ends of the blank; (4) complete forming the link around the arbor, interlocking the link with the adjacent finished link in so doing; (5) weld the joint; (6) trim the joint; (7) twist the link and return the mechanism into position for starting the next cycle of operations. The condition of the work after each successive operation of this cycle is shown in Fig. 15. The two types of chain which have been described constitute the bulk of the chain produced on automatic machines equipped with electric welding apparatus. These are the two types of chain which are filling a great majority of the purposes for which chain is employed. The links are of uniform shape, size, and strength.

A large number of rings are used in connection with chains, and Fig. 16 shows a machine employed for forming and welding rings for this purpose. As regards the principle on which it operates, this machine is essentially the same as the chain making machine employed in the manufacture of plain chain except that different tools are employed. The operations employed in the manufacture of rings on this machine are as follows: The wire is fed forward to a stop; the blank is cut off; and the ends of this blank are bent by auxiliary bending slides. Then the arbor drops down to a lower position, allowing the plunger to come forward and complete the bending operation which brings the scarfed ends of the blank together. The arbor now drops down out of the way and the plunger advances to the welding jaws, at the same time making a quarter turn to bring the ring into the proper position for welding. After the welding operations have been completed, the plunger moves back to the trimming jaws which form the welded joint. While the ring is held in the trimming jaws the plunger moves back to its starting position, and while so doing it must turn back through a quarter revolution. At the same time the arbor moves to its highest position ready to have the next ring formed around it. This machine will make approximately twelve rings per minute when working on ⅜-inch wire.

Needless to say, the perfection of the welds produced is a most important matter in the manufacture of chain. In ordinary welding operations, the metal is sometimes heated beyond the proper welding temperature in order to provide for the loss of heat which takes place during the time which must elapse between transferring the work from the forge to the anvil. This affords an opportunity for an oxide scale to form on the metal, which may result in the production of a poor weld. But in electric welding, the heating and welding of the work take place simultaneously, so that the chance of oxidation is practically eliminated, with the result that the likelihood of producing defective welds is greatly reduced.

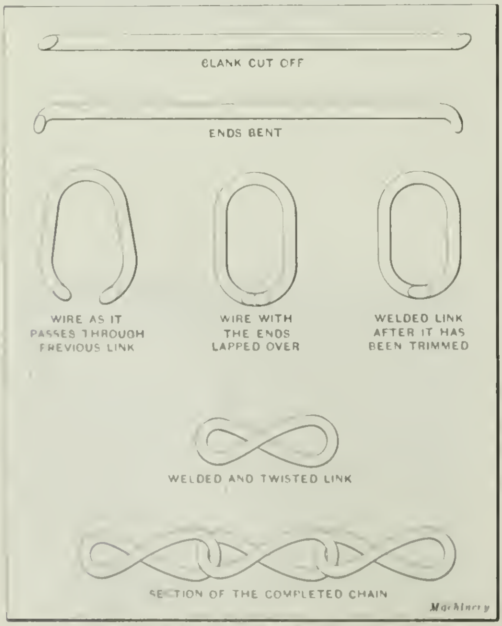
BLANK CUT OFF
ENDS BENT
WIRE AS IT PASSES THROUGH PREVIOUS LINK
WIRE WITH THE ENDS LAPPED OVER
WELDED LINK AFTER IT HAS BEEN TRIMMED
WELDED AND TWISTED LINK
SECTION OF THE COMPLETED CHAIN
Machinery

Fig. 15. Condition of Work after Each Step in Cycle of Operations

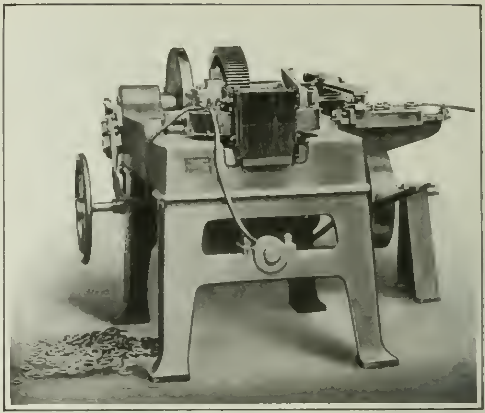

Fig. 16. Machine for Use in Manufacture of Electrically Welded Rings

* * *

THE FUEL VALUE OF WOOD

The fuel value of two pounds of wood is roughly equivalent to that of one pound of coal. This is given as the result of certain calculations now being made in the forest service laboratory, which show also about how many cords of certain kinds of wood are required to obtain an amount of heat equal to that in a ton of coal. Certain kinds of wood, such as hickory, oak, beech, birch, hard maple, ash, elm, locust, long-leaf pine, and cherry, have fairly high heat values, and only one cord of seasoned wood of these species is required to equal one ton of good coal. It takes one-and-a-half cord of short-leaf pine, hemlock, red gum, Douglas fir, sycamore, and soft maple to equal a ton of coal, and two cords of cedar, redwood, poplar, catalpa, Norway pine, cypress, basswood, spruce, and white pine. Equal weights of dry, non-resinous woods, however, are said to have practically the same heat value, regardless of species, and as a consequence it can be stated as a general proposition that the heavier the wood the more heat to the cord. Weight for weight, however, there is very little difference between various species; the average heat for all that have been calculated is 4600 calories, or heat units, per kilogram. A kilogram of resin will develop 9400 heat units, or about twice the average for wood. As a consequence, resinous woods have a greater heat value per pound than non-resinous woods, and this increased value varies, of course, with the resin content.

* * *

The Allied Machinery Co. of America, 55 Wall St., New York City, alleges that an individual representing himself as Frederick H. Brokaw, Jr., or Frederick L. Bond, is posing as a representative of the Allied Machinery Co. of America and endeavoring to obtain loans from machine tool builders throughout the country. His alleged method of operation is to telephone, saying that he has been robbed of his funds and needs from $50 to $100 for traveling expenses to New York City to catch a steamer or to keep an appointment in Chicago, etc. He has also traveled in Europe, where he is alleged to have victimized several machinery houses. Within the past few months he has used the name of Bond and has endeavored to obtain money from Wellman Seaver Morgan Co. of New York City and the A. J. Smart Mfg. Co., Greenfield, Mass.

PROFILE MILLING AND GRINDING

BY EBEN LEA[*]

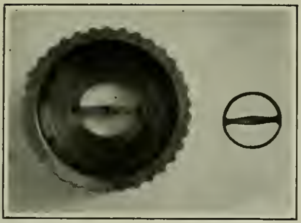

Fig. 1. Profiling Cap and Watch Balance Wheel to be made

On large work, good profile milling can be done without grinding the profiling plates, but on small work, where great accuracy is required, all hardened forms should be carefully ground with a diamond lap. Where a number of these profiling plates have to be made, the following methods will be found to give good results. Suppose it is required to make a plate of the form shown at *A* in Fig. 2. The method of procedure would be as follows: First make a transfer plate *B* in which a hole is drilled to correspond to every hole and small circular arc in the plate *A*. The blank for the plate *A* is then pinned to the transfer plate *B* by means of the center holes, and the ring *C* is placed between them to afford clearance for drilling the holes. The work is clamped to a faceplate and all of the holes are drilled without removing the plate *A* from the transfer plate *B*.

After the drilling has been done, the four segments are cut out of the plate *A* with an end mill. The next step is to make a form *D* in the same way, cutting out the segment with a small end mill. In this connection, it is important to know that in all profiling operations, no mill, lap or guide should ever be used that is larger than the smallest arc in the form, this being especially true for the finishing operations. To avoid under-cutting in the small round corners it is best to use mills with finer teeth than those in general use, the following numbers of teeth having given good results: 0.03 inch diameter, 4 teeth; 0.04, 6 teeth; 0.05 and 0.06, 8 teeth; 0.07, 10 teeth; and 0.08, 12 teeth. A duplicate of form *D* is next made, which is the same in all respects, except that all dimensions are about 0.020 inch smaller. The master form *D* is hardened and then ground on a bench lathe, using the diamond lap *E* for this purpose. The circular arc of the segment is ground in this way, using stops on the rim of the lathe cone pulley to limit the swing of the work in either direction. Then by using the index holes in the back of the cone pulley of the bench lathe, the work may be brought into the correct position so that the lap will follow the radial lines of the segment. After the master form has been completed, it is tested with the gage *F* to make sure of its accuracy.

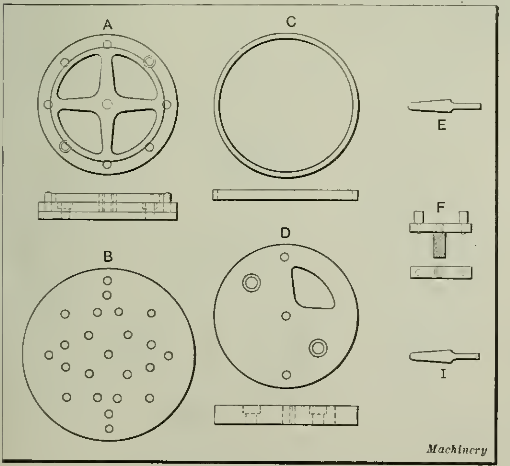

Fig. 2. Profiling Plate, Transfer Plate, Drilling Ring, Master Form, Milling Cutter, Lap and Gage

The master form is then used for finishing the second form which, it will be remembered, was made the same except that all dimensions were 0.020 inch smaller. The work is set up on the profiling machine as shown in Fig. 3, with the master form on the lug *G* and the second form on the lug *H*. Using a 3-degree taper mill, the smaller form is finished the same as the master form except that it has tapered sides. After finishing the milling operation, the second form is hardened; and then it is replaced on the machine to be ground with a diamond lap. After finishing in this way, the second form, which is the working form, is ready for use.

For the profiling operation the master form is taken off the machine and the working form placed on the lug *G*, while the plate *A* of Fig. 2 is set up on lug *H*. The milling operation is performed with a straight end mill. It will be seen that there are four holes equally spaced around the periphery of the plate *A*, and these are used for locating the work in the proper position for the four profiling operations which are necessary to complete it. Obviously, the work is turned through a quarter revolution, after each operation to bring it into the correct location relative to the working form on the lug *G*. After the milling operations have been completed, the work is hardened, and then it is returned to the machine and ground to the required finish. The form of mill used is shown at *I*, the smooth cylindrical part following the profile while the fluted teeth do the cutting. For heavier profiling, the forms are made with a 3-degree taper, but the work is milled with a straight cutter on a machine of similar design to the one shown in Fig. 3. This represents the essential features of a profiling machine, which consists of a double slide rest operated by two handles, the motion being transmitted through racks and pinions. The two handles enable the slides to be moved freely in any direction so that the form may be readily followed.

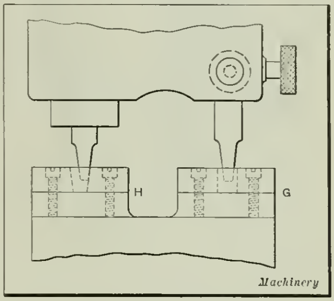

Fig. 3. Working Form and Profiling Plate set up on Machine

Fig. 1 shows a profiling cap and a watch balance wheel which is profiled in this manner. The work is set up on an adapter, on which it is held by the central hole while two square-headed pins that bear against small flats on either side of the work prevent it from turning. The profiling cap covers the adapter, the holes at either side of the cap fitting over the square headed pins at the sides of the work. At the bottom of the fixture on which the work is held, there is a thread which has a lead of 0.04 inch per turn. A pair of lugs on the machine enter slots to engage the thread on the fixture and when the fixture is turned, these lugs act as binding cams to hold the work down while the milling or profiling is being done. Caps made of high-speed steel have good wearing quality.

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ORIGIN OF CIRCULAR SAW

The invention of the circular saw has been attributed to James Murray, of Mansfield, England. Mr. Bale, author of "Woodworking Machinery," states, however, that Murray's claim cannot be substantiated, because it is generally acknowledged that the circular saw originated in Holland in the sixteenth or seventeenth century. Probably the earliest record of its use in England is contained in the patent specifications of Samuel Miller, of Southampton, granted in 1777, in which he claims "an entirely new machine for more expeditiously sawing all kinds of wood, stone and ivory, and the saws used are of circular figure." The motor power employed in this case was a horizontal windmill. In the patent is also claimed an arrangement for bringing the timber up to the saw when in motion.

SNAPSHOTS ON THE ROAD

KEEPING TRADE SECRETS—KINK IN SURFACE GRINDING—POWER REQUIRED FOR DRAWING LARGE SHELLS—EXTRUDING EYELETS—ROUTING CALLS—SPEEDING UP PUNCH PRESSES

THE fallacy in the so-called "trade secret" policy has been frequently pointed out in MACHINERY. The following is an instance which shows up the weakness in the idea that trade secrets can be kept from the "prying public." A short time ago when calling on a prominent machine tool firm, the field service editor was taken through a building where some trade secrets were supposed to be housed. After asking several questions, the nature of the work was told him, but no idea was given as to how it was accomplished. Strolling around, we happened to pass by the door where the work was being done, and the foreman of the department was called out. Instead of closing the door behind him, he stood there with his foot between it and the frame, with the door open, so that the editor could get a good view of the room without going in. The nature of the work being accomplished could be taken in at a glance, and from observation the conclusion was reached that the only reason for keeping this manufacturing method a trade secret was that the firm was ashamed of it. Instead of being up to date, it was accomplished in an out-of-date manner, antiquated, to say the least, by twenty years. This is just another proof of the saying that "In trying to keep ideas in you also keep them out."

"The nature of the work being accomplished could be taken in at a glance"—

A Kink on Surface Grinding

While visiting a large manufacturing establishment, the field editor was shown a little kink in surface grinding which is worth mentioning. Considerable difficulty had been experienced in securing perfectly flat work, and the limits on the part being ground were extremely close. Several months were spent in an endeavor to get the required accuracy without success until a type of magnetic chuck was used for holding the work, in which the work could be disposed along the lines of force or magnetic circuit. This held it without springing out of shape. The wheel used on the job was also provided with eight notches located equidistantly around its periphery and cut at an angle of about 45 degrees to the axis of the wheel spindle. These slots caused the wheel to act as a fan and assisted in keeping the work cool. By this method it was possible to secure limits within 0.0005 inch.

Power Required for Drawing Large Shells

There's a very practical manufacturer of punch presses down near the southern Pennsylvania line. The traveling editors always have most interesting visits in his shop, and almost every time there is an exchange of information that is mutually helpful. On the last trip the field service editor sketched out a set of tools that constituted "a new one" to the press man, but he, in turn, came back with a new idea to the traveling editor.

It was in connection with some of the large press jobs, like drawing up steel barrels, that the "kink" cropped out for determining the power required. The method reminds one of the farmer who found out the number of square feet in his irregularly shaped lot by marking a proportionally small outline on a board, sawing it out and weighing it, and then balancing it with a rectangular board of the same thickness. A little sum in proportion did the rest.

Before this press builder makes a set of tools or determines the press he will use for a particularly heavy stamping or forming job, he makes up a set of tools to produce a part of the same proportions, but on a very much smaller scale—perhaps one-tenth or one-eighth actual size. This specimen set of tools tells him an interesting story. In the first place, the power required for drawing varies as the square of the dimensions of the pieces of work. Then again—just as important—is the knowledge that he gets of the way in which the metal will flow—that is, the amount that can be reduced at each operation, etc. Generally speaking, the characteristics of the operations on the small piece will be the same on the large job.

By following this scheme of making up a reduced size die, a great many blunders are saved to the customer, as well as to the press manufacturer. This practice has been in use for a number of years.

—"the power required for drawing varies as the square of the dimensions of the work"

Extruding Long Eyelets

It was almost five o'clock on an April afternoon when the field service editor struck the office of the manager of an eyelet manufacturing company in southern Massachusetts. The whole office had that appearance of relaxation that comes after the afternoon mail has gone—just before it is time to go home. And the manager, after showing the editor the stunts of the shop, was himself glad to listen to a suggestion.

"I see you use the multiple-plunger press for making your eyelets," said the traveler.

"Yes," said the manager, "and it is the fastest method of producing eyelets that we know of."

"Yes, that's true, and here is a sample"

"But don't you often get work that can't be done on it—long eyelets, for example?"

"Yes, that's true, and here is a sample," replied the manager, as he thrust his hand into a desk drawer and pulled out a seamless brass tube a quarter inch diameter and an inch long.

"Here," said the traveling editor as he rapidly sketched upon the pad, "is a die that will permit you to make that seamless tube one-quarter inch diameter and four inches long in three operations."

The manager scratched his head and replied: "Do you mean to say that I can make that piece in that way?"

"Absolutely," said the editor.

"All right," said Mr. Manager, "I'll have a toolmaker start on this set of tools the first thing in the morning. You've certainly given me an idea that looks practical and I'm glad you came in."

Locating Shops in a Large City

One of the time consuming jobs connected with traveling in a large city is the proper routing of different calls, so they may be covered in the minimum of time. The field service editor has a little wrinkle that greatly facilitates making business calls in a strange city. It is an idea that if followed will help the traveling salesman or the man who has occasion to do business in a strange city.

"With this map before him—"

Briefly, the plan is to lay out upon a pocket map of the city the different calls that are to be made. From this the general direction of the morning or afternoon trip is laid out and the territory systematically covered. The first thing to do is to secure two pieces of cardboard 4 by 8 inches and hinge them along one edge by gluing a small piece of tape or cloth for a hinge. Next, a pocket map may be secured at the hotel news stand, and the business section cut out and pasted upon the cardboard folder just made. Over this a piece of thin writing paper is clipped and the locations of the calls are spotted on this dummy with a lead pencil, adding a word or two for each dot to act as a tracer in identifying it.

With this map before him, the traveling man can cover his territory in the shortest time; and even though he is fairly familiar with the ground, it will save considerable retracing of steps and, moreover, will lead to the formation of regular routes.

"The A. B. C. Electric Co. is running armature disks off at seventy-five strokes per minute"

Speeding up Press Work

Speeding-up is one of the principal fields in which the field service editor can make suggestions that will benefit the shop man. Especially in the case of the isolated shop is the speed likely to be wrong, and it is not noticeable to the man in the shop until some outsider calls it to his attention.

For instance, going through a little electrical shop the other day, the familiar operation of punching armature disks in compound dies was observed. There was nothing unusual about this operation, except the slow speed at which the job was running—perhaps a matter of fifty strokes per minute, when it should have been running at least fifty per cent faster.

"It's none of my business, but why don't you speed up that job a little?" suggested the editor.

"Why, do you think that is slow?" said the superintendent. "We think it's pretty good time here. You know that iron is hard and we don't want to take any chances on that die either. It cost us a pile of money."

"Well," said the field service editor, "here is what I am going by: The A. B. C. Electric Co. is running armature disks off at seventy-five strokes per minute; the Smith & Brown Co. is cutting eighty strokes, and I could name at least a dozen others who are up in that vicinity for speed."

"Well," said the superintendent dubiously, "I'll speed up a little and see how it goes." He will speed up and it will go fine, much to his surprise at first because he will not be accustomed to the higher speed until it becomes more common in his shop.

In visiting many shops, the field service editor unconsciously compares speeds on similar operations in the same way that he compares the quality of the work. Ask the next shop visitor that you have, if he is a mechanical man, what he thinks about the speeds of your operations—you may learn something.

* * *

BLOW-HOLE FILLER

BY WILLIAM WILLIAMS

When turning the face of a large casting the tool frequently breaks through into a hidden blow-hole or other flaw; and although the cavity exposed in this way does not weaken the casting to any appreciable extent, it spoils the appearance of the work and requires it to be discarded. The following describes a blow-hole filler which enables defects of this sort to be remedied without requiring the work to be thrown away. The best plan is to make up a quantity of the filler and keep it on hand ready for use. To do this, secure about 2 pounds of powdered sulphur and 4 pounds of fine graphite; mix these ingredients thoroughly and put the mixture into an iron kettle; then fuse the mixture by heating it over a slow fire. Care must be taken not to overheat while melting, as sulphur may catch fire if it is heated too rapidly. When the mixture has entirely melted it should be stirred for a few minutes to insure a thorough mixing of the sulphur and graphite, after which it is poured into molds and allowed to cool. In its solid form the mixture is hard and possesses a dull metallic luster. When a blow-hole is discovered in a casting, it should first be thoroughly cleaned to remove all grit and dirt, after which a hot soldering iron is used to melt enough of the blow-hole filler to fill the cavity a little more than level. When cool, the surface is smoothed off with a file and emery paper, and will then be scarcely noticeable in the surface of the finished work.

* * *

CRACKS IN CHROME-VANADIUM GEARS

Causes of defects that are obscure often seem perfectly obvious when once discovered. What seemed most mysterious and unexplainable becomes as simple as A B C. The Frost Gear & Machine Co., Jackson, Mich., manufacturer of gear sets for motor cars, was troubled by cracks in chrome-vanadium steel gears. They were ascribed to a variety of causes, but finally were discovered to be due to the use of steam in the forge shop for blowing scale off the dies when forging the blanks. The steam condensed and the water running off the dies collected in little pools into which a red-hot blank would occasionally fall. One side would be quenched while the other remained hot. The unequal shrinkage stresses set up strains that resulted in fractures after the machining and heat-treating operations had been completed. The trouble has led to the substitution of compressed air for steam to clean the forge die.

HOLDER FOR END-MILLS

BY J. P. BROPHY[*]

In this short article the writer will describe some kinks for holding milling cutters. In the shops of the Cleveland Automatic Machine Co. all kinds of end-mills and angular mills are used, and these ideas have been found very satisfactory in practice. In the holder shown in Fig. 1, the shank *A* is made of tool steel hardened and ground. The drivers shown at *B* are produced by milling the metal at each side. This produces a solid driver and the surface on which the cutter rests is ground after being hardened. The hole into which the stud *C* fits is also ground, making a shank that is perfectly true and that will last indefinitely. The stud *C* is a close fit in the hole in the shank *A* and the large diameter of the stud fits into the hole in the cutter. As the cutter is ground all over, it can readily be seen that by inserting a square piece of stock in the square hole in the stud *C*, using a wrench as shown in the illustration, and drawing the cutters down solidly on the end of the shank *A*, a very rigid construction is afforded. It must be understood in this connection that one end of the cutter has a keyway to fit the drivers *B*. In tests which have been made with this kind of an end-mill holder, it has been found possible to break the cutter to pieces or stall the machine without disturbing the concentricity of the stud *C*. This shows that this is a remarkably efficient holder for end-mills.

The holder shown in Fig. 2 is similar to that illustrated in Fig. 1, except that this holder is intended for angular mills. The shank *D* is hardened and ground and has a recess in the center to receive the bolt *E*. The shank *D* has a driver on the end similar to that illustrated in Fig. 1. The shank *G* has a keyway at one end, this shank also being made of hardened and ground steel. When using this holder, a keyway is also milled in the cutter *F* and a small hardened key is used for a driver. The shank *G* is tapered at one end to adapt it for carrying angular milling cutters of small diameter. By placing the cutter in position and drawing up the bolt *E*, an extremely rigid holder is provided. This type of holder has been used in the shops of the Cleveland Automatic Machine Co. for years. When using small angular mills, difficulty was experienced in keeping them true, and also from having the arbor become somewhat damaged. The type of holder described has given excellent results. The holders shown in Figs. 1 and 2 are adapted for holding right- or left-hand mills.

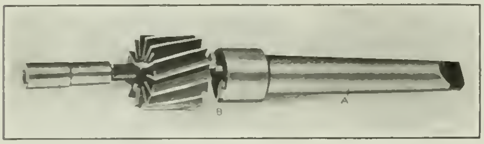

Fig. 1. Efficient Type of Holder for End-mills

The holder shown in Fig. 3 is used exclusively for holding small end-mills. The shank *H* is hardened and ground and provided with a spring collet. The plug *I* fits loosely in the hole in the shank *H* and is merely used for tapping the shank into position in the spindle. If a piece similar to plug *I* were not used for this purpose, the workman would be likely to damage the holder more or less while setting it up in the spindle. The cutter *J* is made double ended to save material; but if made single ended the shank on this cutter should be made about the same length.

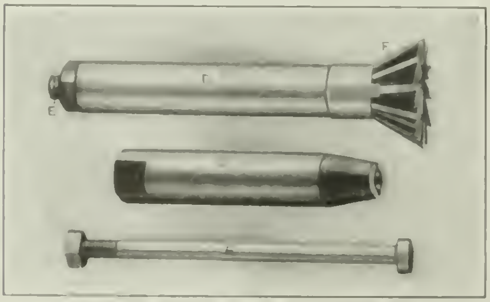

Fig. 2. Two Types of Holders for Angular-mills

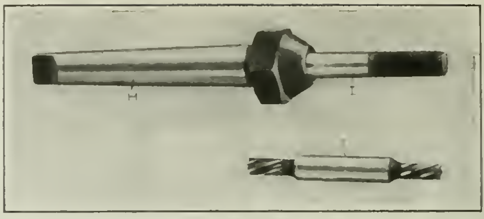

Fig. 3. Holder for Small Sizes of End-mills

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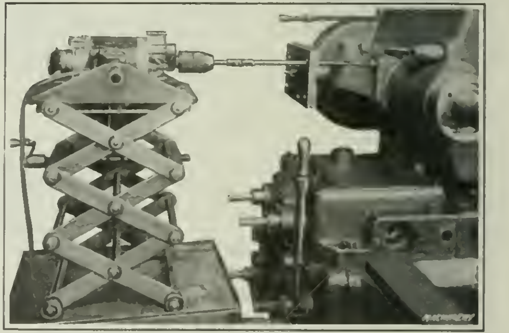
LUCAS ADJUSTABLE SUPPORT FOR ELECTRIC DRILL

Portable electric drills are used extensively in many shops for drilling those holes in work on the erecting floor which cannot be conveniently drilled under the regular drilling machines. The usefulness of these portable tools is often lessened by the lack of suitable means for holding them up to the work; as when drilling horizontally, it is necessary to provide supports in order that the holes drilled shall be square with the work. The supports provided usually consist of blocks, boxes or short pieces of plank picked up in the shop. The collecting of these means time lost, and the resulting pile is perhaps an insecure support. At the best, it is unsightly and not in keeping with efficient shop management.

To meet the need for a convenient, easily adjusted support for the electric drills used in the shop of the Lucas Machine Tool Co., Cleveland, Ohio, the lazy-tongs device shown in the illustration was designed and made. It consists of a cradle for supporting the electric drill, the lazy-tongs extension members and a horizontal adjusting screw. Small casters are provided to facilitate movement about the shop.



Lucas Lazy-tongs Support for Electrical Drill

Turning the handle moves the cradle up or down, the range of vertical adjustment being about fifteen inches. When the cradle is depressed to the lowest position, a set of four coil springs underneath it is compressed. These were provided to assist in raising the cradle when the lazy-tongs stand at an acute angle with one another that makes the action of the adjusting screw difficult and inefficient. The springs overcome the tendency to stick, and the resistance to elevating is practically uniform throughout the range of adjustment.

* * *

The cost of operating a 900-horsepower Diesel oil engine at the Anheuser-Busch Brewery at St. Louis, Mo., is said by the *Compressed Air Magazine* to total only 0.65 cent per kilowatt hour, of which 0.285 is for fuel oil and 0.275 for labor, while the remainder is distributed over the expense for lubricating oil, water, general supplies, etc.

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[*] Vice-president and General Manager, Cleveland Automatic Machine Co., Cleveland, Ohio.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

ADJUSTABLE AND MULTI-CUTTING TURNING TOOLS

Frank H. Mayoh has made a number of interesting comments in the December, 1914, number of MACHINERY, on my article entitled "Adjustable and Multi-Cutting Turning Tools" which appeared in MACHINERY for February, 1914. Some of the points mentioned are well worth discussion. In the first place I am inclined to think that Mr. Mayoh has misunderstood some of the conditions which governed the work mentioned, a case in point being the method of machining bushings (Fig. 4 in the original article). The description clearly states that "a number of short bushings were to be refinished on the outside" and that they were "of various diameters ranging from 2¼ to 4 inches." From 0.008 to 0.010 inch of stock was left for refinishing and it was important that the exterior and interior should be concentric. Pieces were made up from the bar and were found slightly "out" both in the concentricity and squareness of the ends, so that refinishing was resorted to, a small allowance being left for this purpose. The method described proved both economical and satisfactory, and is in use at the present time by one of the largest machine tool manufacturers in this country. Comparing the lathe method suggested by Mr. Mayoh with the one originally described, I find that his equipment is considerably cheaper, but that the assembling and disassembling would require a much longer time because the work would need to be taken to the arbor press each time a bushing was put on. A reasonable estimate of the time required for finishing a bushing 4 by 3 inches in size by the lathe method would be at least 1½ minute, while the same work on the turret lathe with the equipment mentioned in my article took only about one half this time.

In addition to this, it must be remembered that on the turret lathe the ends of the bushing are squared up while on the lathe this work is not done. Although it may seem a trifle unfair to bring up this point, as it was not mentioned in the original article, the fact remains that it was done; and, therefore, it should be mentioned in any comparison of the two methods. In the suggestion for turret lathe tooling shown in Fig. 2 of Mr. Mayoh's article, I will say that this idea is one which is frequently used in turret lathe work; and while it has a number of advantages, it is not by any means as rigid a construction as that illustrated in the original article, although it is more adaptable to various conditions and is comparatively cheap. It is subject to more or less "chatter" if used for heavy cutting, while the other tool is rigid enough to counteract any such tendency. The piloting of the arbor in the holder on the turret is an excellent idea, but somewhat unnecessary for light cutting. Several examples of piloted arbors were given by the writer in the article on "Arbors for Second Operation Work," in MACHINERY for October, 1913, Figs. 7, 10 and 11.

The point which Mr. Mayoh makes relative to the thrust of the cut coming against the screws instead of on solid metal (Fig. 3 of original article) has several times been mentioned by the writer in connection with the design of cutting tools, and he readily acknowledges that in theory it is much better to have the thrust of the cut taken by the solid metal. In actual practice, however, it is sometimes found advantageous to place the screws in such a position that the operator can easily get at them for adjustment, and except in cases where very heavy cutting was required I have never known trouble to be caused by this arrangement, unless the distance from the supporting screws to the end of the tool was excessive. In the very article criticized, several instances are given in which the thrust is taken by the solid metal and not by the screws, *e.g.*, Figs. 4, 5, 6, 11, 13 and 14; and the point is also mentioned under the head of "Points in Design," No. 7, in the first part of the article, which reads, "Arrange the tool-block in such a way that the thrust of the cut does not come against it; it is much better to have the thrust come on the body of the tool." In the instance mentioned, the cuts taken were comparatively light and the placing of the screws as shown gave greater facilities for adjustment. The overhang of the tools beyond the supporting screws was not great and no chatter was apparent when in use, so that it will be seen that circumstances alter cases; and although the criticism on this point is perfectly logical, the tool was very efficient.

Regarding the criticism on Fig. 6, I am afraid I must differ very strongly from Mr. Mayoh on some of the points mentioned. In the first place the statement is made that the work produced by the tooling mentioned "would not be very accurate because the pilot comes above the work and offers no support to the boring tools." This fact is surely obvious and no claim is made that the piloting of the turning tools has any particular supporting effect on the boring tools, and it is not intended to have any such effect, for no boring tools are used in connection with it. The diameter of the hole to be bored is small in comparison to the diameters turned, and although the drill is combined with the turning tools, the boring is done *separately*, although the boring-bar is piloted in much the same way that Mr. Mayoh suggests, which is ordinary turret lathe practice. The spotting tool is, of course, always used on work of this kind and needs no further comment. The contention that the drill and boring-bar help to steady the turning tools in Fig. 4 of Mr. Mayoh's article is not borne out by practical experience, and any endeavor to make these tools take the place of the pilot on the turning tool would be futile. As a matter of fact the tool suggested would have practically no support except that rendered by its attachment to the turret and would therefore be very unsatisfactory on the work in question. Serious chatter would undoubtedly result, as the work was of alloy steel, very tough, and having considerable finish allowance, necessitating heavy cutting.

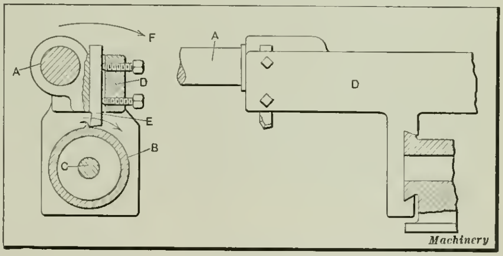


Fig. 1. Diagram showing Effect of Thrust of Cut on Turning Tools

Fig. 1 shows the effect of the thrust of the cut on the turning tools. Holder *D* is secured to the turret face and has a pilot bar *A* which enters a bracket on the spindle cap as illustrated in the original article. The tool *E* is carried by the holder and is at work on the piece *B* which is revolving in the direction indicated by the arrow. Let us suppose there is no pilot bar at *A* and that we are depending for rigidity on a boring-bar *C* piloted in a bushing in the chuck and on the support offered by the turret. It is evident that the thrust of the cut tends to carry the holder in the direction of the arrow *F*, pivoting on the pilot *C*, which does not help matters in the least except that it steadies the work in its relation to the boring tool, but has no useful effect on the turning tool above it. It is a matter of leverage, pure and simple. If, however, we add the pilot *A* to the construction, it immediately counteracts any tendency of the holder to twist in the direction *F;* and as the support is further away radially from the center of the work than the tool is, the support offered is much more efficient. The construction advocated by Mr.

Mayoh is almost identical with that of Fig. 3 in the original article except that the tool-block is on the other side. The conditions governing the two pieces of work were absolutely unlike, for in one case the cuts were light and in the other the amount of stock removed was so great as to require extreme power and rigidity.

The suggestion of a pilot bar mounted in a bracket on the spindle cap (Fig. 5 in Mr. Mayoh's article) has been tried by the writer a number of years ago, and while the scheme has some advantages in the line of manufacture, the rigidity obtained is not as great as if the pilot bar were made integral with the turning tool. Reference to Figs. 2 and 3 of the present article will make clear the advantages of the two methods, and will show why the pilot on the spindle cap does not give as rigid a construction as the other method. The illustrations show a partial plan view of the tools, the holder *V* in Fig. 2 having a tool *B* and a bushing *K* in which the pilot *L* is supported. A bracket *E* on the spindle cap is bored to receive the end *D* of the pilot-bar, which is forced into place. The thrust of the cut takes the direction indicated by the arrow *A* and tends to spring the holder in this direction. This tendency is resisted by the pilot *L* which, being firmly secured to the spindle cap, can bend only from the point *C*, so that vibration (if there is any) will be along the lines *F* and *G*. In the event of extreme pressure being applied to the tool in the direction *A*, the movement of the tool itself would be as great as the vibration of the bar at this point. The other method of construction shown in Fig. 3 of this article has a tool *J* in a holder *N* on the turret with a pilot *O* shouldered and forced into place at *M*. A bushing *Q* in the bracket *P* acts as a guide. In this case, the pressure of the cut tends to pull the tool in the direction *H*, but the shoulder *T* resists the pressure to a great degree, so that it would be found a very difficult matter to spring the bar in the direction shown by the lines *R* and *S*, as the resistance offered by the shoulder is very near that of the tool itself, so there is little likelihood of sufficient vibration being set up to cause any trouble.

The cutting out of the pilot bar in order to clear the gear guard, as noted by Mr. Mayoh, was a very small matter which could have easily been avoided by building a special bracket for the spindle cap and making this high enough so that the entire bar would have cleared the guard. As the bracket used was one which had been made for another job, it was cheaper to use it than to make up a new pattern. The suggestion of placing the pilot bracket in the same position in all cases is hardly practical for the general run of turret lathe work, for in one case a chuck of fairly large diameter may be used in connection with the equipment, necessitating a pilot bar far enough from the center of the spindle to clear it, as shown in Fig. 6 of the original article, while in another instance, as Fig. 7, a special holding device may be used which makes it advisable to pilot the tool lower down. The grouping of the tools and the possible necessity for back-rest supports also has an effect on the construction. The criticism which Mr Mayoh makes on Fig. 10 in the original article, regarding the position of the tool-slide is correct in theory, but a construction such as he advocates would be extremely awkward in practice on account of the difficulty which would be experienced in adjusting the tool. It should further be noted that straps and taper gibs are used in the design and not the dovetail principle mentioned. This point is mentioned in the description of the tool, and a construction of this sort, if properly proportioned in its working parts, is well able to withstand the cutting stresses to which it is subjected.

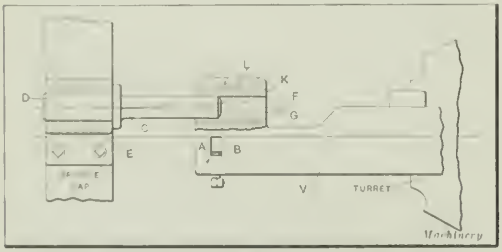


Fig. 2. Shoulder-shank Pilot fitting into Bracket on Spindle Cap

The use of the adjustable tool-block, shown in Fig. 8 of the original article, does not seem to have been clearly understood by Mr. Mayoh, although its purpose was clearly stated. The purpose of the tool was to handle several different sizes of ring pots and pistons, and in order to avoid excessive overhang when machining small diameters, the tool-block was so constructed that it could be dropped down, carrying the tool with it. It is obvious that on loosening the screws which hold the block, the tool would likewise become loosened and have a tendency to fall out; but after the block was reset it might not require changing again for a week or perhaps a month, and so it is not apparent how this could be considered a drawback to the adjustable feature. On turret lathe work, adjustments of cutting tools are frequently made by placing a piece of finished work in position and setting the tool down until it strikes the finished surface, which can readily be done in a construction of the type under discussion. It will therefore be seen that this criticism is hardly borne out by the facts of the case. Many of the points mentioned by Mr. Mayoh are of interest, and while some are more valuable from a theoretical point of view than they are in actual practice, all have their value in calling attention to points in construction and design which have seemed faulty. I have endeavored to go into the matters mentioned as thoroughly as possible, without taking up the entire tooling arrangements utilized in connection with the tools described. It is quite possible that Mr. Mayoh's suggestions might have been somewhat modified had he been cognizant of the complete equipment used in the various cases cited.

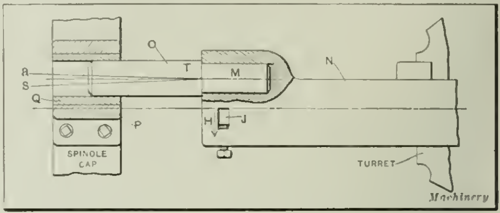


Fig. 3. Straight-shank Pilot guided in Bracket on Spindle Cap

Bridgeport, Conn. ALBERT A. DOWD

ROUGH-TURNING VS. ROUGH-GRINDING CRANKSHAFTS

In the March number of MACHINERY, J. C. Spence criticizes an article entitled "Some Types of Automobile Crankshaft Lathes," by W. O. Strauss, which appeared in the January number, pertaining to rough-turning crankshafts in preference to rough-grinding. It is my opinion that both writers are somewhat biased in their convictions, as arguments may be advanced in favor of both methods, and I think that neither rule can be applied to all classes of crankshafts. Some cranks may be rough-ground more advantageously than they can be turned, while others may be more profitably rough-turned than rough-ground. I also know of certain cranks on which the best plan is to rough-grind the line bearings and then rough-turn the pins, especially if the crankshaft has a balanced-ball or counterweight that must be machined. On other types of crankshafts where the shop receives good forgings of suitable design, the better plan would be to rough-grind the pins.

There are many points to be considered in determining the most economical method of procedure. One big item is the relative amount of power required in rough-turning as compared with rough-grinding. Other items are the expense of grinding wheels and diamonds used for dressing them, the cleaning of the grinding machine (when used for rough-grinding this seems to require at least double the time that it does when the same machine is used for finishing). These items must be compared with the cost of steel for tools and the upkeep of machines when the crankshafts are rough-turned. Ten pounds of good tool steel should rough-turn 800 six-cylinder crankshafts—including the machining of the balance weight—to within 0.025 to 0.035 inch in diameter, and 0.005 to 0.008 inch in the width of the finished dimensions. When cranks can be turned within these limits it will pay to rough-turn them. You may rough-grind to within 0.012 to 0.015 inch in diameter, using a full width wheel, which naturally makes finishing the crank a faster operation than when it is rough-turned, but care must be taken that the sides and fillets are true and that the width does not vary when the crank is rough-ground in this manner.

Mr. Spence writes of using up grinding wheels on other work, that have been worn down in rough-grinding crankshafts. Would it not require a considerable amount of such work to make use of these roughing wheels of a standard grade and grain? I have been interested in the production of crankshafts for more than ten years, during which time I have seen more than 300,000 crankshafts produced. These were of various types and designs, and from this experience I believe that the only satisfactory method of determining whether rough-turning or rough-grinding is the better process is to make a careful study of all requirements of an individual job and adopt that method which has the most features to commend it.

Racine, Wis. E. T. Causer

STEEL PISTON RINGS

In the March number of Machinery, F. W. S. asks for information in regard to the use of steel piston rings for steam engines. When I was engineer on an English steamship several years ago, I had some experience with the Clark & Chapman steel piston rings which were in use on the pistons of the engines that drove the cargo winches. These rings were very satisfactory; we never had any trouble with them, and as both the rings and cylinder were worn to a high polish, they worked very nicely. As nearly as I can remember, the cylinders were about 10 inches bore and the rings of 3/8 inch square section.

I have never seen steel piston rings used in large engines, and cannot say if they would give equally good results. The best way to make a steel piston ring is to roll the ring to a size that is large enough to allow for the spring in the ring plus the stock for machining. Close the ends of the rings together, fasten them and then machine the ring to the size of the cylinder. When made according to this method, the ring will be a perfect fit and have the required amount of spring. The allowance for spring in a steel piston ring should be larger than for a cast-iron ring, a suitable allowance being about 1/32 inch per inch of cylinder diameter.

Hoquiam, Wash. N. W. Kaunitz

Undoubtedly there are steam engine pistons fitted with cast-iron rings which are giving good service and very little trouble, but I have yet to learn of a case where steel piston rings have proved satisfactory in all respects. I have experimented with steel rings on three occasions and the results obtained were very poor. I am not in a position to say why this was the case, but on each occasion, when experiments were tried with the steel rings, the problem of lubrication was found to be more difficult than was the case where cast-iron rings were used. It seems that the steel rings will not carry a film of oil sufficient to lubricate them properly, and as a result the cylinders are cut and worn unevenly, while there is very little wear in the piston rings.

I have found that large rings ranging from 10 to 25 inches in diameter give much better satisfaction when they are made of Swedish iron than if they were made of steel. The Swedish iron rings are more elastic, more easily fitted, and can be kept lubricated more readily. Owing to the superior lubrication possible, the cutting of the cylinder is practically eliminated, and as a result the Swedish iron rings will outlast steel or cast-iron rings by a considerable margin. A further saving results from the fact that breakage of the Swedish iron rings is practically negligible.

I have never had any experience with the piston rings used on steam hammers, but the success obtained with the Swedish iron rings in other classes of service makes me feel confident that it would be a superior material to steel, owing to the severe shocks to which the piston rings on a steam hammer are subjected. It will be found that Swedish iron is slightly higher in price than steel, but the results obtained appear to more than justify the additional expenditure for material.

Fort Wayne, Ind. H. R. Talmage

In reply to the question asked by F. W. S. in the How and Why department of the March number of Machinery, I would say that what are known as the Ramsbottom steel piston rings are extensively used in Europe on stationary, marine and locomotive engine pistons. The advantages claimed for these rings are low initial cost, freedom from breakage, lightness and good wearing qualities. They are easily fitted and inserted in the grooves in the piston, four rings usually being employed on a piston, although two rings have been found to give good results. Owing to their lightness and to the method by which they are manufactured, these rings conform readily to an uneven cylinder wall, and even where the supply of lubricant is scanty it is very rare for the cylinders to show any considerable sign of cutting. In this respect, the steel rings show a marked advantage over the cast-iron rings.

These steel piston rings are of the concentric type, the method of manufacture providing the necessary amount of spring. Either of two methods of manufacture may be employed and in each 0.125 inch per foot of cylinder diameter is allowed for the spring in the ring. The first method consists of rolling the ring to the required shape and size in a double set of rolls, rolling sidewise at the same time that the curvature is being formed. This method results in compressing the inside edge of the ring, and gives the required spring. It is necessary to allow the ends of the ring to overlap to get rid of end distortion. After cutting the rings to the required length, they are clamped on an arbor and ground accurately to size.

The other method of manufacture referred to consists of winding up a coil of metal which is cut into individual rings. These rings are then placed in a circular die and pressed to the required shape and size. This may be done by either hydraulic pressure or by rolling, the latter being the more satisfactory method. If, however, F. W. S. only desires to make up one or two sets of rings, he would find it more satisfactory to forge the rings from steel and then turn them to size in a lathe. Very good results could be obtained in this way, although it will be necessary to peen the rings thoroughly on the inside in order to give them the required tension and strength. This should be done before the finishing cuts are taken.

G. M. H.

EARLY ENGINEERING HANDBOOKS

I read with interest the article on early engineering handbooks in the April number of Machinery. At the present time, I have in my possession a copy of Grier's "Mechanic's Calculator," published by Thomas Wardle, 15 Minor St., Philadelphia, Pa., and dated 1839. It is evidently of the sixth edition and the preface or introduction is dated "Glasgow, 27th August, 1832."

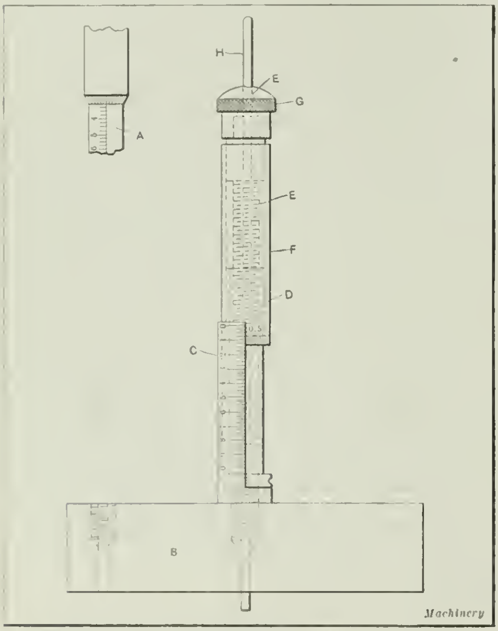
This "Mechanic's Calculator," 1839 edition, printed in Philadelphia, seems to be earlier than any of those mentioned in the article referred to. The book contains some interesting material, including steel engravings of the steam engine, windmills and water wheels.

Mount Vernon, N. Y. Warren L. Smith

[The work referred to, which was submitted to the editorial department for examination, is a curious compendium of arithmetic, geometry, mechanical drawing, conic sections, mensuration, mechanics, strength of materials, hydrostatics, hydrodynamics, pneumatics, heat, steam engines, steamboats, friction, and machinery in general, concluding with tables of square and cube roots and useful recipes for workmen. It is interesting to compare this old work with a modern handbook highly specialized, containing in some cases more on one subject alone than is in this whole work. The book, nevertheless, was a good one for its time, and any old-time mechanic who had read it, studied the problems and understood the principles, would have compared very favorably in knowledge of general engineering principles with mechanics of today.—Editor.]

EXTERNAL SCALE DEPTH GAGE

The external scale depth gage described herewith is believed to be of sufficient novelty to warrant bringing it to the attention of readers of Machinery. The superiority of this design over the usual form of micrometer barrel can be best explained by first referring to the detail of an ordinary micrometer barrel shown at *A*. It will be evident that the figures on a depth gage must read from the top down, and hence as the thimble descends it covers the figure that constitutes the starting point in taking the reading. Thus it will be seen that the figures 1, 2 and 3 of the thimble and barrel shown at *A* are covered; and in taking the reading it is necessary to refer back from the figure 4 to obtain the reading. Although there is no great difficulty in so doing, mistakes are likely to be made.



Micrometer Depth Gage with Scale on Outside of Thimble to facilitate reading

With the external scale all of the figures are always visible, the bottom of the thimble and the right-hand edge of the scale being used in taking the reading. Referring to the illustration, it will be seen that the tool consists of a block *B*, upon which the scale *C* is mounted. The micrometer nut *D* runs over the 40-pitch screw *E*, which is a combination micrometer screw and collet; and the thimble *F* is graduated into twenty-five spaces in the usual way. The nut *G* is for the purpose of binding the collet *E* onto the plunger *H*, which extends down through the block *B* of the depth gage to enable the tool to be used in the ordinary way.

Elgin, Ill. Eben Lea

TRUING UP CHUCK JAWS

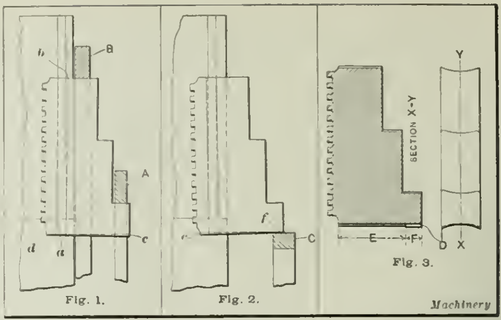


Fig. 1. Incorrect Method of using Setting Ring

Fig. 2. Correct Method of using Setting Ring

Fig. 3. Error produced by not using a Shim in re-setting

It is hard to see why anyone should attempt to true up the inside gripping faces of chuck jaws with the jaws straining out against a ring, as shown at *A* in Fig. 1, but this is done by many men who consider themselves good mechanics. If the ring were placed as shown at *B*, the conditions would not be so bad; but in order to obtain the most favorable results, the ring should be placed as shown at *C* in Fig. 2, as this places the jaws under the same conditions which exist while they are holding a piece of work. The illustration shows the nature of the error that is introduced when the jaws are trued up with the ring applied as shown at *A* and *B*. With the ring in position *A*, the straining out of the jaws sets them at an angle with the body of the chuck, indicated by *a* and *b*. It makes no difference how new and close fitting the jaws of the chuck may be; there is bound to be a certain amount of error of this nature. And even if we could imagine a chuck with absolutely no play in the bearing surfaces of the jaws, there would still be a tendency for the chuck body to spring. Boring the jaws while in this position results in cutting away more metal at c than at *d*, the cut being indicated by the dotted line. When gripping the work with a surface finished in this way, the pressure of the jaws is reversed and a bell-mouthed opening is produced that is shown by the full line in Fig. 2. With the ring set at *B* the tendency to strain the jaws and chuck body out of true is not so great, but there is still likelihood of trouble from this source.

When using a ring in the position shown at *C* in Fig. 2, the jaws are strained open at the outside, and a parallel cut taken from the inside of the gripping surface cuts away more metal at *e* than at *f*. The jaws should be carefully centered with the chuck body and a cut started at *e* that will almost reach the surface when the left-hand side of the ring *C* is reached. The ring is then placed farther in to allow the cut to be completed; and in making this second setting of the ring it should not be placed any farther back than necessary. The ring will have to be increased in size by the use of suitable shims in order to compensate for the metal which has been removed from the chuck jaw by the partially completed cut. If this is not done, the condition shown at *D* in Fig. 3 will result. The surface *E*, which has been bored on a larger radius, will be flatter than the surface *F*. This error will, however, be negligible in most cases.

Turtle Creek, Pa. William S. Rowell

DIES FOR DRAWING CUPS

When drawing sheet steel cups under a power press, there are many points in the construction of the dies, the observance of which will add materially to the quality of the work and the rate at which the parts are produced. It is generally known that the required size of cup and the gage of the metal from which it is to be made, determine the dimensions of the draw-ring. As a rule, however, it is not desirable when redrawing to allow the cup to come in contact with the entire height of the draw-ring, as the frictional resistance which the

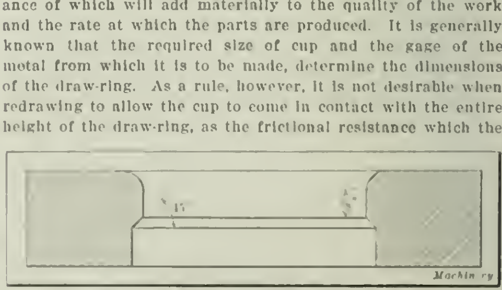


Fig. 1. Drawing Die counterbored from Under Side to relieve Frictional Resistance between Die and Work

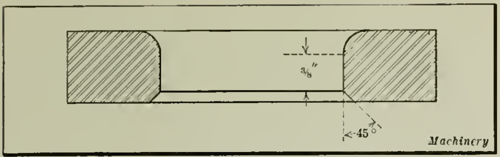


Fig. 2. Die with Under Edge beveled; the Height does not warrant counterboring

ring offers to the passage of the work might result in drawing the wall of the shell too thin. To avoid this and still maintain the necessary height of the ring, I have found it desirable to counterbore the draw-ring from the under side to a diameter about ¼ inch larger than the diameter of the hole in the die. This construction is clearly shown in Fig. 1.

Experience has shown me that ⅜ inch of straight wall is sufficient for the draw-rings used for drawing most forms of cups, but it is not desirable to have a sharp edge at the bottom of the draw-ring. This edge should be beveled off at an angle of 45 degrees, as shown in Fig. 1, to avoid the possibility of chips breaking off, as they are likely to do if the edge is left sharp. Although beveling the edge in this way eliminates the danger of breaking chips from the bottom of the die, it is not always possible to follow this method of procedure, as the sharp edge is sometimes relied upon to strip the shell from the punch. However, this method of stripping is very poor and I personally prefer to use stripper dogs for the purpose. Fig. 2 shows how this method of beveling the under side of the die may be used to advantage even though the height of the die is not sufficient to warrant counterboring.

H. E.

BEVEL CHANGE GEARS

It is a commonly accepted theory that when the number of teeth in one of a pair of bevel gears is changed, the pitch cone angle is changed also, and this necessitates the provision of a new running mate for the gear with a pitch cone angle to conform with the changed angle of the first gear. While this may be quite true in theory, there are times when a great deal of unnecessary expense would be incurred if this rule were followed. Occasionally it is desirable to have a series of change bevel gears, and if the foregoing theory were strictly adhered to it would mean that each change would require two special bevel gears. Fortunately, however, this rule has its exception, as is shown by the following.

It was desired to make a set of bevel pinions having a range of from twenty to forty teeth, increasing by steps of five teeth. This set of pinions was to be used for driving an 80-tooth bevel gear. To avoid making a special 80-tooth gear for each pinion of the set, the following experiment was tried and found to work with entire satisfaction. As previously stated, the pinions were required to have from twenty to forty teeth ranging by intervals of five teeth. The draftsman selected the middle pair of gears, *i. e.*, the 30-80 tooth combination, and figured their face and cutting angles, outside dimensions, etc., in the regular way. Next he drew up the entire set of pinions, giving each pinion the face and cutting angle found correct for the 30-tooth pinion running with the 80-tooth gear. From these drawings, iron patterns were made, from which the pinions were cast, and when these pinions were tried out with the 80-tooth gear, they were found to run satisfactorily with practically no alteration. In one or two cases the patterns were filed up just a little to remove a slight "cramp."

W. J. Hamilton

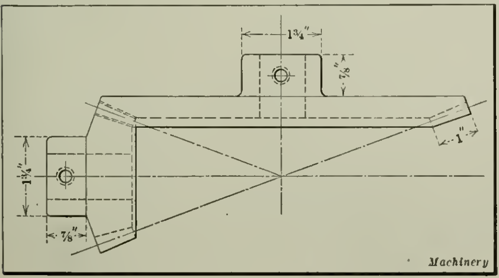
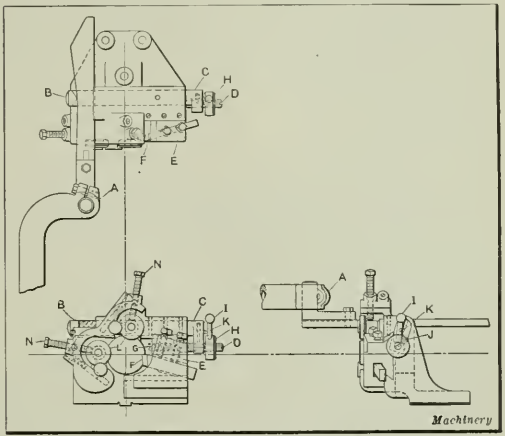


Diagram showing 30-tooth Pinion in mesh with 80-tooth Gear

TAPER-TURNING ATTACHMENT WITH ROLLER BACK-RESTS

The taper-turning attachment illustrated and described herewith was recently designed and built by the Jones & Lamson Machine Co., Springfield, Vt., for turning tapers up to 20 degrees included angle on bar stock. It is made in two sizes, the smaller to take stock from ½ to 2¼ inches in diameter and adapted for use on the 2¼ by 24-inch flat turret lathe; the larger size takes stock from ½ inch to 3 inches in diameter and is adapted for use on the 3 by 36-inch flat turret lathe. To turn any taper within the capacity of the attachment, a templet is accurately ground to the required taper. This templet is clamped into the end of an arm extending from the head of the lathe, in such a way that it is rigidly though adjustably held, as shown at *A*. The templet is adjusted to the proper height from the turret, and runs freely in a groove in the base casting of the attachment which is securely bolted to the turret.



Taper Turning Attachment for Use on Jones & Lamson Flat Turret Lathe

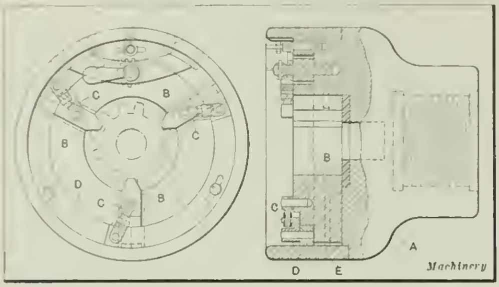
As the turret is fed toward the chuck, the templet actuates a follower which passes through the base of the attachment. This follower is notched at the end *B* to receive the templet, while the other end *C* is off-set to carry the screw *D*. The screw *D* engages the sliding block *E* which carries the cutting tool *F*, the sliding block being held securely against the screw by a spring *G*. In this way the pressure of the templet always holds the tool against the work while the action of the spring prevents the tool from digging in. The screw *D* provides an adjustment for the tool and block; and when the tool is properly adjusted to the work, the nut *H* on the screw *D* is turned until the handle *I* strikes the stop-pin *K*, after which the binder screw *J* is set. In this way a rapid method is provided of relieving the tool while drawing the carriage back from the chuck. A slight turn of the handle *I* relieves the tool; and by moving the handle back against the stop-pin, the tool is brought back into the operating position.

The roller back-rests or steadyrests shown at *L* are mounted on swinging roll carriers, and are easily adjusted to run on any diameter of stock by adjusting the screws *N*. The rolls are designed to run on the straight stock in advance of the cutting tool and do not follow the taper that is being cut. The direct sliding movement of the tool-block in its dovetail bearings and the rigid backing provided by the roller rests work together to insure the production of a smooth taper, the accuracy of which is limited only by the accuracy of the templet.

Springfield, Vt. C. R. Ranney

GEAR GRINDING FIXTURE

It is the purpose of this article to describe a fixture for grinding the bearing holes in gears after they have been hardened, the fixture providing for having the hole central with the pitch circle. It consists of a cast-iron body *A* which is threaded to screw onto the spindle of the machine on which the fixture is used. The face has three slots machined in it to receive the jaws *B*, these jaws being hardened and ground. The jaws are operated by adjustable links *C* which, in turn, are connected to the ring *D*. By rotating the ring *D*, the links *C* actuate the jaws *B* so that the gear is centered ready to be ground. The ring *E*, which surrounds the body of the chuck, is pressed into place, after the body has been machined where required.



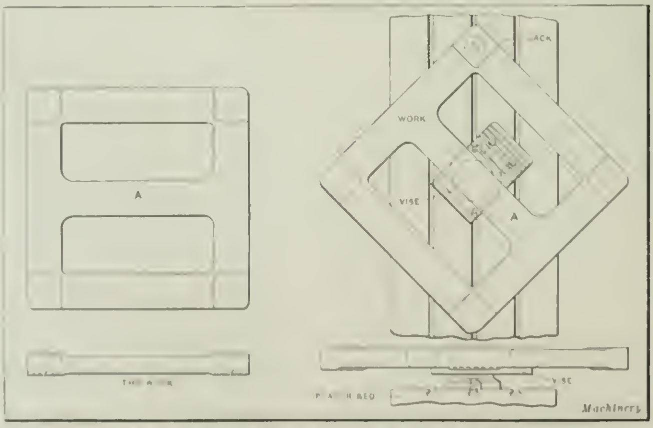
Fixture for grinding Bearing of Gears central with Pitch Circle

Detroit, Mich. C. A. Sieweck

AN UNUSUAL PLANER JOB

After finishing the design of a machine which we were going to build, I found that the baseplate was too large to be finished in the usual way on any of our planers or milling machines. As shown in the illustration, this plate was 40 inches square and had a 5-inch square boss at each corner, which had to be finished on both sides. It was required to have the faces of these bosses as nearly parallel as possible, and on that account it was important to finish the first side of the base at a single setting.

After giving the matter considerable thought, we hit upon the idea of clamping the cross-bar *A* in a large swivel vise mounted on the planer table. After truing up the four corners of the work as nearly as possible with a surface gage, the work was swung around so that two of the corners came approximately over the center of the planer table, after which the swivel head of the vise was clamped. Set up in this way, ample room was provided to run the front of the work far enough under the cross-rail to permit planing the surface of the boss. In this connection it should be mentioned that a jack was placed under the corner of the work while it was being planed. By swiveling the vise, the other three corners were successively brought into position for planing.



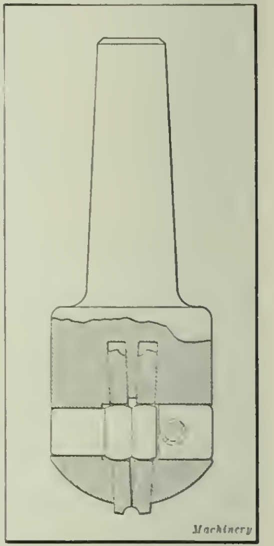
Work to be machined and how Job was handled on a Planer

After the four bosses on one side of the plate had been finished in this way, the work was taken out of the vise, turned over and replaced with the finished side down, this finished side then being used to true the work up properly. The jack was brought up under the first corner to be planed so that it just touched the work, after which the screw was fastened and the jack left at that height. As each corner was brought into position for planing, the jack was placed under it to afford the necessary support. Very satisfactory results were obtained in this way, and when the plate was finished it was found that the corners did not vary over 0.002 inch, this error being corrected by scraping.

Middletown, Conn. E. M. Bidwell

RIVET SPINNING TOOL WITH IMPROVED BEARING FOR ROLL PIVOT

Rivet spinning tools, as commonly made, have two rolls set at a slight angle with each other but both turning on the same pivot. This construction forms a very poor bearing for the rolls, as the hole in the roll must be larger than the pin, and therefore can only touch the pin at one point—the face of the roll. If the hole is tapered to bring its lower side in line with the pin, greater side play is produced in the hole which is already too large, and the roll is subjected to a twisting movement of considerable force when in use. As a result, it is forced to one side, when the carefully tapered hole will no longer match the straight pin; and the bearing is transferred from the calculated line, which reached through the whole thickness of the roll, to a single point. With the rolls out of line, inferior work is produced and the pivot subjected to excessive wear, which shortens the life of the tool.



Rivet Spinning Tool with Improved Bearing for Roll Pivot

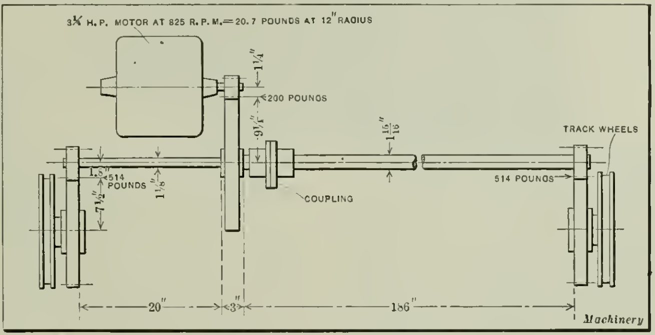
The accompanying illustration shows how these troubles may be avoided by so shaping the pivot that each roll bears upon the circumference of a sphere which, as it fills the hole, allows no side play and thus holds the rolls accurately in line. A brief consideration of the subject will suffice to show that a movement of the pin through the holder and rolls lowers one roll and raises the other, thus allowing them to be matched at their circumference, after which the pin may be fixed in place by the set-screw. This feature of adjustment makes it possible to use a pair of rolls which may vary slightly in diameter, and still match at the working point, thus securing a decided advantage over the old type of holder that is made with a straight pin.

F. W. Barrows
Bridgeport, Conn.

THE ANGLE OF TORSION

I was much interested in the article of this title by B. D. Pinkney which appeared in the November number of MACHINERY. It will be recalled that this article dealt with the angle of torsion of double or compound geared machines; *i.e.*, it showed the effect of different angles of torsion in a shaft in producing wear in a pair of driving pinions when the power could not be applied directly to the center of the shaft to equalize the torsion. The different angles of torsion resulted in uneven wear on the teeth of the pinions. This condition is very noticeable on the bridge driving shafts of electric cranes, although here it is not so much a matter of uneven wear of the teeth of the driving pinions as the tendency of one end of the crane to travel ahead of the other, or to lag behind as the case may be. This causes a variety of troubles, such as excessive wear and tear on the crane tracks and wheels, undue wear of the pinion and gear teeth, twisting of the crane bridge, and other equally unsatisfactory operating conditions.

The most obvious method of eliminating the difficulty is to apply the power exactly at the center of the shaft carrying the two pinions, but in many cases this is difficult to accomplish because mounting the motor on a bracket attached to the side of one of the bridge beams near the center of the span means that an excessively large beam must be selected in order that it may possess sufficient lateral strength to support the motor with the required degree of rigidity. This is especially true when the designer is called upon to use beams of standard structural shapes in the construction of the crane bridge. I have in mind the case of a crane which I designed for use in our own shop. This crane was of the three-motor type, *i. e.*, one motor provided to hoist the load, one to drive the hoist trolley on the bridge and one to drive the bridge along the runways. It was the mounting of the last motor referred to that caused most of the trouble. The crane bridge was constructed of two 10-inch 25-pound I-beams which we had in stock. The hoist and trolley occupied all of the space between the beams and traveled on the top of 2-inch rails secured to the top flanges of the beams. As a result, the mounting of the motor at the center of the crane meant that it would have to be supported by a bracket secured to the outside of the web; and as the span was 18 feet and the beam unsupported for its whole length, such construction would have caused too much deflection. I finally placed the motor on one of the end trucks and coupled a shaft to it, which was long enough to deliver the power to the center of the bridge shaft through a gear and pinion.



Bridge Driving Shaft of a Crane, in which a Consideration of the Angle of Torsion would have saved Trouble in designing

Since reading Mr. Pinkney's article I have been wondering whether it would have been practicable to have proportioned the bridge shaft as suggested in the illustration which he designates as Fig. 4. The illustration which accompanies the present article shows the shaft for the crane, to which I have referred, designed in accordance with this idea. Such a method would make it possible to mount the motor on one of the end trucks, where it would be rigidly supported, while the difference in the angles of torsion of the shaft would be taken care of by the difference in shaft diameters, as suggested by Mr. Pinkney. The only question in my mind is whether it would be as satisfactory as to apply the power directly to the center of the bridge shaft. For the conditions under consideration, we see that the torsion moment T is:

$$T = 514 \times 1.8 = 925 \text{ inch-pounds.}$$

The angle of torsion Δ for the 186-inch length of shaft is found from Formula (4) of Mr. Pinkney's article:

$$\Delta = \frac{687.5 \times 925 \times 15.5}{1.36 \times 10{,}500{,}000} = 0.69 \text{ degree.}$$

In the preceding calculation the value of the polar moment of inertia of 1.36 corresponds with the shaft diameter of 1 15/16 inch. Using the same formula and solving for the value of the polar moment of inertia, we have for the 20-inch length of shaft:

$$0.69 = \frac{687.5 \times 925 \times 1.6}{J \times 10{,}500{,}000}.$$

$$J = \frac{687.5 \times 925 \times 1.6}{0.69 \times 10{,}500{,}000} = 0.1405.$$

From the formula $J = 0.098D^4$ we have:

$$D = \sqrt[4]{\frac{0.1405}{0.098}}$$

$D = 1$ 3/32 inch, or say 1⅛ inch which is the required diameter for the smaller shaft.

York, Pa. W. B. GILBERT

A HAND SCREW MACHINE KINK

It sometimes happens that certain kinds of small threaded work produced on automatic screw machines have to be finished on hand screw machines. In such cases the work is usually held by the threaded part and must be screwed onto the arbor before it can be operated upon. Then after the operation is completed the work must be screwed off the arbor. The best kink that the writer knows of for rapidly setting up such work is to mount a piece of fiber in the back toolpost of the hand screw machine. The front end of this fiber block is made to conform to the profile of the work, which is started onto the threaded arbor while the machine is running and screwed up tight against the shoulder of the arbor by bringing the fiber block to bear against the revolving work. As soon as the second operation has been completed, the machine is reversed and the fiber block again brought to bear against the work, causing it to be unscrewed from the arbor and dropped into a receiver placed to catch it. The reason for using a fiber block for this purpose is that it does not injure the finish of the work, and still has the required degree of durability.

TOOL SETTER

WAXING COMPOUND TO MAKE DRAWINGS TRANSPARENT

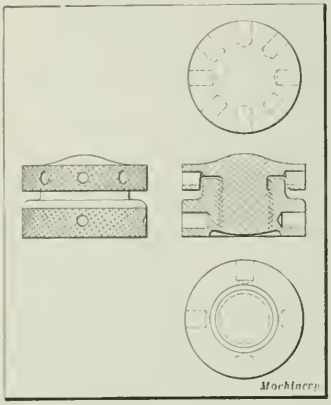
If it is required to make a blueprint from a drawing on heavy bond paper, trouble is often experienced on account of the amount of time required to make the print, due to the opacity of the paper. If, however, the reverse side of the drawing is rubbed with a compound made by dissolving enough ordinary beeswax in spirits of turpentine to form a thin paste, the paper will become quite transparent and a print may be made from the drawing in a very short time. In applying the compound, a cloth should be used and the compound rubbed well into the pores of the paper. After this has been done, the surplus wax and turpentine should be removed by vigorous rubbing with a dry piece of cloth.

WALTER E. LAMB

SHOP AND DRAFTING-ROOM KINKS

INGENIOUS MEANS AND SHORT CUTS FOR SAVING LABOR AND MATERIALS

JACK FOR TRUING UP LATHE WORK



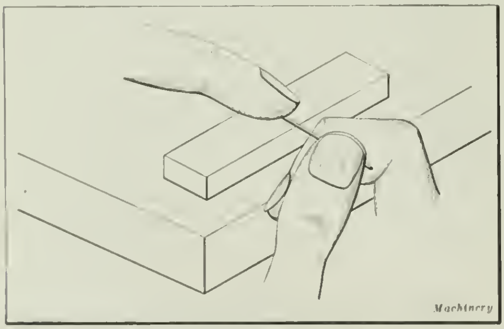
Jack for truing up Work held in Chuck

The jack which I am going to describe was designed to meet conditions often found in chucking medium or small sized work, where the time-honored bolt and nut fail to enter a narrow opening where they may be needed for making adjustment. The size of the jack may be made to suit different classes of work, and where economy of space is the first consideration a large "run" of the screw is out of the question. An adjustment of a few thousandths of an inch is generally sufficient, and in the case of the jack shown in the illustration the maximum "run" is only 1/8 inch.

Turtle Creek, Pa. WILLIAM S. ROWELL

GRINDING DULL COMPASS POINTS

Dull points on a draftsman's compass or dividers are a source of annoyance and inaccuracy, but this trouble can easily be overcome by keeping a carborundum slip for use in occasionally grinding the points to keep them sharp. The accompanying illustration shows the method of procedure which I have found to be very satisfactory. The stone is placed near the edge of the drawing board; and the point to be sharpened is revolved on it by twirling the point between the thumb and index finger of one hand, while the index finger of the other hand is used as a steadyrest.



Method of sharpening Dull Compass Points

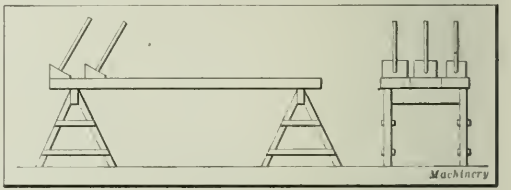
Chattanooga, Tenn. RUSSELL K. ANNIS

TO ENLARGE OR REDUCE DRAWINGS

In the January number of MACHINERY a method was described by Sidney K. Eastwood for enlarging or reducing the size of drawings, which involves laying out a line of given slope on coordinate paper I can see no reason for some of the steps recommended in this article. Suppose it is required to increase the size in the ratio of 2 to 1; all that is necessary is to lay off a length of 2 inches from a given point on a straight line and from this point draw a perpendicular line 1 inch high Next draw a line through the starting point and the point thus located, and you have a line of the required slope for increasing the size in the ratio of 2 to 1, or decreasing in the ratio of 1 to 2. For any other increase or reduction, it is merely necessary to have the required ratio between the horizontal and vertical distances which are measured off in constructing the diagram. N. G. NEAR

SHRAPNEL SHELL PAINTING RACK

In making 18-pound English shrapnel shells, the greatest care is required in all departments of manufacture, including the painting of the finished shells. When each shell is ready to be painted, it must weigh 17 pounds, 10 ounces, 14½ drams, and in painting the weight must be increased 5½ drams for the shell to come up to specifications. The accompanying illustration shows a shrapnel shell painting stand which is made from 2- by 4-inch and 2- by 8-inch lumber. The trestle supports the stand at a convenient height from the floor, and the rods which project out from the bevel faces of the blocks enter the central fuse tubes in the shells so that the painter can rotate each shell while he is painting it. The blocks are spaced on the stand so that ample room is provided for painting. The complete stand has a capacity for 120 shells; it should be noted that the illustration shows only a part of the stand.



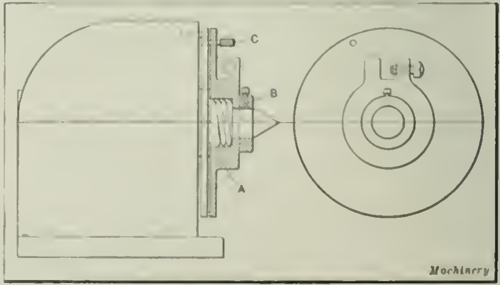
Rack used to support 18-pound English Shrapnel Shells while they are being painted

Hamilton, Ont., Canada. JAMES HAMILTON

A DIVIDING HEAD KINK

The center of a dividing head is likely to become eccentric after long service and this makes it difficult to machine a square arbor concentric with the centers. The following describes an inexpensive device which overcomes this difficulty by making the center dead and revolving the work on it. The accompanying illustration shows a driving plate *A* that takes the place of the driver usually fastened on the center by a set-screw. The driving plate is bored to a running fit on the center and is held in place by a set-collar *B*. The driving plate has an index hole located at the same distance from the center as the holes in the regular index plate. The work is indexed by moving over the desired number of holes and then locking the driving plate by means of the index pin *C*. After the centers have been lined up for milling one side of the work in this way, there is no further trouble with the other three sides.

Davenport, Iowa. R. L. ABERNATHY



Driving Plate for Use in overcoming Error in Dividing Head Center

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

NATIONAL BOLT HEADER

In the operation of this machine the gripping of the stock, and the starting and stopping of the machine are performed automatically, so that the operator is merely required to feed the stock into the machine, as in the case of a rivet header. As a result, he does not become unduly fatigued, and there is no falling off of the rate of production or quality of the product from this cause. The machine may be set to make a bolt head in from three to eight blows which are delivered during one cycle; and as the heads of all bolts are finished by the same number of blows, the quality of the finish of the heads of all bolts is quite uniform. These changes of timing are effected by a simple gear and cam mechanism. There is no clutch on the main shaft; the heading slide, hammer levers, and main shaft run continuously.

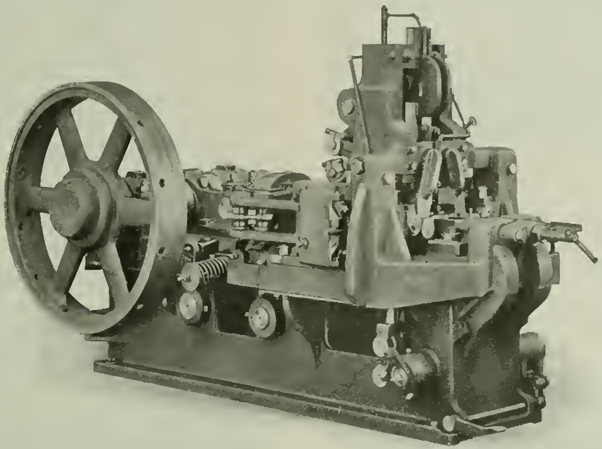


Fig. 1. The National Continuous-motion Semi-automatic Bolt Header

A recent addition to the line of bolt and nut machinery manufactured by the National Machinery Co., Tiffin, Ohio, consists of a continuous-motion semi-automatic hammer type of bolt header which is adapted for forging the heads of square, hexagon, and T-head bolts from heated stock. The design of this machine has been worked out in such a way that the gripping of the stock, and starting and stopping of the machine are performed automatically, so that the operator does not have to do this part of the work and can devote his entire energy to feeding the machine. The main shaft, heading slide, and hammer slides of the machine run continuously, and as a result the machine tends to set the pace for the operator. Relieving the operator of the work of manipulating the levers for the purpose of gripping the stock, and starting and stopping the machine, does away with excessive fatigue, so that there is no falling off of the rate of production or quality of the work from this cause. The eliminaof the starting and stopping clutch on the main shaft, which is secured through having the main shaft, heading slide, and hammer slides run continuously, does away with troubles resulting from wear or breakage of the clutch members, and enables the machine to run at higher speeds.

An important feature of the design of this bolt header consists of the provision of a simple gear and cam mechanism which enables the machine to be set or timed in such a way that the heading operation is completed by from three to eight blows which are delivered during a single cycle. With the machine set to deliver a predetermined number of blows in this way, the finish of the heads of the bolts is necessarily uniform. The time that the grips are open for feeding the stock can also be regulated to suit the length or type of bolt which is to be made. The bed of the machine is of box construction, and it is heavily ribbed to provide a high degree of strength and rigidity.

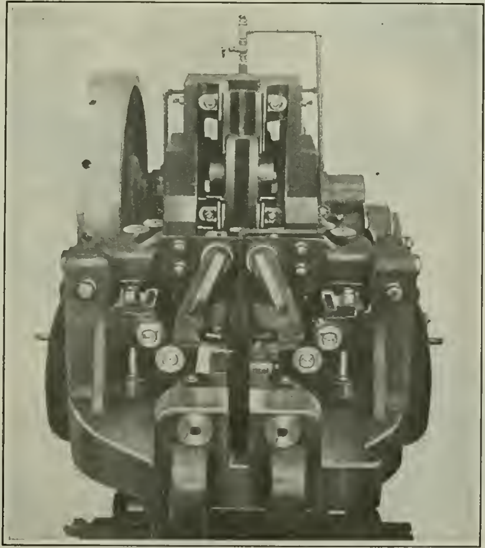


Fig. 2. Front View of Machine equipped with a Shear for making Bolts off the Rod

All parts of the mechanism are made correspondingly massive. As a result, the heading can be performed in this machine in the minimum of time, and with a minimum number of blows, so that the best possible conditions are obtained for the flow of the metal to enable it to fill out the corners of the head. This also makes it possible to work the metal at the lowest temperature that is practical, which is the means of affording a better finish.

The importance of great rigidity in this machine, and the provision which has been made for completing the heading operation with the minimum number of blows, makes it necessary for the machine to be exceptionally heavy. For example, the 1-inch machine weighs approximately 13,000 pounds; but this unusually heavy construction has not caused the speed to be lowered. The 1-inch machine just referred to runs at 140 revolutions per minute on work of the maximum size for which it is adapted, and this speed can be materially increased when running on smaller sizes of work. The rigid constructon of the machine, combined with the feature of a mechanically operated gripping device, has made it possible to introduce a cut-off attachment in the gripping dies, so that short bolts can be made direct from the rod. The provision of this attachment enables short bolts to be made just as efficiently as the longer ones. Four to six bolts can be made from one heat, the number depending somewhat upon the diameter and length of the bolts which are being produced.

Another feature consists of a yoke lever substituted in place of a slide for carrying the lower hammer. The claim is made for this construction that it takes the bearings out of the zone of scale and water, and thus avoids the excessive wear and disalignment which would otherwise result from damage done in this way. It is claimed that this feature of the design will prove an important factor in reducing the cost of upkeep on the machine.

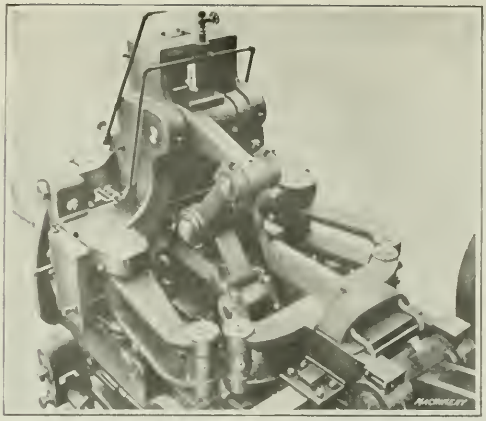


Fig. 3. The Hammer Levers are operated by Links to avoid Excessive Wear and Lost Motion

The slides which carry the side and top hammers are operated by bronze-bushed links, a construction which is claimed to be particularly satisfactory in that it eliminates excessive wear, spring, and lost motion. The flywheel is of the friction-slip construction which has been adopted on headers and forging machines built by the National Machinery Co., and serves as an automatic safety device in case cold stock or an excessive amount of metal is fed into the machine and obstructs the travel of the heading tool. This flywheel also serves to protect the motor from damage in cases where direct motor drive is employed. An automatic relief device is also provided on the gripping mechanism to protect the machine from damage, should the operator accidently get stock or some foreign object between the grips in such a way that it would prevent them from closing, and consequently prevent the machine from completing its regular cycle.

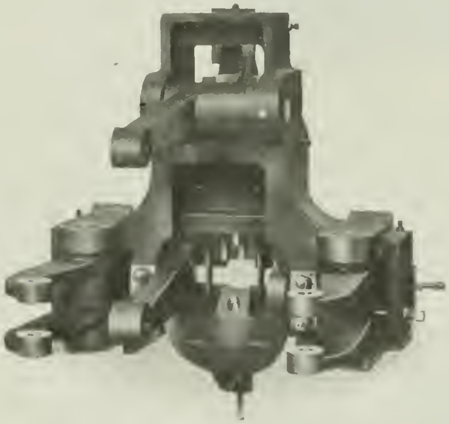


Fig. 4 The Lower Hammer Yoke-lever Construction that avoids Damage done to a Slide by Scale and Water

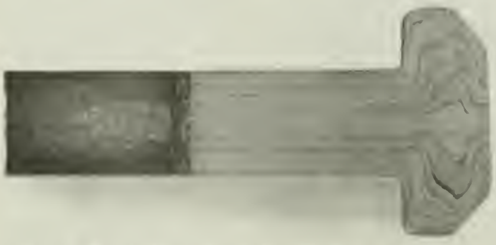


Fig. 5. Etched Section of an Iron Bolt Head made on the Machine, showing how the Metal Fibers are left unbroken after the Upsetting Operation so that the Bolt has the Maximum Strength

The slides in this machine have been made exceptionally long, and the shaft bearings are of large diameter; all shaft bearings are bronze-bushed, and the main shaft bearings are automatically lubricated. All bearings have large oil pockets or cup oilers that are readily accessible and these pockets, in common with all oil holes, are provided with sliding or hinged covers which guard against the possibility of scale or other foreign matter finding its way into the bearings. From the preceding, it will be evident that the design has been carefully worked out with the view of providing means to overcome all avoidable bearing troubles. The National Machinery Co. is building this continuous-motion semi-automatic hammer type of bolt header in three sizes which have capacities for heading stock up to ¾ inch, 1 inch, and 1½ inch in diameter, respectively. The machines can be equipped for either belt drive or individual motor drive, according to the requirements of the shop in which they are to be used.

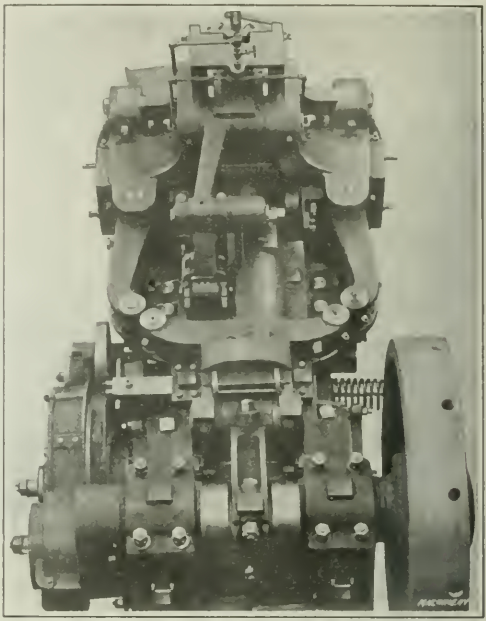


Fig. 6. Rear View of the Machine showing Liberal Dimensions of all Parts of the Mechanism

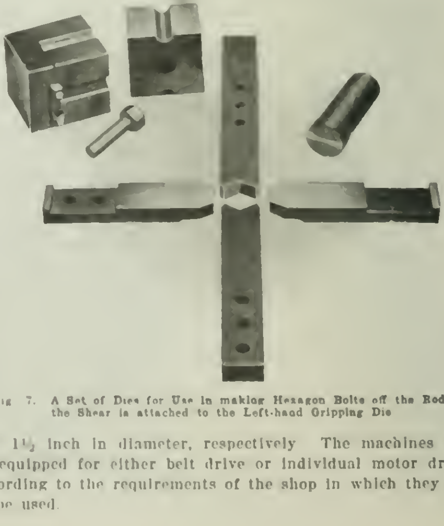


Fig. 7. A Set of Dies for Use in making Hexagon Bolts off the Rod; the Shear is attached to the Left-hand Gripping Die

TAFT-PEIRCE TOOL-ROOM SPECIALTIES

In introducing this line of tool-room specialties, the purpose is to provide tools which are made on a manufacturing basis, where advantage can be taken of every possible economy in production. As noted in the article, the different sizes in which these tools are made are carried in stock, so that prompt deliveries are assured. Each of the tools has been carefully tried out under actual working conditions in the tool-room of the Taft-Peirce Mfg. Co., and during the course of these tests, all weak features of the design have been detected, and remedies applied.

The result of a wide experience in tool making led the Taft-Peirce Mfg. Co., Woonsocket, R. I., to believe that many manufacturers would be glad to avail themselves of the opportunity of purchasing such tool-room specialties as parallels, V-blocks, sine-bars, etc., if they could be obtained in suitable sizes, instead of having such work done in their own tool-rooms. As a result, the line of tools which forms the subject of this article has been designed and thoroughly tested out in the factory of the Taft-Peirce Mfg. Co. before being offered to the public. The claim is made that by having these tools carried in stock, as in the case of other machinists' small tools, the purchaser secures the double advantage of securing tools at a lower price, which are fully as good as his own toolmakers could produce; and of avoiding loss of time which occurs when orders have accumulated in the tool-room, so that each must await its turn before receiving attention.

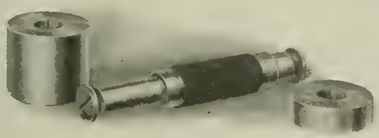


Fig. 1. Double-end Internal Limit Gage

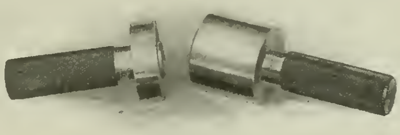


Fig. 2. Single-end Internal Limit Gages

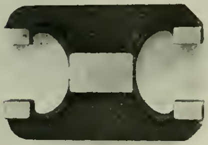


Fig. 3. External Limit Gage

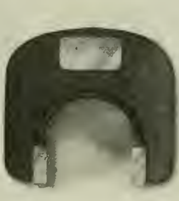


Fig. 4. Single-end External Gage

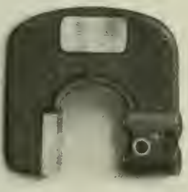


Fig. 5. Adjustable Limit Gage

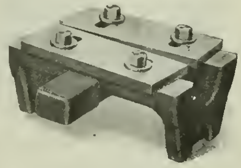


Fig. 6. Adjustable Taper Gage

Internal and External Gages

In designing the line of internal and external limit gages, no attempt has been made to bring out a line of standard plug- and snap-gages as it is believed that this demand has already been met in a very satisfactory manner by other manufacturers. The main object was to standardize the sizes and styles of the gage members so that a customer can order any number of gage-plugs or handles from stock at any time, and be sure they will interchange with the gages he already has in use; moreover, he can secure them without delay. Fig. 1 shows the internal-limit or plug-gage of the double-end type, with the "go" plug at one end and the "not-go" plug on the opposite end. The gage may be readily taken apart, as shown in this illustration, and different gage-ends substituted by simply loosening the screws in the ends. The flexibility of this type of gage is further increased by having the plugs so well fitted that they may be easily reversed on the handles, thus practically doubling their life.

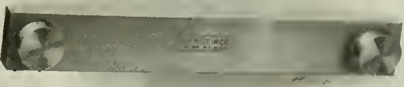


Fig. 7. Sine-Bar

All sizes of these gages are carried in stock from ½ inch to 3 inches by steps of 1/16 inch. Special attention is called to the fact that for each standard size there are three variations obtainable in "go" plugs, and three variations in "not-go" plugs, all of which can be supplied from stock. There are "go" plugs of standard size, also 0.0005 inch undersize and 0.001 inch undersize; and there are "not-go" plugs of standard size, 0.0005 inch oversize and 0.001 inch oversize. All of these plugs fit the same handle, and four standard sizes of handles are used to cover the range of gages from ½ inch to 3 inches. From this it will be seen that stock limit gages or stock plugs may be obtained at any time for work of a given size, and the choice of limit plugs will fit in with the shop system working to 0.001 limits or to 0.0005 limits, above standard, below standard or both sides of standard. The economical feature of being able to make up different combinations of limits from one set of gages will be readily appreciated. Fig. 2 shows a single-end type of internal gage made up by using a different type of handle with the same plugs that are employed on the double-end gage shown in Fig. 1. The "not-go" gage is shown on the left- and the "go" gage on the right-hand side of the illustration. The plugs are held from turning on the handles by means of small keys.

The features of the external limit gage illustrated in Fig. 3 are the

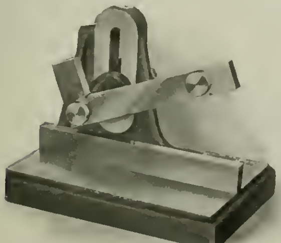


Fig. 8. Sine-Bar Fixture

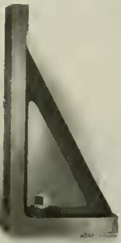


Fig. 9. "Measuring-iron"

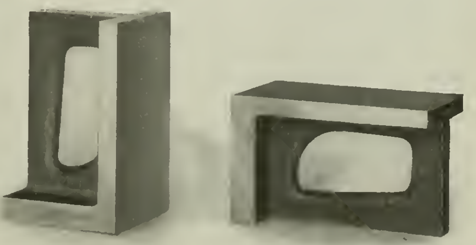


Fig. 10. Universal Right-angle Irons

provision of exceptionally large gaging faces, and a thin web of the drop-forging that ties the four extremities of the gage together to prevent springing or injury of the tool when placed in the hands of a "hustling" pieceworker. This type of limit gage has thus far only been made for gaging rough-turned work. Sizes from ¼ inch to 2 inches, varying by steps of 1/16 inch are carried in stock. The tolerance provided on these gages under the 1-inch size is about 0.008 inch; and from the 1- to 2-inch sizes, it is about 0.012 inch. Single-end gages of the form shown in Fig. 4 are also carried in stock in sizes from 2 to 3 inches, with a tolerance of 0.015 inch. Large pads carry the size inscriptions on both types of gages.

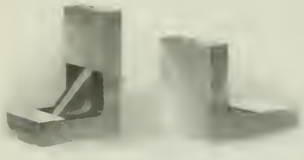


Fig. 11. Toolmaker's Kneee used for setting up Work

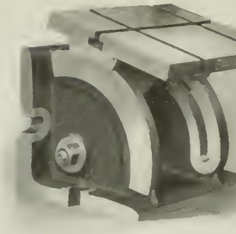


Fig. 12. Knee provided with Means of Angular Adjustment

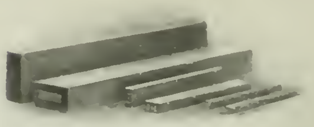


Fig. 13. An assortment of the Steel Parallels

Another type of external limit gage is shown in Fig. 5, which has the lower gaging face fixed, and two opposite "go" and "not-go" points independently adjustable. These adjustable gaging points are threaded into sockets and they may be clamped in any desired positions. The ends are made slightly convex to afford a better contact with the surface that is being gaged. Thirteen stock sizes of this gage cover all diameters from ¾ inch to 7 inches. One of the advantages of the large flat lower gaging face is that the work cannot drop down between the two gaging points.

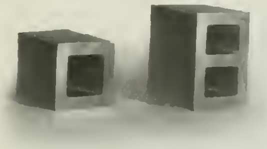


Fig. 14. Cast-iron Boz Section Parallels

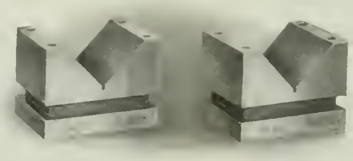


Fig. 15. V-Blocks

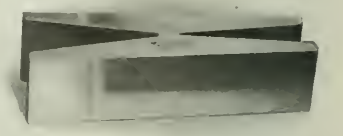


Fig. 16. Equalizing Jaws for holding Tapered Work

Included in this line of gages is a taper gage illustrated in Fig. 6, which consists of two adjustable hardened and ground straight edges mounted on a cast-iron body. There is a convenient handle on one side with which the gage may be held while in use or, if preferred, it may be clamped in a vise. The gage may be quickly set for any taper. Three sizes of this gage are provided, the smallest having blades 3 inches long and taking diameters up to 1 inch at the large end of the taper; the medium size having blades 5 inches long and taking work up to 1⅞ inch in diameter at the large end; and the largest size having blades 7½ inches long and taking diameters up to 2⅞ inches at the large end

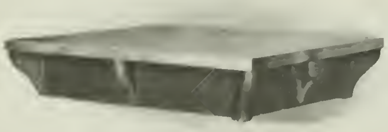


Fig. 17. Bench Plate

Sine-Bars and Sine-Bar Fixtures

It is believed that Figs 7 and 8 show the first sine-bar and sine-bar fixture that has ever been manufactured for the market. These tools are intended for laying out or testing any work where angles are involved, according to the usual method The studs are exactly 5 inches apart on the bar, so that by finding the difference in height of the two studs, when set on the work, and dividing this difference by 5, the result will be the sine of the angle which is to be laid out on the work. The bars are made of steel, hardened and ground so that the edges are parallel with a line passing through the center-line of the studs.

In the case of the sine-bar fixture shown in Fig. 8, the bar pivots on a stud that has a vertical adjustment to accommodate work of various thicknesses or diameters. A projecting edge of the upright and one end of the base are finished, so that the fixture will stand square when this end is placed on a flat surface. In this position the sine-bar can be set to angles of nearly 90 degrees with the base, by using the sine of the complement of the angle. This is a more accurate method owing to the greater difference in the sine of the complement of the angle per degree, as the angle approaches 90 degrees.

Angle-Irons and Knees

The "measuring-iron" shown in Fig. 9, is primarily intended for use on the milling or boring machine, to provide a surface from which accurate measurements may be taken in locating the work. It also may be used for laying out or locating work on other machines or on a bench plate. These angle-irons are made of fine-grained cast iron and are accurately finished by planing. They are made in two sizes, the smaller being 2½ inches wide, with angle faces measuring 6 by 8 inches; while the larger size is 4½ inches wide and the angle faces measure 12 by 20 inches. Similar to the measuring-irons, but more adaptable in their use, are the universal right-angle irons shown in Fig. 10. A web is cast in the center of the back of these irons; and as they are finished all over, they may be used in either of six positions. Work may be clamped to either of the two main faces and the angle-iron set in different positions without the necessity of relocating. These angle-irons are intended to be used in the pattern shop as well as in the tool-room. Four sizes are furnished varying from 3¾ to 8 inches in width, with angle faces ranging from 4 by 5 inches up to 16 by 20 inches in length.

The toolmaker's knees illustrated in Fig. 11 are used in a variety of ways in setting up work, where accuracy is absolutely necessary. They will also be found most useful by the inspector in checking up work. Still another important use is for holding small parts on the surface grinder for light

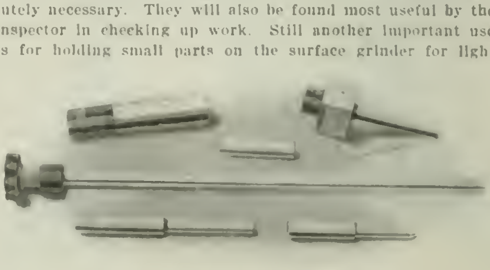


Fig. 18. Boring Equipment for the Milling Machine

grinding operations. The width of these knees is 2½ inches and the length of the angle faces is 3 and 4 inches. A more elaborate tool of this kind is the adjustable knee shown in Fig. 12. On the table of this knee, work may be located and any desired angle of inclination quickly obtained. The setting for the angle is obtained from a vernier, which provides for making settings within 5 minutes of accurate. If desired, this fixture can also be equipped for setting to the sine of any angle. The working face is 7 by 10 inches in size, and T-slots are provided for clamping the work. The extreme height of the table when horizontal is 9 inches.

Parallels, V-Blocks, Equalizing-Jaws and Bench-Plate

One of the most important members of the line of toolroom specialties which is now being carried in stock by the Taft-Peirce Co. is a series of different sizes of parallels, an assortment of which is shown in Fig. 13. These are made of a special grade of steel, and they are hardened and ground on four sides, with the edges slightly rounded to avoid burring. Thirty-four sizes are carried in stock. The sizes range from 5/16 by ¼ by 5 inches up to 1½ by 1¼ by 8 inches. The sizes are interchangeable in every way. Another type of parallel included in this line are the box parallels shown in Fig. 14, which are intended to supplant the use of steel parallels when mounting work for inspection or when the use of smaller parallels would require too much building up. These are made of cast iron, cored out as shown to reduce weight, and are ground on all six faces. The cored holes also provide means for clamping. Three sizes of these tools are made, namely, 4 by 4 by 6 inches, 4 by 6 by 6 inches, and 5 by 8 by 12 inches, respectively.

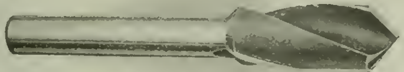


Fig. 19. Drill for use in Equipment shown in Fig. 18

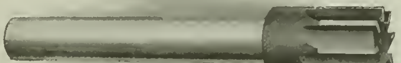


Fig. 20. Reamer for use in Equipment shown in Fig. 18

The V-blocks shown in Fig. 15 are made of steel, and they are hardened and ground all over. Particular attention has been paid to grinding the vees so that they will be central with the outside edges of the blocks to insure perfect alignment. Wide grooves are cut around the blocks to provide means for clamping; and for convenience in attaching gages or other parts, holes have been drilled and tapped in the top faces. These blocks measure 2⅞ by 2⅞ by 4 inches, and the clearance groove at the bottom is ⅛ inch wide.

Another of the tools in this line is the pair of equalizing jaws shown in Fig. 16, which are intended for use in the machine vise to hold tapered or other unequally sized work. The jaws are made of hardened tool steel with the faces and sides of the jaws accurately ground. A cylindrical fulcrum in the center of the back of one of the jaws fits into a corresponding recess in the back of the other jaw, and thus allows the faces of the jaws to adjust themselves to the work. Both the cylindrical rib and recess are form-ground so that they fit perfectly. These jaws are 5⅛ inches long, 1¼ inch high, and 1½ inch wide, when the faces are parallel.

The bench-plate illustrated in Fig. 17 is made for general bench use and is not intended to be used as a surface plate. These plates are made of fine-grained cast iron; they are well reinforced, and thick enough so they may be refinished a number of times. The surface is finished either by scraping or planing. The edges are machined square with each other and with the surface of the plate. The dimensions are 13 by 15 by 3 inches thick, and the weight is about 55 pounds.

Boring Equipment for Milling Machines

Fig. 18 shows a special equipment to be used on the milling machine for performing accurate boring operations on jig, fixture and similar work. It consists of a draw-in rod, a collet, three reducing sleeves, a test plug, a work center, and a boring tool-holder. The outfit is standard for milling machines having a No. 10 or No. 11 Brown & Sharpe taper hole in the spindle. The draw-in rod is furnished to fit any length of spindle, one end being threaded to fit the collect and the other end provided with a knob for tightening. Below the knob, the casting is hexed off to permit the use of a wrench for tightening. The collet is made of tool-steel, which is hardened and tempered; and the reducing sleeves permit tools with shanks ⅜ inch, ½ inch, or ⅝ inch in size to be used. These sleeves are hardened, tempered and ground to size.

The test-plug is found helpful in locating work accurately with relation to the spindle. It is 1½ inch in diameter at the plug-end and the shank that fits the collect measures 13/16 inch in diameter. The over-all length of the test-plug is 8 inches. The function of the work-center is to aid in locating center holes, centering taps and reamers. etc. The fact that it is held in a straight collet means that it can be adjusted lengthwise, a feature that is not available with solid taper-shank tools. The center is hardened and ground. Its over-all length is 6 inches. The special boring tool of this equipment has an adjustable cross-slide operated by a fine-threaded screw which is carefully graduated so that readings may be taken to determine the relative movement of the tool. The clamping and adjusting screws do not project above the surface and both are controlled with a single wrench. A special straight shank drill chuck, and special drills and reamers, as shown in Figs. 19 and 20, respectively, are provided for use with the outfit.

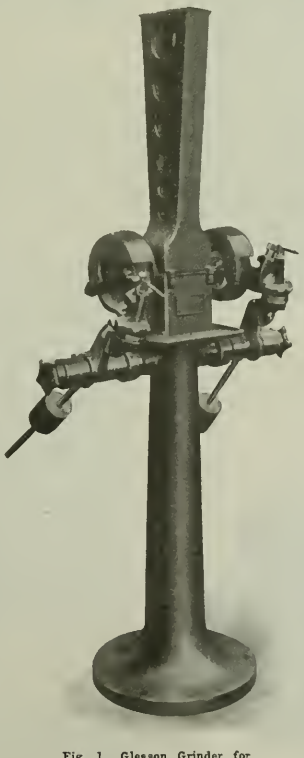


Fig. 1. Gleason Grinder for sharpening Cutters for Two-tool Bevel Gear Generators

GLEASON TOOL GRINDER

For use in sharpening the tools used in the two-tool type of bevel gear generating machines of their manufacture, the Gleason Works, Rochester, N. Y., have recently placed upon the market a tool grinder which is illustrated and described herewith. This is a single-purpose machine in that it is only intended for sharpening one type of tool; and the decision to manufacture this machine for sale to users of Gleason two-tool bevel gear generating machines resulted from the very satisfactory service obtained from machines of this type which have been in use at the Gleason Works for several years.

It will be seen from the illustration that there is a wheel at each end of the spindle. Under each wheel there is an adjustable swinging arm which carries a universal tool-holder; the upper tools are ground by one wheel and the lower tools by the other. The wheels run in the direction indicated by the arrow in Fig. 2, and the holders are so arranged that the grinding is always against the cutting edge of the tool, thereby eliminating the burring of the edge. Each tool-holder has a turning movement on its binding stud which is controlled by a positive stop in both directions, these stops being set for a 14½-degree tool in one direction and a 20-degree tool in the opposite direction. Lines on the side of the tool-holder indicate which way it should be set, and the swivel joint is graduated both ways to facilitate setting for any special pressure or rake angle.

The machine is of very simple construction and convenient to operate. Its use insures accuracy of the tools because they are all ground with a cutting edge exactly square with the cut, which eliminates the necessity of grinding to a gage. This not only saves time but it also eliminates the tendency to grind away more stock than necessary in sharpening cutters. As a result, the life of the tools is prolonged. The wheel spindle is made of hardened steel and accurately ground to size; it runs in bronze bearings which are provided with means of compensation for wear. The equipment furnished with the machine includes a countershaft and two 7 by 2 by ¾ inch cup wheels. The floor space occupied by the machine is 18 by 31 inches, and the net weight 300 pounds.

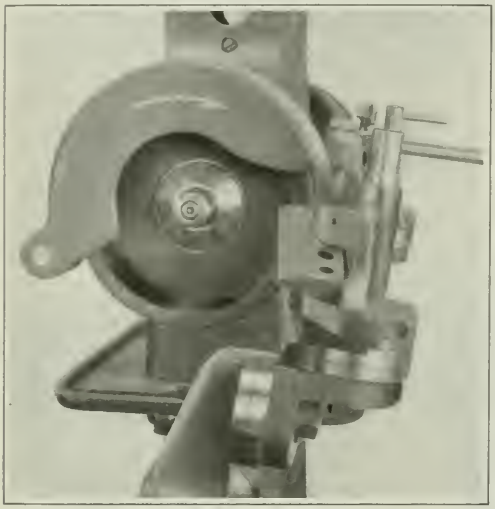


Fig. 2. Close View of the Universal Tool-holder on the Gleason Grinder

GARVIN SQUARE-HEX MILLING ATTACHMENT

Fig. 1 shows a four-spindle, vertical square-hex milling machine attachment which is intended for use in performing such operations as hexing spark-plug nuts, squaring screw or bolt heads, straddle milling, and a variety of similar classes of work; and Fig. 2 shows the attachment in use on a Garvin milling machine. The attachment can be arranged for holding the work by double taper contraction collets operated by a wrench, which is shown on the milling machine table in Fig. 2; or the work may be held on the threaded arbors or plugs, and when this method is employed the fixture is of the form shown in Fig. 1. The work is run up tight against the hardened steel washers or collars by using a special wrench which is also employed for taking off the finished work without marring its surface.

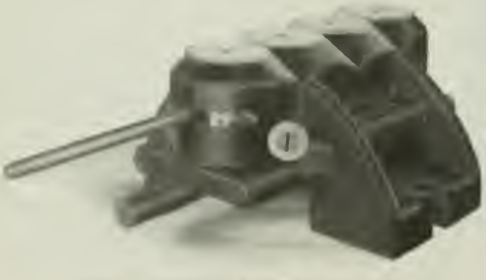


Fig. 1. Garvin Square-Hex Milling Attachment

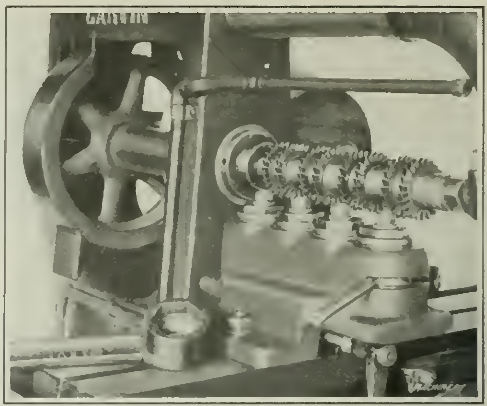


Fig. 2. Square-Hex Milling Attachment in Use on a Garvin Miller

The four spindles of the attachment are geared together so that a single operation provides for indexing all of the spindles for either hexing or squaring operations. The indexing lever is the horizontal lever shown in Figs. 1 and 2; and the vertical lever shown below the attachment in Fig. 2 is arranged to eject the finished work after the collets have been released. The collets have a capacity of 1½ inch, and the distance between centers of the spindles is 3 inches. This attachment is one of the latest products of the Garvin Machine Co., Spring & Varick Sts., New York City.

PEERLESS DRILL AND REAMER HOLDER

To provide for obtaining perfectly true holes when drilling and reaming operations are performed on a lathe, the Peerless Machinery Co., 44 Binford St., Boston, Mass., has placed upon the market a floating drill and reamer holder which is illustrated and described herewith. The capacity is from ¼ to 1¼ inch and the floating feature effectually prevents the production of bell-mouthed or tapered holes which are likely to result if the drill or reamer is rigidly held in the tailstock spindle. Another feature is that the danger of breaking the tool at the time when it cuts through the work is eliminated; and this does away with the liability of the mechanic having his hands cut or fingers broken, a form of

Fig. 1. Tool-holder as it is employed for Drilling and Reaming Operations

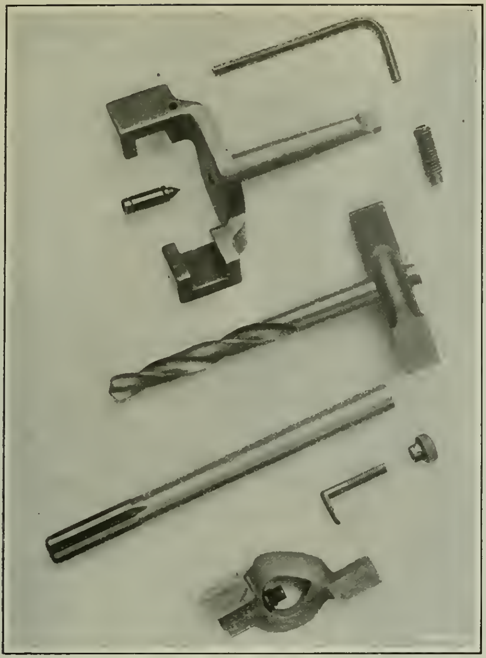


Fig. 2. Parts of the Peerless Drill and Reamer Holder

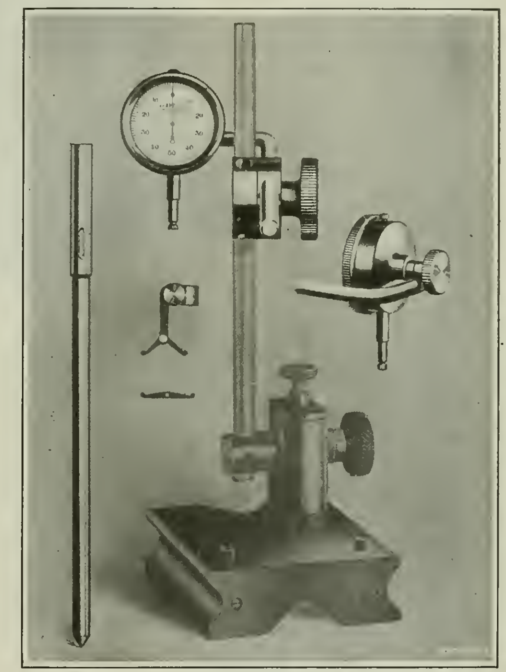
accident which sometimes occurs when a drill which is held by an ordinary dog slips off the center. The avoidance of this danger was the direct cause which led to the development of this tool-holder. With chucking work, it is not necessary to use a centering tool to start the hole, as the facing tool in the tool-post held against the suspended end of the drill provides for obtaining a perfectly true center.

This tool may also be employed in steady-rest work, for facing, internal screw cutting and boring; and drilling and tapping operations may readily be performed by using the tool-holder in the headstock instead of in the tailstock, as in the case of chucking operations. Fig. 1 shows the tool-holder as it is employed for drilling and reaming operations, and Fig. 2 shows the parts of the holder. Referring to the latter illustration, the way in which the drill or reamer is supported on the center in the holder, and still prevented from slipping forward by means of the dog which has drivers fitting into the grooves in the holder, will be readily understood. Fig. 3 shows the holder carried in the headstock of the lathe, as it is employed for the performance of drilling and tapping operations on parts carried in a steadyrest.

Fig. 3. Holder mounted in the Lathe Headstock to provide Reverse Motion for Tapping

AMES TEST GAGE

The accompanying illustration shows what is styled a No. 22 toolmaker's test gage which has recently been placed upon the market by the B. C. Ames Co., Waltham, Mass. As shown in the illustration, this gage is intended for use in connection with the stand of a surface gage, and this stand is not included as part of the test gage equipment. However, most toolmakers have a surface gage in their kit so that a stand is available for this purpose. The gage is fitted with an Ames No. 5 gage head which is guaranteed to be accurate to 0.0005 inch in the entire run of the gage. When used on a surface plate, this gage makes a very useful tool for laying out jigs and fixtures, testing duplicate pieces of work for thickness, etc. Although primarily intended for the use of toolmakers, the gage is suitable for use in a great variety of metal working establishments. For instance, it can be employed for testing the bearings, spindles, slides, centers and other parts of machine tools; and planer and surface grinder work can be tested for thickness without removing it from the platen.



Ames Toolmaker's Test Gage mounted on a Surface Gage Stand

CLEVELAND TOGGLE DRAWING PRESS

The Cleveland Machine & Mfg. Co., 4944 Hamilton Ave., Cleveland, Ohio, has recently added to its line of power presses, a toggle drawing press which is illustrated and described herewith. The most important feature of this machine consists of the provision of a mechanical movement for operating the blank holder slide. This movement gives a complete dwell to the blank holder during more than 90 degrees of travel of the crankshaft, and is timed to release the blank shortly after the crank passes the lower center, and rises at practically the same speed as the plunger, thus giving the maximum amount of time for the removal of the stamping and the substitution of a fresh blank in the die. One of these new toggle presses is illustrated in Fig. 1, and Fig. 2 shows a chart giving the relative travel of the plunger and blank-holder slide on both the down and up strokes, and the dwell of the blank-holder during the drawing operation.

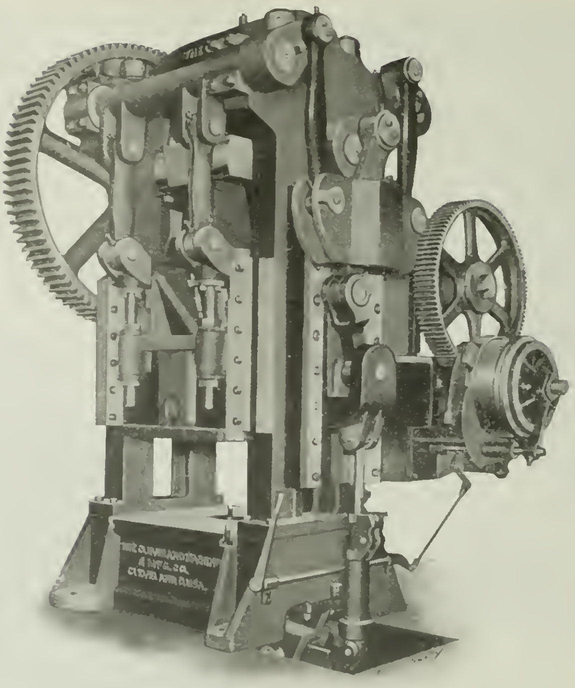


Fig. 1. The Cleveland No. 111 Toggle Drawing Press

The blank-holder and its supports are designed to resist a strain equal to that exerted by the plunger during the drawing operation without any tendency to spring, and this extreme rigidity of the holding parts, together with the complete dwell of the blank, permit drawing operations to be conducted up to the full capacity of the press with a very small percentage of broken or defective work. Reference to Fig. 1 will show that the tie-rod form of construction has been adopted, in which the bed, arch, and housings are tied together by steel rods which are shrunk into position under a greater strain than the maximum overload capacity of the press. Tongue and groove joints are provided between the housings and bed, and between the housings and arch, to preserve perfect alignment under all operating conditions. The yokes, rocker-shafts, cranks, links, and connections operating the blank-holder slide are steel castings, and all pin bearings are bronze-bushed. All of the gears and pinions are of steel, with the teeth cut from the solid metal; and the crankshaft is made of high carbon open-hearth steel which is carefully heat-treated.

The bottom knock-out is operated from the outer slide and provided with an adjustable trip to release the plunger when the stamping is lifted to the top of the die, so that the knock-out plate will drop to the bottom of the die where it will not interfere with the setting of a fresh blank in position. The plunger acts in an air chamber which cushions the return stroke. The friction clutch is of the multiple disk type and has universal adjustment of the friction disks. The brake arms and clutch disks are locked by toggle links which are operated by a hand lever. The friction brake ring is separated from the clutch drum, and it is said to be practically impossible for the clutch to become heated while in operation. The perfect balance of this clutch makes it unnecessary to employ an outboard bearing at the end of the shaft.

The machine shown in Fig. 1 is the No. 111 Cleveland toggle drawing press, and the dimensions of this machine are as follows: drawing capacity, 12½ inches; bed area, 52 by 52 inches; blank holder area, 52 inches wide by 48 inches long; plunger area, 40 inches wide by 35 inches long; stroke of plunger, 26 inches; stroke of blank-holder, 18 inches; distance from bed to blank-holder at the bottom of the stroke and with the adjustment up, 28 inches; distance from the bed to the plunger at the bottom of the stroke and with the adjustment up, 30 inches; adjustment of blank-holder and plunger, 8 inches; speed, 7 strokes per minute; and weight, 110,000 pounds. These machines are built in fifteen other sizes, so that a complete line of these toggle drawing presses is available to meet the requirements of the work for which they are adapted.

* * *

ECK DIRECT-CURRENT MOTOR

In designing the Type D direct-current motor which is a recent product of the Eck Dynamo & Motor Co., Belleville, N. J., the features of commutating poles, positive ventilation by means of internal fans, and the employment of self-aligning ball bearings have been included. Commutating poles have greatly improved the operation of direct-current motors in that they neutralize the harmful effect of the armature field and create a force in the armature coils directly under them. This insures complete reversal of the current in these coils while the commutator bars, to which they are connected, are under the brushes. Sparkless commutation, and long life of the commutators and brushes is thus assured.

The fans giving positive ventilation were adopted to re-

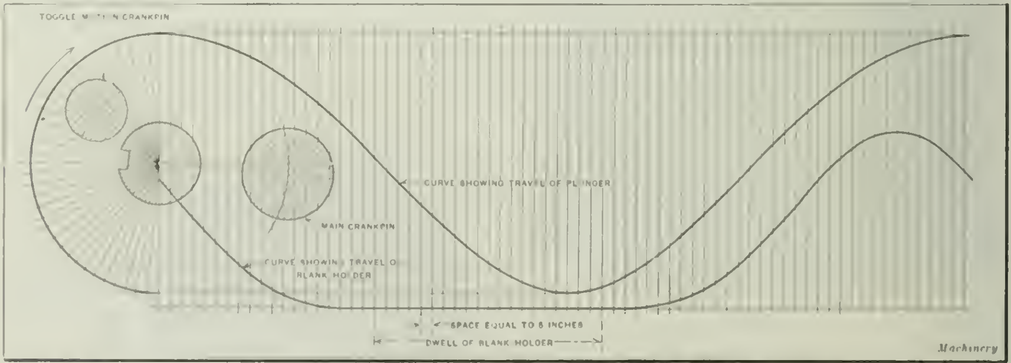


Fig. 2. Chart showing Relative Travel of the Plunger and Blank-Holder Slide on the Down and Up Strokes, and the Dwell of the Blank-Holder during the Drawing Operation

duce the temperature rise, unavoidable in the operation of electric motors. This rise of temperature is due to resistance offered by the windings to the passage of the current, the losses in the iron under magnetic influence, the friction of the brushes on the cummutator, and friction of the shaft bearings. Excessive heat results in injury to the insulation and increased copper losses. To avoid these troubles, air channels lead to the interior of the armature, and through the commutator and core in directions both parallel and at right angles to the shaft. The fan drives cool air through these channels and prevents excessive heating. The use of self-aligning double-row ball bearings provides highest transmission efficiency of the bearings, together with greater durability and ease of maintenance.

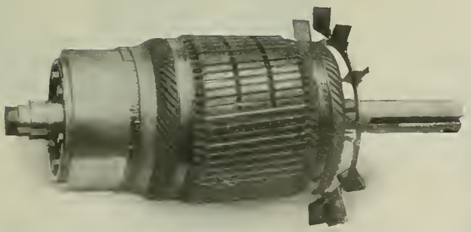


Fig. 1. The Complete Armature showing Ducts in the Core to permit the Passage of Air from the Center to the Periphery

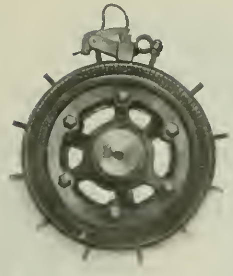


Fig. 2. End View of the Armature and Commutator

Having referred in general to the features of the Eck Type-D motor, brief mention will now be made of certain specific features of the machine. The field frames are made of soft cast steel of high magnetic permeability and afford full protection for the windings. The main poles are made of laminated sheet steel, the laminations being assembled under pressure and riveted together. Ventilating spaces are provided in the poles through which a current of cool air is delivered by the fan, so that both the interior and exterior of the field coils is kept cool. The commutating poles are made of machine steel, and they are fastened to the field frame in the same manner as the main poles. The main field coils are wound on spools made of sheet metal and horn fiber. Ample insulation is provided between the spools and the windings, and the coils are dipped in a moisture-proof insulating varnish, after which they are thoroughly baked.

The armature is carried by a machine steel shaft of liberal size, and through the use of ball bearings the length of the shaft has been reduced so that it has an exceptionally high resistance to the transverse strains. The armature cores are made of laminated sheet metal and each disk is japanned to reduce eddy currents to a minimum. Fiber disks at both ends protect the coils where they enter and leave the slots. Figs. 1 and 2 show the unobstructed air spaces which have been provided in the armature with no points where air pockets can be formed. The multi-blade fan shown at the right-hand end of the armature draws cool air through all of the interior parts. The armature coils are formed and taped before they are laid in the slots, and all of the coils are treated with an insulating varnish, and then baked.

The commutators are made of a large number of hard drawn copper bars of high conductivity which are assembled under pressure and locked by bolts. They are heat-treated and subjected to increasing pressure until the commutator becomes entirely solid. The mica insulation between the bars is of a grade which wears evenly with the copper; and this feature, together with the great rigidity of the commutator, prevents any possibility of the mica insulations working their way above the sections of the commutator. Box type brush holders are employed with radial brush feed; and they need not be reversed nor the connections disturbed when changing the direction of rotation. Flexible terminal leads are carried through the frame by insulating bushings, and the connection terminals are soldered onto the ends of the leads to receive the feed wires. When it is required to change the direction of rotation, it is merely necessary to rearrange the external leads, no adjustment of the internal connections or reversal of the brush holders being necessary.

W. P. DAVIS CUTTING-OFF MACHINE

For use in the manufacture of shrapnel shells, the W. P. Davis Machine Co., 305 St. Paul St., Rochester, N. Y., has redesigned the 4½ and 6 inch cutting-off machines of its manufacture to adapt them for the rapid cutting off of blanks from round stock, and for trimming the rough edges of forgings. The frame of the machine is cast in one piece, and the spindle bearing is a part of the main casting. This makes an exceptionally rigid construction. The supports for the cutting-off slide are large pads which are cast on the frame, providing ample support for the slide and preventing the tools from chattering. The end of the bed is open to facilitate the removal of chips and the bottom of the bed is inclined to drain all of the cutting compound.

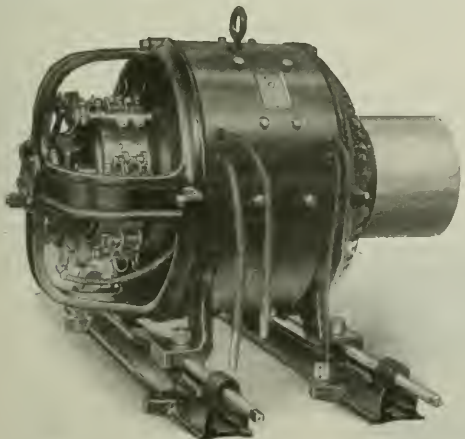


Fig. 3. The Eck Type D Direct-current Motor

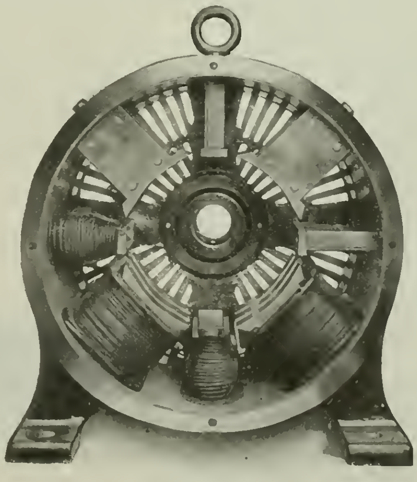
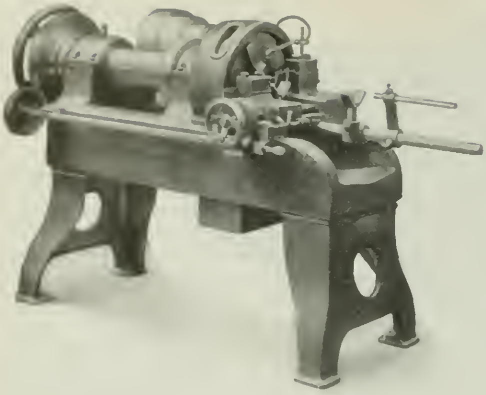
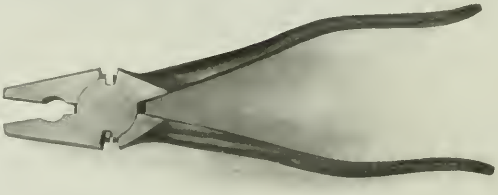


Fig. 4. Interior of the Frame



W. P. Davis Shrapnel Shell Cutting-off Machine

The spindle runs in bearings lined with anti-friction metal. There is a collar just behind the front bearing, through which four round-nosed bolts project. These bolts are intended to support the work when pieces are being cut which are too short to be gripped in the rear chuck. A heavy pattern three-jaw chuck is mounted at the front of the spindle, and there is a quick-acting scroll chuck at the rear which is operated by a handwheel. The cut-off slide is provided with two tools; and it has power feed and an automatic trip which acts when the tools reach the center of the work. A stock limit gage is mounted on this slide. No accelerating apparatus has been attached to the machine, as the four-step cone pulley and a double-friction countershaft provide sufficient additional speed as the cutters approach the center of the work, thus maintaining an efficient rate of cutting.



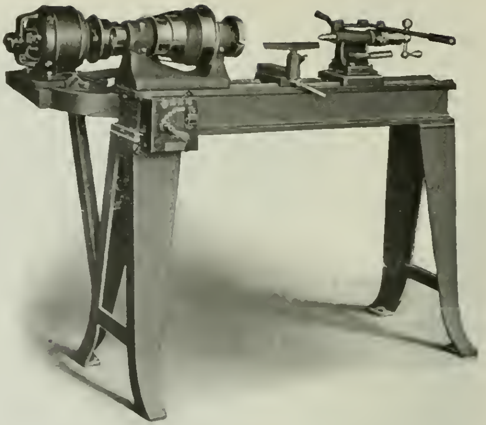
H. D. Smith Slot-cutting Pliers with the "Enchased Joint"

SMITH "ENCHASED JOINT" PLIERS

The feature of the slot-cutting pliers shown in the accompanying illustration is the provision of what is styled an "enchased joint." This joint provides a bearing around its entire circumference with the exception of the points where slots are provided to form the cutters. It is claimed that this joint is stronger than either the riveted lap-joint or the box-joint constructions which are commonly employed on this class of tools. With the enchased joint the pliers would operate satisfactorily without the central rivet, but the rivet is provided in order to give additional strength and durability. These pliers are made in 6-, 8-, and 10-inch sizes by the H. D. Smith & Co., Plantsville, Conn.; and it is planned to use the same form of joint on the side cutting pliers and diagonal cutting pliers of this company's manufacture.

BLOUNT MOTOR-DRIVEN LATHE

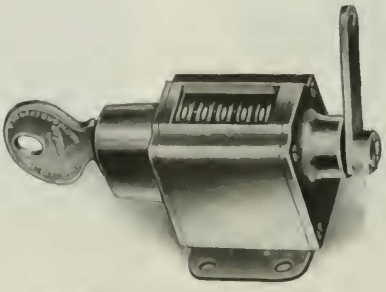
The motor-driven speed lathe which forms the subject of this article is one of the latest products of the J. G. Blount Co., Everett, Mass. A constant speed motor is employed, which is mounted on a plate provided with an extension arm to support a bearing for the outer end of the motor shaft. The motor plate is fitted to a slide on a shelf fastened to the back of the lathe bed; and the position of the motor plate and motor on this slide is regulated by means of a screw to enable the belt tension to be adjusted. It will be seen that the motor shaft and lathe spindle carry four-step cone pulleys which give the same variation as when a countershaft is employed; and by using different sized cones, a wide range of speeds may be obtained. The lathe spindle is made of high-carbon steel; it is accurately ground to size and runs in self-oiling bronze-bushed bearings. The tailstock has screw and lever feed. The bed is cross braced and all clamping levers are located above the ways.



J. G. Blount Motor-driven Speed Lathe

VEEDER SET-BACK COUNTER

The Veeder Mfg. Co., 39 Sargeant St., Hartford, Conn., is now making the zero re-set counter which is shown in the accompanying illustration. This instrument is particularly adapted for recording the production of all kinds of automatic machinery. It is a ratchet counter and indicates one for each oscillation of the lever, which moves through an angle of about 45 degrees. The counter is made with 3-, 4- or 5-figure wheels, and can be set back to zero by one turn of a knob, provided for the purpose. The instrument shown in the illustration is provided with a lock and key to prevent unauthorized persons from tampering with the re-setting device. The same form of instrument is made without the lock; and another instrument of similar design is made with a thumb lever with which it is operated by hand.

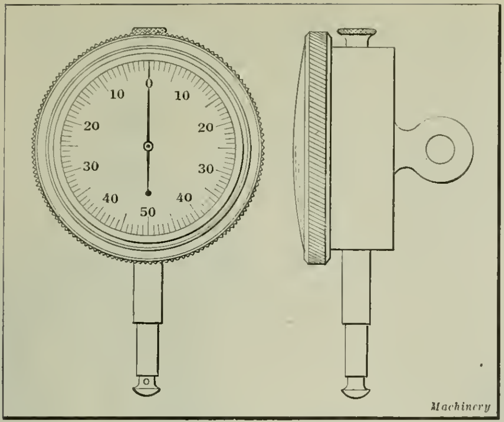


Veeder Set-back Counter with a Lock and Key

RANDALL DIAL GAGE

The design of the dial gage shown in the accompanying illustration has been worked out with the view of attaining the greatest possible simplicity of construction. Two advantages are obtained from this course. The gage has a small number of parts which means that there is less liability for it to get out of repair; and at the same time, it is possible to make gages of this form to meet the demand for relatively inexpensive instruments.

The diameter of the head of this indicator is $2\frac{1}{4}$ inches over-all, and the dial is $1\frac{5}{8}$ inch in diameter. It will be seen that the dial is divided into 100 spaces which are graduated from zero to 50 in both directions; but when so desired, dials can be



Front and Side Views of the Randall Dial Gage

furnished with graduations reading from zero to 100. Each division represents 0.001 inch, but the indicator can also be furnished with metric graduations. The dial is "friction tight" in the case so that it may be revolved to bring the zero into coincidence with the needle in any position that happens to bring the indicator point into contact with the work.

The spindle has a travel of 0.5 inch and may be fitted with either a button or point as desired. The back of the head is fitted with a lug through which there is a ¼-inch hole for use in attaching the head to special fixtures; it can also be mounted by the stem. With either of these methods of attachment, a mount can easily be devised so that almost any kind or size of work can be quickly and accurately measured. This instrument is applicable for a great variety of work and will be found particularly useful as an attachment to the surface gage, and as an indicator. It is manufactured by Frank E. Randall, 248 Ash St., Waltham, Mass.

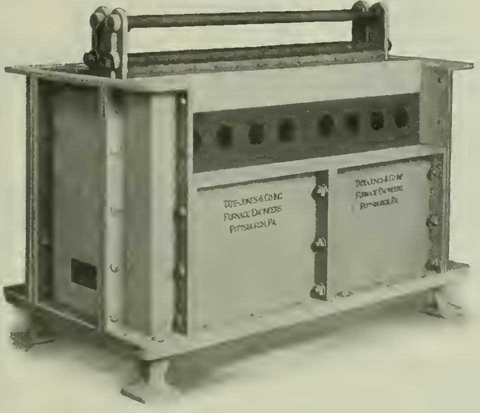


Fig. 1. Tate-Jones Furnace for Use in "Nosing" Shrapnel Shells

TATE-JONES SHRAPNEL "NOSING" FURNACE

The accompanying illustrations show a furnace which may be heated by either gas or oil burners, made by Tate-Jones & Co., Inc., Pittsburgh, Pa. It is used for heating shrapnel shells preparatory to the performance of the "nosing" operation, and has a heating chamber 50 inches in length, and provides for heating 3½-inch blanks for a length of 6 inches. It will be seen that there are eight openings to receive the shells, and these openings are arranged in a water jacket so that the work is not heated farther back than necessary. Three burners are used in order to distribute the heat evenly and also to enable the heating to be done quite rapidly. The furnaces can be built in different lengths, depending upon the number of shells which it is desired to handle at a time; and it will be evident from the cross-sectional view shown in Fig. 2, that provision is made for adjusting the position of the water jacket in order to regulate the length of shell which is exposed to the heat.

It will also be noticed from the cross-sectional view that the vents are located directly above the shells so that the heat leaves the furnace at the top, thus avoiding discomfort which would otherwise be experienced by the workmen in removing the heated shells and replacing fresh blanks in the holes in the water jacket. The furnaces can be built in different sizes to accommodate different numbers of shells, and also for shells of different sizes. A heavy lining is provided to withstand the high temperature of the furnace; and corundite brick is used opposite the burners, as this material is found to outwear the average firebrick when exposed to very high temperatures. The front and back walls of the furnace are lined with Armstrong "nonpareil" insulating brick between the firebrick and the cast-iron frame of the furnace, as this material is found to be particularly efficient in reducing radiation losses to a minimum.

DALTON 6-INCH LATHE

The Dalton Machine Co., Inc., 1901-1915 Park Ave., New York City, is now building a 6-inch lathe which has the countershaft carried on an upright secured to the lathe bed, making the machine self-contained. Reference to Fig. 1 will show that this countershaft is provided with two driving pulleys, one of which carries an open and the other a crossed belt. These pulleys run loose on the countershaft and either pulley may be engaged with the shaft by means of a friction clutch, thus providing forward or reverse rotation of the lathe spindle. The clutches are controlled by means of the handle shown at the right-hand end of the countershaft, and the design is arranged in such a way that the handle may be located in the position shown, or it may be placed at the left-hand end of the countershaft.

The design of the friction clutches used on this machine is somewhat unusual and is shown in detail in Fig. 2. It will be seen that this is the ring type of friction clutch, but the design has been worked out so that the entire clutch member *A* is made in a single piece. A tapered collar on the clutch operating rod engages the lever *B* of Fig. 2, causing this lever to swing on its pivot and expand the clutch ring to engage the friction surface on the inside of the pulley. When the clutch-rod is moved back so that the tapered collar releases lever *B*, the clutch ring springs away from the pulley to

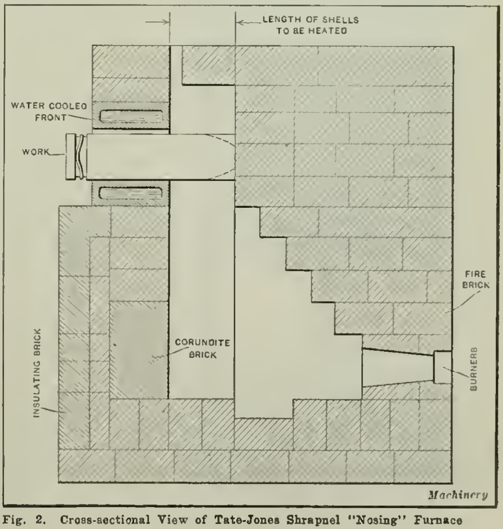


Fig. 2. Cross-sectional View of Tate-Jones Shrapnel "Nosing" Furnace

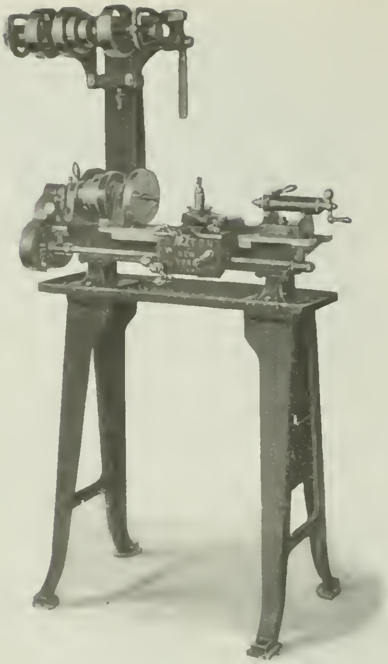


Fig. 1. The Dalton 6-inch Lathe with a Self-contained Countershaft

release the drive. The two clutches are controlled by a pair of tapered collars, so arranged on the clutch-rod that when one clutch is released, the other is engaged by continuing the movement of the clutch lever. In this way the reversal of the lathe is accomplished with a minimum loss of time. The two clutches cannot both be engaged at the same time, and there is a neutral position in which neither of the clutches is engaged.

The bracket which carries the countershaft is secured to the upright by means of four bolts, which fit in elongated holes. To adjust the belt tension, these bolts are loosened and the countershaft bracket is then raised or lowered by means of a bolt which is carried by the upright and bears against the bottom of the countershaft bracket. When the desired belt tension has been obtained, the four bolts are retightened to secure the bracket to the upright. This provides an accurate method of adjusting the belt tension, which is of considerable importance owing to the short center distance between the cone pulleys on the countershaft and lathe spindle. The bolt which provides for adjusting the belt tension, and the two lower bolts which secure the countershaft bracket to the upright are shown in Fig. 1. The countershaft bearings are ring oiled, and provided with oil reservoirs of ample capacity, so that adequate lubrication is assured at all times.

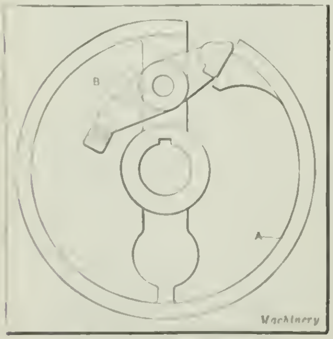
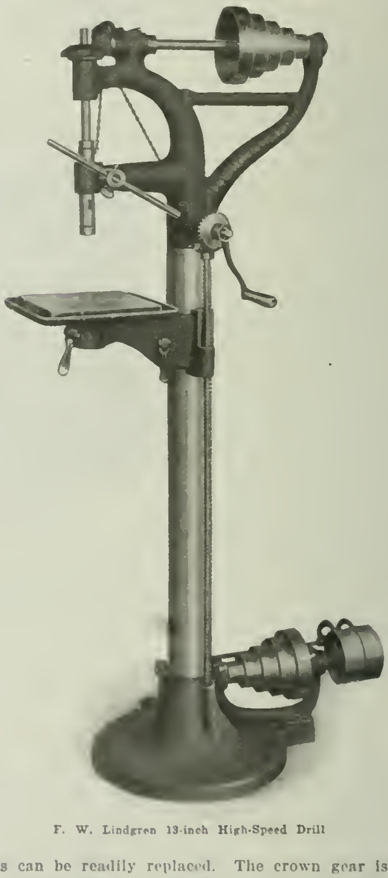


Fig. 2. Design of the Countershaft Friction Clutch

The lathe is single back geared in the ratio of 7 to 1; and power is transmitted from the spindle to the lead-screw through the usual arrangement of change gears. The lead-screw has twelve threads per inch, and change gears are provided for cutting thirty-four threads, ranging from 3 to 140 per inch, including the 11½ pipe thread. A hinged guard is provided that may be swung back to give access to the gearing when it is necessary to make adjustments of the change gears; and a brass plate at the front of this guard shows the different threads which may be obtained, and the change gears which are required to cut these threads. The principal dimensions of the machine are as follows: Maximum traverse of tailstock spindle, 3 inches; swing, 6¼ inches; maximum distance between centers, 11 inches; weight of machine, 275 pounds.

LINDGREN HIGH-SPEED DRILL

The F. W. Lindgren Co., Rockford, Ill., has recently placed a 13-inch high-speed drill upon the market which is suitable for all kinds of light drilling, and is particularly adapted for tool and die work. To provide for operation at high speed, all of the bearings are bronze bushed and equipped with ring oilers, which provide constant lubrication. When worn, the bushings can be readily replaced. The crown gear is fitted with a thrust bearing at the end of the hub, and a fiber washer prevents the escape of oil. The spindle is equipped with ball thrust bearings and the sleeve is graduated in inches. The capacity of the machine is for drills up to ⅝ inch.

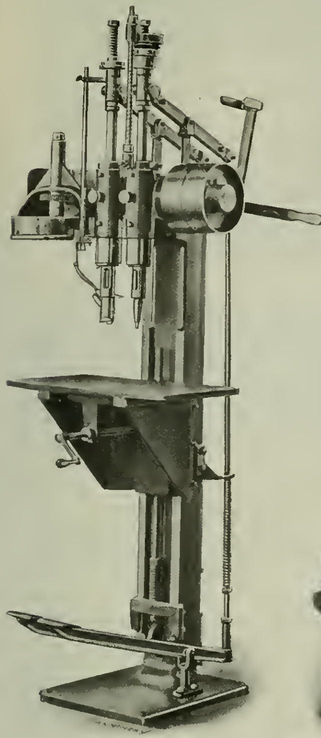


F. W. Lindgren 13-inch High-Speed Drill

The principal dimensions of this new Lindgren drill are as follows: Height, 63 inches; maximum distance from spindle to base, 47 inches; maximum distance from spindle to table, 34½ inches; diameter of column, 3½ inches; size of table, 9 by 11 inches; hole in spindle, No. 1 Morse taper; width of belt on cone pulleys, 1¾ inch; width of belt on tight and loose pulleys, 1½ inch; floor space occupied, 17½ by 26½ inches; and net weight of machine, 170 pounds.

REYNOLDS SCREW DRIVING MACHINE

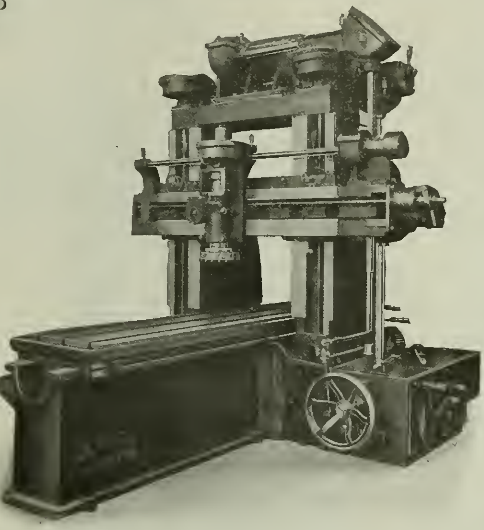
It is the practice in some lines of manufacturing, and especially in sewing machine work, to fasten parts together with temporary screws while certain machining and fitting operations are being performed, and then to remove these screws and insert new ones when the parts are finally assembled. To provide for the operations of removing one set of screws and inserting the other set, the Reynolds Pattern & Machine Co., Moline, Ill., has developed the machine which is illustrated and described herewith. It is similar to the standard screw driving machine which this company has been manufacturing for a number of years, so far as the screw-driving mechanism is concerned, but the present machine is provided with an auxiliary spindle which is driven left-hand. This auxiliary spindle is operated by an independent foot treadle and carries a screw-removing bit. The screw-removing bit is normally at rest, but when it is brought down by means of the foot treadle it starts to revolve and backs out the screw at high speed. The work is then moved slightly to the left and the new screw is inserted by the bit carried by the regular screw-driving spindle of the machine. The new screws are fed to the work from a magazine on the machine, which operates in the same manner as that of the standard Reynolds screw-driving machine.


Reynolds Screw Driving and Screw Removing Machine

NEWTON VERTICAL SLABBING MACHINE

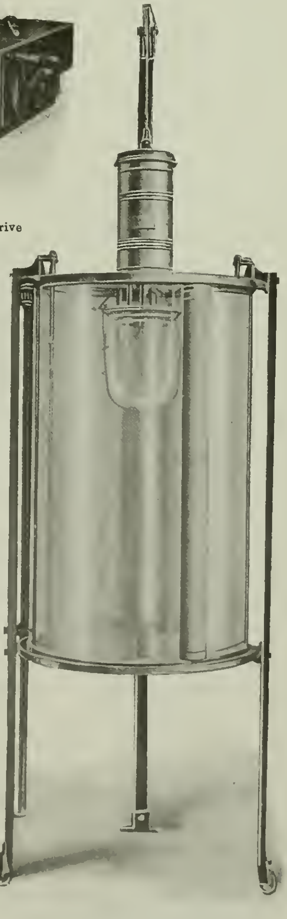
The accompanying illustration shows a vertical slabbing machine designed with single pulley drive, which is a recent addition to the line of the Newton Machine Tool Works, Inc., Twenty-third and Vine Sts., Philadelphia, Pa. In this machine, nine changes of speed are obtained through a gear box, which provides a range of from 16½ to 99 revolutions per minute. Twelve changes of reversible cross-feed on the rail are provided, in addition to reversible fast power traverse. The table has twelve changes of feed, ranging from 0.355 inch to 13 inches per minute, these changes of speed being independent of the spindle speeds. In addition, rapid power traverse at the rate of 30 feet per minute is provided in both directions. All speeds and feeds are obtained through gear boxes, which entirely enclose the gearing and are oil-tight, so that the gears may be kept flooded with lubricant. The machine will take work 34 inches wide by 36 inches high.

The vertical spindle is driven by a bronze worm-wheel and hardened steel worm, which is fitted with roller thrust bearings which run in oil. The spindle is 3⅛ inches in diameter, and has a No. 6 Morse taper hole in the end with a broad faced key for driving cutters. The spline shaft bushings carry auxiliary bushings which rotate with the shaft to prevent the escape of oil and preserve the fixed bushing from undue wear through contact with the spline or key-seats. The spindle sleeve is adjustable by means of a hand-controlled rack and pinion. This machine can be built with either two, three, or four spindles in addition to the single spindle type of machine which is illustrated herewith.


Newton Vertical Slabbing Machine with Single Pulley Drive

SHAW BLUE PRINT MACHINE

The accompanying illustration shows a continuous blue-print machine which has been placed upon the market by the Shaw Blue Print Machine Co., 9-13 Campbell St., Newark, N. J. This machine is known as the Model B, and has a capacity for making prints up to 30 by 36 inches in size. The machine is entirely self-contained and automatic in operation. It is suitable for use in making blue, black, Van Dyke and direct process prints; and prints of any length may be made in one piece. These machines are equipped to operate on any electric current which is available in the drafting-room where they are to be used. It will be evident to the reader that this machine is of the vertical cylindrical type. The way in which the arc light is supported and the general features of the design will be readily apparent from the illustration.


Shaw Continuous Blue Printing Machine

ALLEN-BRADLEY STARTING SWITCHES

It is frequently desirable to start small alternating-current motors from a distance by means of a push button or some other contact-making device; and to meet the demands of such service the Allen-Bradley Co., Milwaukee, Wis., has developed a line of automatic starting switches for single and polyphase squirrel cage induction motors, which can be thrown directly across the line. These automatic starting switches are intended for the remote control of motors driving fans, ventilators, pumps, drill presses, lathes or other kinds of machine tools. In designing these self-starters great care has been taken to have them as noiseless in operation as is possible. The plain automatic starting switch, illustrated in Fig. 1, consists of a two-pole, magnetically operated, clapper-switch mounted on a slate panel. The clappers are held in the closed position by the magnetic pull of the electromagnet, the terminals of which are connected to the line.

This electro-magnet is designed for continuous service and exerts a sufficient pull to insure a good contact of the clappers. Since the circuit to the motor is opened immediately the electromagnet is deenergized, this starter affords full no-voltage protection. Ample overload carrying-capacity is provided; and all switches, with the exception of the very smallest, are provided with a magnetic blowout. The contacts of the clappers are made of hard drawn copper. They are so shaped and pivoted on a shaft, that in closing the switch, a long roll contact is effected. The magnetic circuit is built up of sheet steel laminations and is provided with a shading coil which makes the starter practically noiseless. Careful attention has also been paid to the power consumption of the switch in its closed position, with the result that it has been reduced to a minimum and is too small to be worthy of consideration. The switch is extremely quick and snappy in closing and opening the circuit, which makes its arc disrupting-capacity very great, and, furthermore, materially reduces the expense of replacing contacts. All parts of the apparatus are readily accessible and the contacts can be easily cleaned.

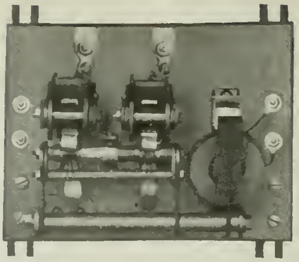


Fig. 1. Allen-Bradley Plain Automatic Starting Switch

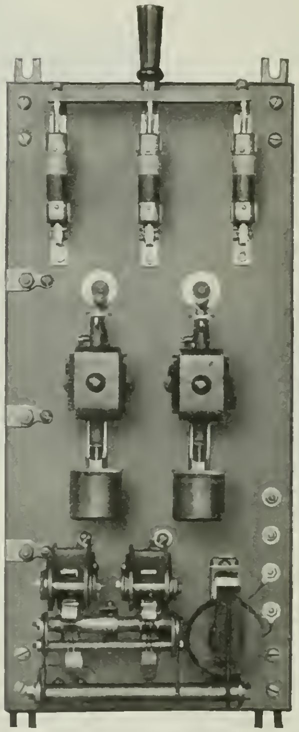


Fig. 2. Starting Switch with Line Knife Switch, Fuses and Two Time-Limit Overload Relays

The type-E automatic starting switch for small alternating-current motors is built in several forms. Fig. 2 illustrates the most complete type. This automatic starter is provided with two adjustable time-limit overload relays, line knife switch and fuses, which equipment absolutely protects the motor against burnouts. Another form of this starter consists of a combination of the automatic switch itself with the line switch and fuses, while in still another form the two time limit overload relays are substituted for the switch panel. All of these forms are very compact, and because of their variety, make it possible to equip the motor with the starter that is best suited to the existing operating conditions. Some kind of a contact-making device such as a push button, snap switch, gage type pressure regulator, float switch or similar apparatus is necessary for the operation of this starter. When the line contacts are closed, which in the case of the push button is done by pressing the starting button, the coil of the clapper switch, which acts as an electromagnet, is energized and its magnetic pull immediately closes the clappers of the starter. These clappers connect the motor directly to the line.

Although these automatic starters can be used in connection with either a two- or three-wire push button system, it is to be recommended that the three-wire system be given the preference because it permits the multiple station control of a motor, while its protective features are also greater. Of course, where float switches, pressure regulators or thermostats control the operation of the starter, only the two-wire system can be used. Although the remote control of small alternating current motors used on machine tools has never been given the same attention as has been devoted to this branch of direct-current electricity, experiments and practical applications have conclusively proven that the same economies are effected, and the productive capacity of the equipment increased.

UNITED STATES BENCH DRILL

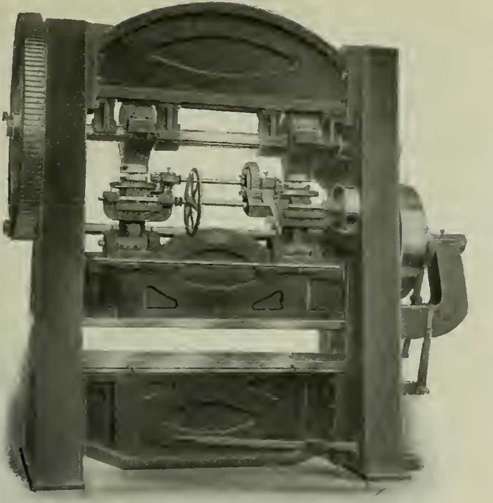
One of the recent products of the United States Electrical Tool Co., Sixth Ave. and Mount Hope St., Cincinnati, Ohio, is an electric bench drill which is driven by a motor provided with a cord for making connection with an ordinary lamp socket. Motors are provided to take power from 110 or 220 volt circuits of either alterating or direct current. When so desired, the drill can be taken out of the frame and used as a portable tool. The capacity is for driving drills up to ¼ inch in diameter.

There are many shops in which a convertible tool of this nature can be used to advantage. When mounted in the stand, as shown in the accompanying illustration, it is suitable for various classes of light drilling; but in those shops where there is not enough work of this character to keep the tool busy, the drill can be removed from the stand, have the handle attached to it and be used for any of the numerous purposes for which a portable electric drill is adapted. The handle, which is not shown in the illustration, forms part of the regular equipment of the tool.

United States Bench Drill

BERTSCH BENDING BRAKE

The accompanying illustration shows a bending brake which is a recent product of Bertsch & Co., Cambridge City, Ind. This machine has a capacity for bending plates up to ¼ inch in thickness, and is built in different sizes with from 6 to 12 feet between the housings. The pressure capacity of the different sized machines is up to 100 tons. The drive is through a friction clutch that is so controlled that the slide head can be instantly stopped at any point in the stroke; and the head is adjusted by either hand or power. This machine was particularly designed for use in the manufacture of fire-proof doors, windows, par-



Bertsch Bending Brake with a Capacity for Plates up to ¼ inch Thick

titions, and trimming; and it is also well suited for use in the manufacture of general classes of sheet metal products such as metal furniture, lockers, shelving, etc. The machine can also be equipped for gang punching operations.

* * *

NEW MACHINERY AND TOOLS NOTES

Ratchet Wrench: Chicago Mfg. & Distributing Co., Chicago, Ill. A combination wrench and drill capable of holding round or square taper-shank tools from 1/4 to 9/32 inch in diameter. The wrench is intended for use in connection with a drill post.

Straightening Machine: Abramsen Engineering Co., Pittsburg, Pa. A machine for straightening rods, bars and pipe which will straighten the work by a single pass through the machine. These machines are built in sizes to handle material from ⅜ to 6 inches in diameter.

Combination Tool-holder: Duckett Tool & Mfg. Co., Detroit, Mich. The important feature of this tool-holder is that the socket in which the cutter is carried may be swiveled to any required angle in relation to the shank of the tool-holder, and held in this position by tightening the binding screw.

Baling Press: Tempus Reclaiming & Mfg. Co., Philadelphia, Pa. A machine for compressing scrap metal into bundles, which can be conveniently packed for remelting. This is a stationary machine and compresses the scrap into cylindrical bundles 18 inches in diameter by 26 inches long.

Radial Drill: Almond Mfg. Co., Cleveland, Ohio. This is the same machine which was illustrated and described in the June, 1914, number of MACHINERY, except that it is provided with a base upon which the radial arm is mounted instead of having the arm secured to a post or to the wall of the building.

Grinding and Polishing Machine: C. L. Hawes, Ashtabula, Ohio. This machine is adapted for all classes of grinding and polishing where speeds from 1800 to 3600 R. P. M. can be used. It carries wheels from 6 to 14 inches in diameter; and guards are provided over all danger points—hence the name, "safety first" grinder.

Driving Wheel Lathe: Niles Tool Works Co., Hamilton, Ohio. This lathe swings up to 100 inches, and the design follows the general lines of the standard 90-inch tool of this company's manufacture. The range is for wheels from 32.7 to 94½ inches in diameter on the tread, with a maximum distance between centers of 11 feet 2¼ inches.

Reverse Gear: Carlyle Johnson Machine Co., Manchester, Conn. This gear is applicable for use on all types of machinery where reversal of the spindle is required, as in the case of the tapping machine. The design is such that the reverse gear can be applied to the driving mechanism of machines to provide for reversal of the spindle.

Riveting Machine: Barnes & Kobert Mfg. Co., Milldale, Conn. An electrical riveting and forging machine which is provided with an electrically heated die which brings the head of the rivet to a forging temperature, and the punch which performs the riveting operation. Working under practical conditions, only five seconds is required to bring a ⅝ inch rivet to the forging temperature.

Motor-driven Screw-driver: United States Electrical Tool Co., Sixth Ave. and Mt. Hope St., Cincinnati, Ohio. This tool has been developed to save time in driving wood or lag screws or screwing nuts onto bolts. The tool is driven by a universal motor which may be operated on either direct or alternating current, and a friction clutch with a spring release controls the starting and stopping of the bit.

Multiple-spindle Boring Machine: Reynolds Pattern & Machine Co., Moline, Ill. A multiple-spindle machine adapted for wood boring and light metal drilling. The spindles are adjustable so that they can reach any point between the housings of the machine. The drill spindles are carried by brackets which can be swiveled through a complete revolution, so that the drills reach over an area of considerable width.

Gear Shaping Machine: Fellows Gear Shaper Co., 25 Pearl St., Springfield, Vt. With the exception of the work spindle construction used on this machine, the design is similar to that of the other standard gear shapers of this company's manufacture. The machine is designed primarily for cutting the teeth of shaper bull-gears and lathe back-gears. The spindle is hollow, and made large enough to accommodate the large gear while the pinion is being cut.

Portable Electric Tools: Van Dorn Electric Tool Co., Cleveland, Ohio. This company has recently brought out a combination drilling and grinding machine, and a high-speed universal electric drilling machine. The first machine referred to may be used as a portable tool or it may be mounted on a bench stand. The high-speed universal drill is intended for the regular classes of work for which a portable tool of this character is ordinarily employed.

Cartridge Case Finishing Machine: Bullard Machine Tool Co., Bridgeport, Conn. It is claimed that this is the only machine upon the market which is designed in such a way that the mouth-boring operation is included. The essential features of this machine are those of a four-faced turret and cross-slide machine, on which are mounted the tools required for machining the head or flange-end of the case, with the addition of means for the mouth-boring and trimming operations.

Combination Internal and External Grinder: Hisey-Wolf Machine Co., Cincinnati, Ohio. This little machine is adapted for a wide range of work. The motor has a double set of oil cups to insure adequate lubrication at all times. A quick-acting switch fastened to the connecting cable is located at a distance of about 6 inches from the motor where it is convenient for the operator. The general features of design of this machine are similar to the regular line of portable tools of this company's manufacture.

Welding and Cutting Torch: Turner Brass Works, Sycamore, Ill. The feature of this torch is that all the valves are grouped in such a way that the torch can be operated with one hand, either valve being reached by a slight movement of the thumb or forefinger. The valves which control the oxygen jet when cutting is being done can be adjusted to a fixed position, thus avoiding the necessity of holding the valve down when long cutting operations are being done. The mixing chamber is located in the handle instead of in the head of the torch.

Cold Saw: Espen-Lucas Machine Works, Philadelphia, Pa. A cutting-off machine particularly designed for cutting off shrapnel-shell blanks from steel bars. Speed and feed variations are provided that can be used for cutting at from ½ inch to 5 inches per minute. Any amount of feed may be used as the cutting capacity of the machine is only limited by the nature of the material that is being sawed. The changes of feed are obtained through a friction plate and any change may be obtained while the machine is in operation. The saw carriage is also provided with a quick return mechanism, and an automatic stop for controlling the cut.

* * *

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC.

of MACHINERY, published monthly on the 1st, at New York City, required by the Act of August 24, 1912.

Editor, Fred E. Rogers	140-148 Lafayette St., New York
Managing Editor, None	
Business Managers Alexander Luchars, President	" " " " "
M. J. O'Neill, General Manager	" " " " "
Publisher, The Industrial Press	" " " " "
Owners of one per cent or more of the stock:—	
The Industrial Press	" " " " "
Alexander Luchars	" " " " "
Matthew J. O'Neill	" " " " "
Fred E. Rogers	" " " " "
Louis Pelletier	" " " " "
H. L. Brown	" " " " "
Erik Oberg	" " " " "

There are no bondholders, mortgagees, or other security holders.

MATTHEW J. O'NEILL, General Manager.

Sworn to and subscribed before me this 18th day of March, 1915

HARRY B. HEALEY,
Notary Public No. 84, Kings County,
Certificate filed in New York County No. 74.
(SEAL) (My commission expires March 30, 1916.)

CONVENTION OF THE N. M. T. B. A.

The thirteenth semi-annual convention of the National Machine Tool Builders' Association was held at Atlantic City, N. J., May 20 and 21 in the Marlborough-Blenheim Hotel. President W. A. Viall of the Brown & Sharpe Mfg. Co. occupied the chair, and Charles E. Hildreth, general manager of the association, assisted in conducting the sessions. Although the attendance was below normal, those who attended were in an optimistic frame of mind, quite different from that prevailing among the members of the association a year ago. The manufacturers of lathes, turret lathes, automatics, milling machines, and other machines used in the manufacture of war munitions are very busy, many of them having orders booked months ahead. The demand for machine tools for this purpose is so heavy that there is some prospect that reviving railway business will be hampered by the inability to get machine tools required for locomotive repair work.

The usual roll-call following registration of members was omitted, as was also the reading of the minutes. After hearing the reports of committees and following other routine business, President Viall spoke of the safety and sanitation work being accomplished by the members of the association, and especially of the apprenticeship instruction work. The National Machine Tool Builders' Association has been one of the foremost in promoting apprenticeship instruction. Its apprenticeship indenture papers have served as a model for other associations. A movement is on foot to harmonize and extend the work in apprenticeship instruction among the association, and Magnus W. Alexander, of the General Electric Co., has proposed a conference board on the training of apprentices. This board will be composed of members appointed from the National Machine Tool Builders' Association, the National Association of Manufacturers, the National Metal Trades Association, the National Founders Association, and the United Typothetæ of America.

C. O. Smith, of the Norton Grinding Co., in the absence of S. H. Bullard, chairman of the committee, read the report on the proposed association card index. The catalogue idea has been abandoned, and instead it is proposed to issue an association card index which will consist of two parts. First is a subject index in which will be listed every machine tool made in America; all manufacturers of machine tools will be included regardless of association membership. The second part of the card index will consist of a manufacturers' index, and will be confined to the members of the National Machine Tool Builders' Association. These cards give the principal data of each machine, including weight, capacity, and dimensions.

Robert T. Kent, editor of *Industrial Engineering* and an efficiency engineer associated with Taylor, Gantt and others, delivered an address, "The Application and Use of Time Study Data." Mr. Kent described the system of time study applied to a certain lathe job, showing how the process of lifting a given casting into the lathe, chucking, setting the tools, turning and boring could be divided into simple elements, and the time required for each could be ascertained; then these data could be applied to other operations. Thus, with these time elements, the analysis of other jobs comprising similar operations, could be easily made, and the time required accurately fixed. With the facts obtained from time study, the fixing of rates is a comparatively simple and easy matter. Very little is left to guess-work on the part of those who have to fix the rates.

Harold C. White, superintendent of assembling of the Pierce-Arrow Motor Car Co., Buffalo, N. Y., read a paper, "How to Profitably Operate a Night Force." Mr. White reviewed the well-known difficulties of organizing an efficient night force. The purpose of his paper was to show how these difficulties might be overcome, and good work and the same quantity of it produced by a night force as by the day force. He pointed out that the problem could be divided into three principal parts: first, time; second, labor; third, facilities. Time is fixed, there being but twenty-four hours a day, but it is possible to utilize all this time. The difficulty with labor is to secure the trained help that will work nights and produce work that will pass inspection. Labor employed at night is at a disadvantage because of the difficulty in getting meals, and of sleeping through the day. It is necessary to pay higher rates for night work, and desirable to provide hot coffee and other light refreshments. The tools require to be kept up to a high standard; it will not do to let them run down. Machines and tools are being used twice as much, and hence their wear and tear is twice as great. Mr. White pointed out that this is one reason why night work is generally regarded as productive of poor work. The upkeep is not properly attended to and machines and tools get into bad shape before the cause of the trouble is detected.

On Thursday afternoon the business of the convention was done in committee meetings, these consisting of meetings of the lathe, sensitive drilling machine, boring machine, gear cutting machine, grinding machine, hand screw machine, and planing machine committees. The forenoon of Friday was also given up to committee meetings, the following committees then holding their sessions: multi-spindle drilling machine, milling machine, shaping machine, vertical drilling machine, turret lathe and radal drilling machine committees.

On Friday afternoon a paper, "Drop Forgings," by A. M. Tilton, president of the Drop Forging Co. of New York, Jersey City, N. J., was read, following which was an address on "Neutrality" by George Grafton Wilson, professor of international law, Harvard University.

* * *

SHOOP METAL SPRAYING PROCESS

The monthly meeting of the American Society of Mechanical Engineers was held at the Engineering Societies Bldg., New York City, Tuesday evening, May 11. John Calder, mechanical engineer with the Metals Coating Co. of America, read a paper: "Metal Spraying Processes in Engineering and Art" illustrated with lantern slides. A practical demonstration of the Schoop metal-coating "pistol" was given in the basement of the building, which showed that it is commercially feasible to spray objects made of metal, wood, stone, cloth, paper, etc., with brass, aluminum, copper, and lead.

Mr. Calder pointed out the great need of effective means of protecting bridges, viaducts, elevated railways and other steel structures from rust and corrosion. These structures are now protected only at great expense by painting, and painting must be frequently done to be effective. The Schoop process may be used either in the shop or in the field to deposit coatings of zinc or other metals on the parts, forming an effective rust-protecting coating. He described the inception of the process. M. Schoop, the inventor, was first led to investigate the possibilities of coating objects with pulverized metal by noting the effect of rifle bullets fired against stone walls. He concluded that an apparatus might be devised for projecting lead and other metals against walls and metal structures. The first apparatus weighed over a ton and was commercially unsatisfactory. This apparatus comprised a melting pot, the metal being in a molten condition when projected by an air-blast. The inventor concluded from his experiments that it was not necessary that the metal be molten, but that it should be in a finely divided state. His next apparatus consisted of a means for projecting finely divided metal dust. This apparatus worked but it, also, was commercially unsatisfactory. The third and successful apparatus is the Schoop pistol, weighing only about 3½ pounds. It is essentially a Bunsen flame apparatus for melting the metal and blowing it out in a finely divided state against the object to be covered. The metals used are supplied to the pistol in the form of wire, and the pistol comprises a mechanism for feeding the wire to the nozzle through which it is projected and where it comes in contact with the flame. The metal is instantly melted and then blown into fine globules against the object. The globules are given a velocity of about 3000 feet per second, and they imbed themselves into the rough surface of the oject and particles subsequently deposited interlock with those already sprayed, so that a continuous and impervious coating is formed. The coating effectually prevents the entrance of oxygen and corrosive elements in the atmosphere.

TURBO SPEED TRANSFORMER

The speed transformer which forms the subject of this article is manufactured by the Turbo-Gear Co., Industrial Bldg., Baltimore, Md., and may be used for either reducing or increasing the speed of rotation. It is called a "turbogear," the term being derived from the fact that this transmission is frequently used to give the required speed reduction between a steam turbine and the machine driven by it. To operate economically, a steam turbine must run at high speed and the turbo-gear is well adapted for the purpose of reducing the speed, so that it is suitable for the driven member of the unit. The same problem arises in cases of electric motor drive, and in such installations, the turbo-gear is said to be giving satisfactory service. It has already been mentioned that this speed transformer can be used for either decreasing or increasing the speed of rotation, and two instances have been cited where the gear is used as a means of reduction. As an example of the use of this transformer for increasing the speed, take the case of certain steam, gas or oil engine installations which are employed to drive such high-speed machines as centrifugal pumps, blowers, etc.

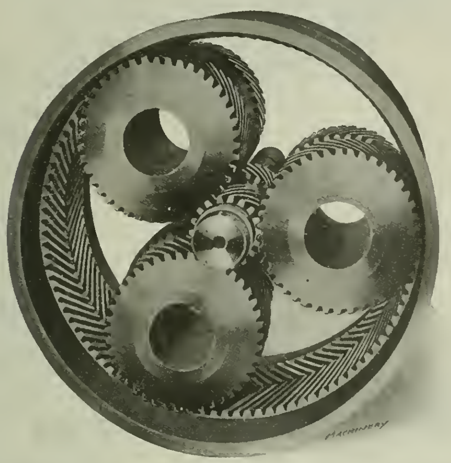


Fig. 1. Gearing of the Speed Transformer made by the Turbo-Gear Co.

The teeth of the helical gearing of this speed transformer are of the involute stub-tooth type. The large double internal helical gear is cut from an open-hearth steel forging. The double helical pinion is integral with the high-speed shaft, this pinion and shaft being made of chrome vanadium steel which has an elastic limit of 210,000 pounds per square inch. The intermediate double helical gears are made of Lumen manganese bronze, and are mounted on hardened and ground forged steel shafts which are secured to the slow speed member by means of a taper fit and Woodruff keys. The slow speed member has the slow speed shaft secured to it, and is mounted on two heavy-duty S. K. F. ball bearings. Thus the slow speed member and the shafts carrying the intermediate gears, and the high-speed shaft and pinion, are independent of each other as far as support is concerned, each being held directly by the housing.

Both the high-speed shaft and pinion, and the slow speed member which carries the intermediate gears, are accurately ground all over and carefully balanced before the speed transformer is assembled. The housing is made of gray cast iron and is split horizontally to afford access to all internal parts. The housing is heavily constructed and ribbed to provide a rigid support for all of the gear members. The high-speed shaft has a central passage through which oil is pumped, and a continuous stream of oil is sprayed onto the gears through radial passages in the pinion. In addition to forced feed lubrication, the high-speed bearings are provided with oil-rings and reservoirs of liberal capacity for emergency use. The superfluous oil from the high-speed bearings is collected by a centrifugal oil-ring and forced through the hollow shafts which carry the intermediate gears. After lubricating the bearings and gears, the oil is drained to the main reservoir in the base of the housing, where it is strained, cooled and returned to the pump, ready for subsequent use. From this description, it will be evident that the gears do not run in oil so that the loss of efficiency is avoided, due to back pressure resulting from this cause. It is claimed that the turbo-gear has a transmission efficiency of 95 per cent.

* * *

SPRING MEETING OF THE A. S. M. E.

The spring meeting of the American Society of Mechanical Engineers will be held in Buffalo, N. Y., June 22 to 25, inclusive. The headquarters during the meeting will be at the Hotel Statler, where most of the sessions and entertainments will be held. One day will be spent at Niagara Falls, the morning session being in the large auditorium of the Shredded Wheat Biscuit Co. The afternoon will be devoted to an inspection of some of the Niagara Falls plants, including the famous Niagara power plants. Many other large plants in Buffalo and vicinity will be open for inspection, including among others, the Buffalo Foundry & Machine Co., Lackawanna Steel Co., Wickwire Steel Co., Snow Steam Pump Works, Pierce-Arrow Motor Car Co., Buffalo Forge Co., Simonds Mfg. Co., etc.

The entertainment of the visiting members will, as usual, be in the hands of a local committee, of which David Bell is chairman. The Engineering Society of Buffalo will cooperate with the Buffalo Society of the A. S. M. E. in extending a welcome to visiting members and showing them features of special engineering interest. The papers to be presented include the following:

"Laps and Lapping," by W. A. Knight and A. A. Case.

"Model Experiments and the Forms of Empirical Equations," by E. Buckingham.

"Rational Design and Analysis of Heat Transfer Apparatus," by E. E. Wilson.

"Influence of Disk Friction on Turbine Pump Design," by F. zur Nedden.

"A Study of an Axle Shaft for a Motor Truck," by John Younger.

"Corrugated Furnaces for Vertical Fire Tube Boilers," by F. W. Dean.

"The Effect of Relative Humidity on an Oak Tanned Leather Belt," by William W. Bird and Francis W. Roys.

"The Relation Between Production and Costs," by H. L. Gantt.

"Design of Rectangular Concrete Beams," by Howard Harding.

"Some Mechanical Features of the Hydration of Portland Cement and the Making of Concrete as Revealed by Microscopic Study," by Nathan C. Johnson.

"Surface Condensers," by Carl F. Braun.

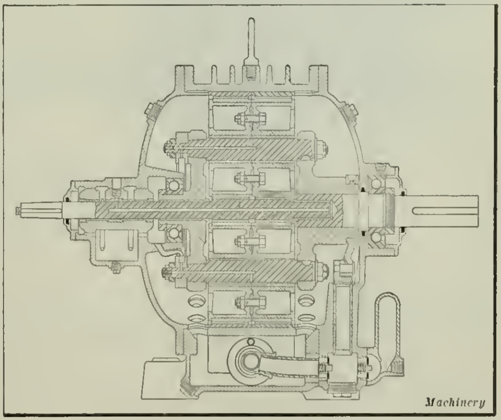
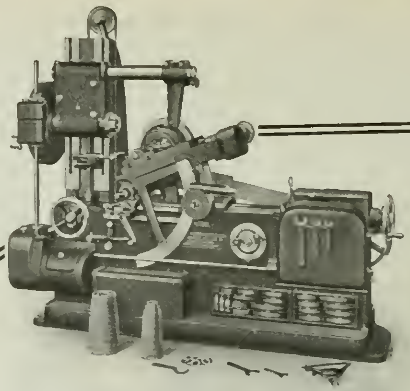
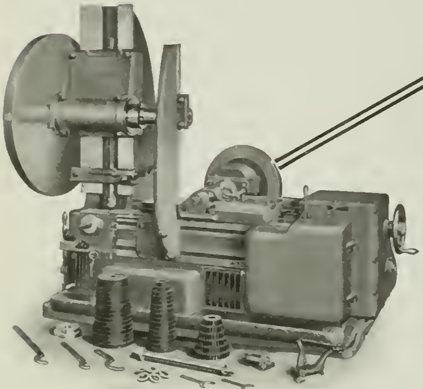


Fig. 2. Cross-sectional View of the Turbo-Gear Co.'s Speed Transformer

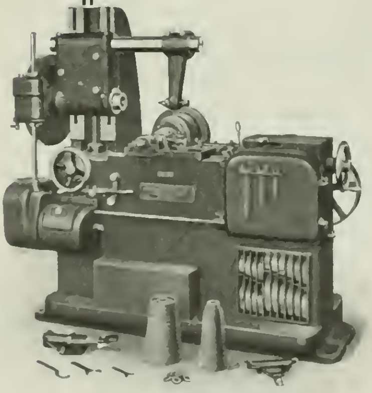


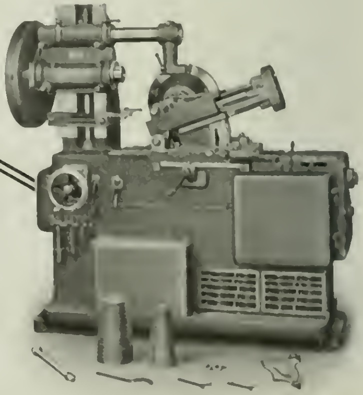


4

Efficient Machines From Our Line of Gear Cutting Equipment

Four representatives from our line of eight automatic gear cutting machines are shown herewith. Those directly above and below are for spur and bevel gears; those at the side are for spur gears only. All are well worth considering.





4 Reasons Why You Should Consider These Machines

They are Easy to Set Up—Handy to Operate That is where our machines start right—they find favor with the operator. The simplicity of design makes it easy to get a quick start on every job. All operating parts are within easy reach and there is no complex mechanism to cause confusion or loss of time. Setting-up time—non-productive time—is reduced to a minimum, and efficient results are attained with little attention from the operator.

They Produce Work Rapidly and Accurately That's where these machines score with your production men. They know what can be expected and how well these machines can be relied upon for fast production on all kinds of work. For fast roughing and accurate finishing such features as the rapid and efficient indexing mechanism, the large accurate index wheel, the smooth and powerful drive to the cutter spindle, the reduction of time of idle movements to a minimum, and the general stability to withstand heavy manufacturing service create a feeling of confidence.

They Keep Your Gear Costs Uniform and Low This interests every owner, manager and superintendent. It is the final test of a machine's worth—what it can produce and how much it costs for such production. On manufacturing jobs a man can run more than one machine which, coupled with quick setting up and fast production, means low costs. Then the fact that the same satisfactory production conditions can always be secured insures uniformity in costs.

They Give Such Service for Many Years This determines the ultimate wisdom of an investment and shows the real economy of a machine. Like all our machine tools, B. & S. Automatic Gear Cutting Machines are built with this end in view. In addition to the efficient operating and production features, the solid construction, the high quality materials, the careful workmanship and the rigid inspection insure long life and good service. Write for descriptive circulars.

Brown & Sharpe Manufacturing Co.

Providence, R. I., U. S. A.

READ PAGE 71

BALL BEARINGS*

POINTS OF CARDINAL IMPORTANCE IN THE DESIGN AND OPERATION OF BALL BEARINGS

THE anti-friction qualities of ball bearings have long been known, but until recent years the ball bearings actually devised have been unreliable. While they lasted, they ran well, but they broke down too easily, the principal reasons being faulty design, the use of steels that were insufficiently hard and lacking in uniformity, and inaccuracies of size and form which resulted in unequal loading of some of the balls and the consequent destruction of those overloaded. One of the earliest investigators to conduct a systematic research into the subject of ball bearing design was Prof. Stribeck of the Technical Laboratories in Neubabelsberg, Germany. From his experiments, Stribeck developed the following equation for the carrying capacity of an annular or radial bearing:

$$P = \frac{KD^2N}{5}.$$

Where P = carrying capacity of bearing in pounds;

D = ball diameter in eighths of an inch, *i. e.*, for a ball ½ inch in diameter, $D = 4$;

N = number of balls in the bearing;

K = a constant dependent upon the material, the shape of the ball supporting surfaces, and the speed.

This is the commonly accepted equation for determining the carrying capacity of a radial bearing, and one that is generally made use of by those exponents of the theory that the carrying capacity of a bearing is directly proportional to the number of balls contained. Other things being equal, this would be true, but it must be borne in mind that the race cross-section also plays a vital part in determining the carrying capacity of a bearing. Any device that may be employed for the insertion of a larger number of balls than can be gotten into the bearing by eccentric displacement, such as filling slots, making one side of the race groove shallow, etc., weakens the race and hence results in a decreased carrying capacity. A bearing with continuous rings, deep ball grooves, and as many balls as can be inserted without forcing, proves the best. These stiff rings are susceptible of extreme accuracy of manufacture and maintained accuracy in service, even though they are mounted in slightly out of round housings.

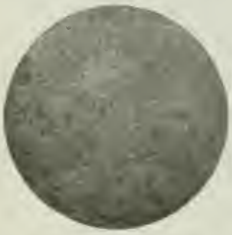


Fig. 1

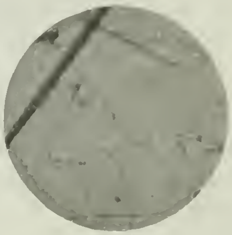


Fig. 2

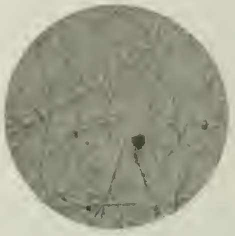


Fig. 3

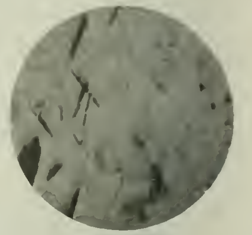


Fig. 4

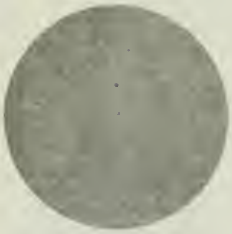


Fig. 5

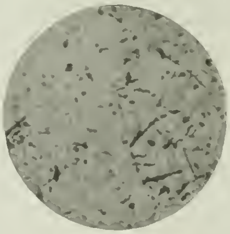


Fig. 6

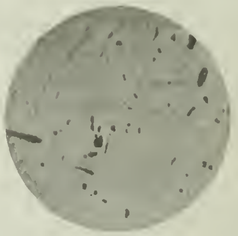


Fig. 7

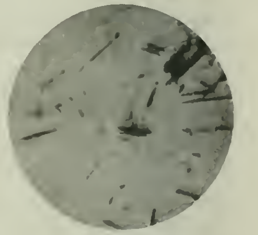


Fig. 8

Figs. 1 to 8. Reproductions of Microphotographs of Ball Surfaces magnified 120 Diameters, showing Various Degrees of Perfection attained in the Grinding and Polishing Operations. Fig. 5 shows the Finish of Balls used in Hess-Bright Bearings

The problem of producing a successful ball bearing was not solved with the adoption of the proper cross-section and form; truth of shape is necessary to true rolling action and the avoidance of sliding. Loading must inevitably cause some distortion and so introduce sliding action. This sliding action must be minimized by using materials sufficiently elastic to avoid permanent deformation. This demands the use of steels of the very highest grade, which have been most carefully hardened, and eliminates all case-hardened materials. These demands made on the ball material are made on the race materials in even higher degree. In time, the entire surface of the ball is presented to the load, vibration or change of load, either in amount or direction, sufficing to frequently bring in a new axis of rotation. As one of the races is usually fixed, it always presents the same point to the action of the load. It may safely be said that only the advent of high-grade alloy steels has made the ball bearing possible as a heavy load-bearing machine element.

Ball bearings are being used with satisfaction in automobiles, electrical, flour, and woodworking machinery, in street railway motors, on street and steam railway main axle-journals, in line shaft hangers, and in countless other applications where power economy and freedom from wear are desired. Naturally, satisfactory service from a ball bearing can only be secured when the bearing is designed to conform to the service for which it is intended. The elements entering into such design are the direction of the load, *i.e.*, whether at right angles (radial) to the shaft, parallel with it (thrust) or acting at an angle. Within each type, sizes are affected by the loads and by the speeds. Bearings are further affected in their relative arrangement, by varying combinations of load-direction, and by the load and speed.

In bearings for carrying radial loads, resistance to the shock of a given load is greater, the greater the ball diameter. When shock is present, of two bearings having the same carrying capacity, that having the larger balls should be used. Radial bearings, as commercially manufactured, are made up in three series, *i.e.*, light, medium, and heavy weight series. Thus, for a given bearing bore, a choice between three sizes of bearings of increasing capacity and ball diameter is afforded. Radial bearings are capable of carrying considerable thrust load, amounting, in bearings with deep race grooves, to about 25 per cent of their rated radial capacity.

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* Abstract of a paper by B. D. Gray, vice-president and manager of the Hess-Bright Mfg. Co., Philadelphia, Pa., read before the meeting of the Electric Vehicle Association of America, in Philadelphia, Pa., on April 11, 1915.

The CINCINNATI No. 5

High Power Miller with Power Quick Traverse

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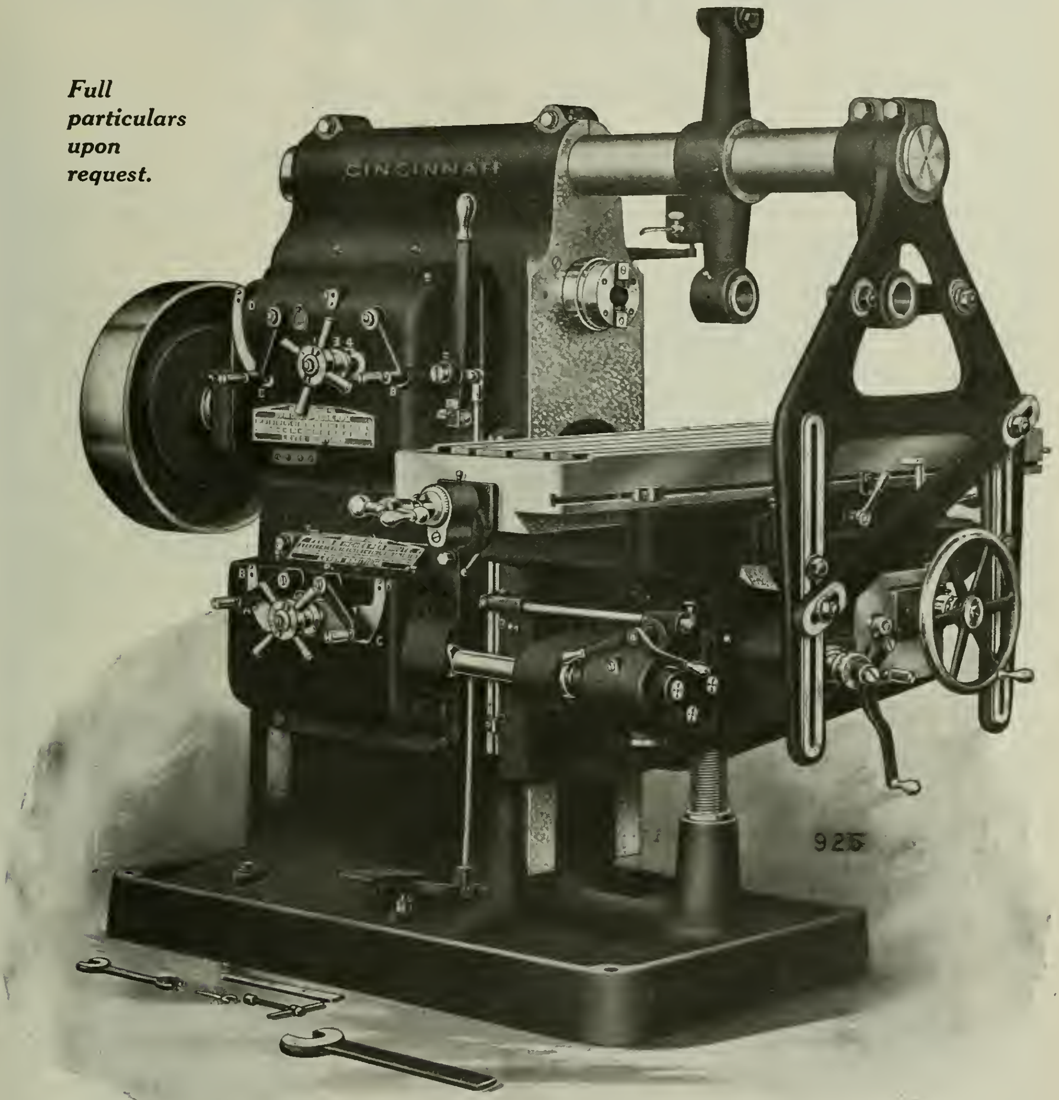

RANGE: Power Travel Feed 50"; Power Cross Feed 14"; Power Vertical Feed 21". Pieces 36⅜" wide can be passed between face of column and braces. 20 Horse Power.

THE CINCINNATI MILLING MACHINE CO., Cincinnati, Ohio

Where it seems desirable to subject radial bearings to a thrust load, it is advisable to consult with the bearing manufacturer.

It may be stated as an axiom in ball bearing manufacture that "the value of a ball bearing is in direct ratio to the accuracy attained in the manufacture of its component parts, and the suitability of the material entering into them." The limits of tolerance are much smaller than are generally considered feasible. The finish of the working surfaces of the balls and races must be of the highest. Grinding or polishing marks that may be detected by the naked eye condemn balls and the ball tracks utterly. Oft-repeated endurance tests under conditions where the finish was the only variable, abundantly proved this, at first unsuspected, fact. The higher the finish, the better the endurance of the bearing. Microphotographs of ball surfaces reveal that what appears to be an absolutely flawless surface is in reality composed of fine scratches, pittings and even gash-like defects (see Figs. 1 to 8) according to the care devoted to the final operation. Mere polish alone will not do; the polish must be the final touch applied to truly ground shapes.

TABLE SHOWING RESULTS OF TESTS OF CARRYING CAPACITIES OF DIFFERENT SHAPED BALL TRACKS

Disk Surface	Pressure in Pounds per Square Inch
Flat	581,395
Grooved	212,766
Cupped	146,413

Machinery

Ball bearings do not differ from other elements of mechanism, in that they must be used in conformity with their individual characteristics. Directions for correct mounting that are hereafter cited must be absolutely adhered to under penalty of failure. A strict adherence to all of the directions—and they are neither many nor troublesome—will result in a reliability as near to absolute as even the most exacting can expect—a reliability far beyond that of any other form of journal—and such reliability is gained with the advantages of a practical absence of friction, small space occupied, and the minimum of attendance. Surely there are advantages enough to make a careful study and following of the directions worth while.

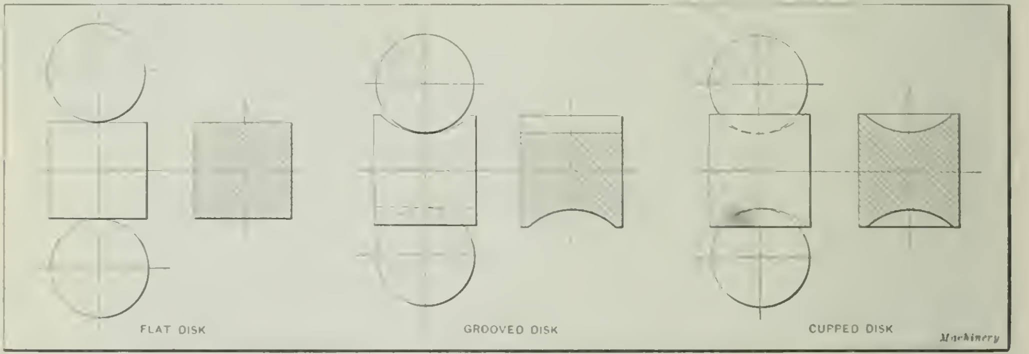

Fig. 9. Disks on which Tests were made to determine Relative Carrying Capacities of Different Shaped Ball Tracks

1. The proper size selection for the load must be made. Rated capacities are usually for steady loads and speeds. Variations from these conditions demand recognition by corresponding variations of the listed capacity.

2. Bearings must be lubricated. The oft-repeated statement that ball bearings can be run without lubricant is pernicious.

3. Bearings must be kept free of grit, moisture and acid. This prohibits the use of lubricants that contain or develop free acids. It is entirely practicable, by very simple means, to follow injunctions 2 and 3.

4. The inner race must always be clamped solidly to the shaft, so that no vibration can cause it to turn. This requires that the shaft be ground perfectly true, in order that it may make contact with the race all around, not merely at a few points. Unless this is done, a peening action will start, resulting in looseness. The race itself should be mounted with a light press fit, and very solidly clamped between a nut and shoulder.

5 The outer race must be mounted in such a manner as to permit of a slow creeping of the race in its housing. This has two beneficial effects. First, it avoids any possibility of an undesired endwise cramping of the balls in the race; second, such minute wear as occurs in the ball path is distributed around the entire circumference of the latter. To accomplish these results the housing must be accurately bored to such a diameter that the outer race will be a sucking fit in it, and the race is either left entirely free endwise or is confined between shoulders which give it a slight endwise freedom amounting to 1/64 inch or less. Only one bearing on a shaft may be confined endwise in this manner, since otherwise expansion or errors in machining or workmanship would produce undesirable axial or endwise cramping.

6. The bearing enclosures must retain oil or grease, while excluding dust and water.

Finally, after having observed all these precautions, submit your design to the bearing manufacturer and get the benefit of his experience. By so doing, many little things which you, from your experience may consider of minor importance, but which his broader experience shows him are pernicious, may be avoided.

In the ball bearing we have not a point contact as many suppose, but a substantial area due partly to deformation and partly to the shape of the parts in contact; I refer to the concavity of the ball path or groove whose radius in one direction very nearly coincides with that of the ball. This was very clearly brought out in a test which the Hess-Bright Mfg. Co. made a short time ago. Balls 1½ inch in diameter, in contact with a flat disk, a grooved disk, and a cupped disk, as shown in Fig. 9, were subjected to a load of 10,000 pounds in the testing machine. Vitriol was applied around the contact points and allowed to etch the exposed surfaces, *i.e.*, those which were not actually in contact. Then the load was relieved and the contact diameter was measured by means of a micrometer microscope. In the cases of the flat and cupped disks, the areas of contact were circular, but in the case of the grooved disk, the area of contact was elongated resembling an ellipse. The pressure per unit area was computed and found to be in accordance with the tabulated results. This test shows clearly the reason for the increased carrying capacity of the curved (grooved) ball track type of bearing as against that type with flat or practically flat tracks. It is self-evident that the more closely the groove envelops the ball, the lower will be the pressure per unit area, and hence the greater will be the ability to carry the load.

As an indication of the capacity and durability of ball bearings, I will give you the results of a test recently completed. A Hess-Bright No. 6407 bearing was subjected to a radial load of 3500 pounds and a thrust load of 1750 pounds, and run continuously at 1445 revolutions per minute for 531¼ hours before failure occurred. This bearing has a bore of 1.3780 inch, outside diameter of 3.9370 inches, and a width of 0.9843 inch. To get an idea of what the above radial and

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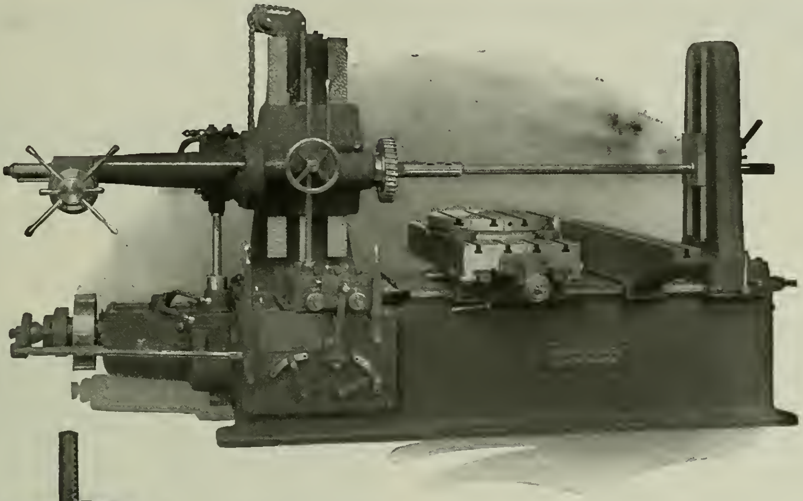

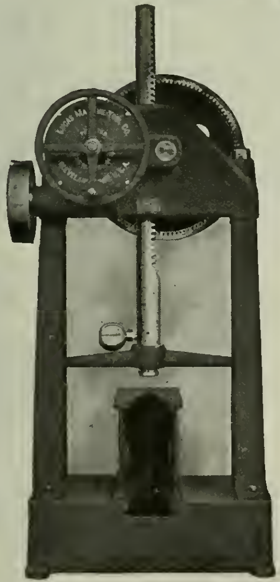

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MACHINE and
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LUCAS MACHINE TOOL CO., NOW AND ALWAYS OF CLEVELAND, O., U.S.A.

thrust load figures would be the equivalent of, in automobile front hub service, let us assume the case of a 36-inch wheel running at 1445 revolutions per minute. This would mean a speed of 154.6 miles per hour. A run of 531¼ hours would be the equivalent of 154.6 × 531.25 or 82,141 miles. Also assume that two bearings are used to a hub, one carrying 3500 pounds radial load and 1750 pounds thrust, while the other carries 3500 pounds radial load only. The total radial load per hub would then amount to 7000 pounds, and with four hubs (assuming the rear hubs carry the same load as the front hubs—in the average car they carry more) the total load would be approximately 28,000 pounds. Based on the above, conservatively this would be the equivalent of 82,141 miles in the front hub of a car weighing (with the live load) 7000 pounds and running continuously at 154.6 miles per hour. (Allowing a factor of 4 for shock.)

The question of lubrication is a matter of such vital importance to the satisfactory operation of ball bearings that a paper of this character would hardly be complete without some reference to it. Some time ago we made a few tests of graphite oils and greases as ball bearing lubricants. We tested a Hess-Bright No. 308 bearing running under 100 per cent overload and using a graphite oil as the lubricant. The test was normal in every way and nothing unusual was noticed. After a run of 337 hours the bearing was removed and examined, and it was noticed that a considerable amount of wear had occurred—much more than was the case in similar tests where only a pure oil or light grease was used. The only conclusion we can draw from this is that the graphite in the oil, in spite of its being extremely finely divided and practically impalpable, had a slight abrasive action, and that it does not improve the running qualities of the bearing. On the contrary it is slightly injurious and tends to increase the friction slightly over that when oil alone is used.

Another test was conducted with a graphite grease which the manufacturers recommend for the lubrication of ball and roller bearings. It wss a heavy grease with finely pulverized graphite. A trial was made of this by putting a quantity into the thrust bearings of one of the heads of our endurance testing machine. After a run of a few days the head became very noisy and finally "locked" the shaft. Examination of the bearings disclosed very distinct and somewhat irregular markings in the ball tracks—something like long "chatter marks"—as if the graphite had caused each ball to slide a short distance, thus slightly abrading the surface of the steel, until a little mound of the graphite had packed so hard under the ball that it was forced to roll over, only to repeat the sliding until another mound of graphite had packed under it. These results show clearly that graphite has no value in so far as reduction of ball bearing friction is concerned, and while it may be of considerable value to the other elements carried upon the ball bearings themsives, such as transmission gears, etc., the possible source of damage to the ball bearings cannot be overlooked.

The effect of speed upon the choice of lubricants should also be considered. As a general statement, it may be said that greases are suitable for low speeds, while oils are preferable for high speeds. Oil is really the better all around lubricant. It should be of sufficient viscosity to maintain a film between the pressure surfaces and the quantity used should only be enough to cover the surfaces—at high speed—the less, the better. Oil is more difficult to retain in the bearing box than grease. This, however, is merely a detail of design, since it is an easy matter to design a box that will not leak oil, and then it is simply a question of good workmanship to make sure that the joints are tight.

In conclusion, I feel that a few "Dont's" for ball bearing users would not be out of place, especially since the majority of us are users of ball bearings in one way or other. These "Don'ts" are particularly for the automobile owner, but are also generally applicable to the user of any machinery having ball bearings, as they stand for principles which are of universal application.

Don't let the bearing fill up with grit.

Don't hammer the races of the ball bearings.

Don't let acid get into the bearing. Always use a neutral lubricant.

Don't let water get into the bearing. In washing an automobile, especially the wheel hubs, be careful not to let the stream of water under city pressure play directly against the inner end of the hub.

Don't let oil leak out of the bearing.

Don't believe the man who says a ball bearing will run without oil.

Don't use grease containing foreign fillers such as sawdust, ground cork, etc. These may be of value in deadening the sound of gears, but they are injurious to ball bearings.

Don't take a bearing apart. If you want to play with it get an extra one.

Don't put new balls in—send the bearing to the manufacturer if you think they are needed.

Don't set a thrust bearing up until it resists rotation. Ball bearing friction is so low as to be perceptible to the touch only under excessive loads.

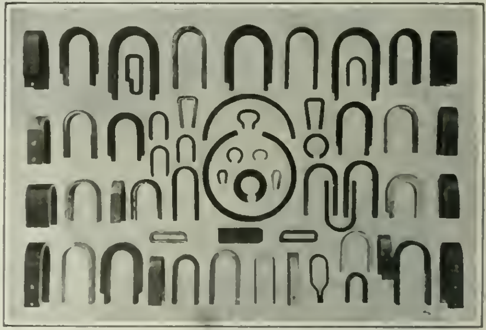
Don't tamper with the locks provided by the car builder—they are provided for the express purpose of keeping you from making adjustments.

When in doubt, communicate with the bearing manufacturer or his qualified representative.

• • •

PERMANENT MAGNETS MADE IN AMERICA

The forms of permanent magnets shown in the accompanying illustration are manufactured by the Esterline Co., Indianapolis, Ind. These magnets are used in such electrical instruments as watt-hour meters, ignition magnetos, etc. For use in handling this work, the Esterline Co. has built special machines for testing magnet steel and permanent magnets, which enable rapid determinations to be made of the quality of the steel which is used, and also of the properties of the finished magnets. Every lot of steel is tested at the time it comes to the factory and the finished magnets are subjected to careful tests before they are passed by the inspection department. Mr. J. W. Esterline, president and general manager of the Esterline Co., was for a number of years chairman of the Committee on the Magnetic Properties of Iron and Steel of the American Society for Testing Materials, and is a recognized authority on this important subject.


A Collection of Permanent Magnets made by the Esterline Co.

• • •

The standards committee of the Society of Automobile Engineers, having investigated the cotter sizes used by automobile manufacturers, found that some of the car manufacturing concerns are at present carrying 250 sizes of cotter pins in stock. After carefully considering all the factors involved, a table of forty-one cotter pins of various lengths and diameters was formulated, in the belief that it provides an adequate number of sizes for use in motor car practice. In connection with the proposed standard cotter pin table, a table of suggested practice for the application of cotter pins with relation to the diameter of the bolt of the pin and the hole drilled therein has also been prepared.

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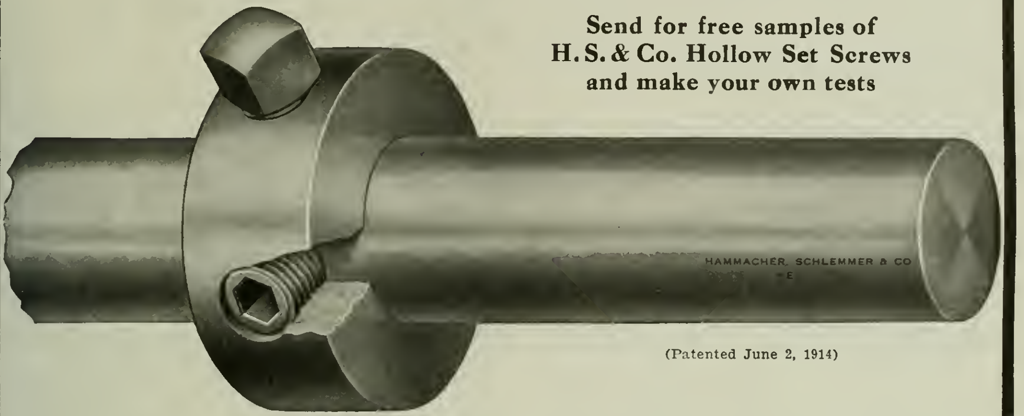
A Stamped or a Milled Screw?

Send for free samples of
H. S. & Co. Hollow Set Screws
and make your own tests



(Patented June 2, 1914)

The H. S. & Co. Hollow Set Screws have certain marked advantages, notably—

1st. Are tougher and "bite" better and therefore hold better.

2nd. Being made from sheet metal, they outlast and out-test any screw milled from solid bar.

3rd. Sides are absolutely uniform, insuring perfect fit of wrench.

4th. Holes are deeper, permitting wrench to come closer to point of screw, thereby insuring full tightening power.

Proper tests prove beyond a doubt that stamped screws are stronger and tougher than those milled from solid bar, owing to the position of the fibres of the steel. Well-known proof of this is found in the comparative values of semi-finished nuts, those milled from solid rod not being as strong as the stamped goods.

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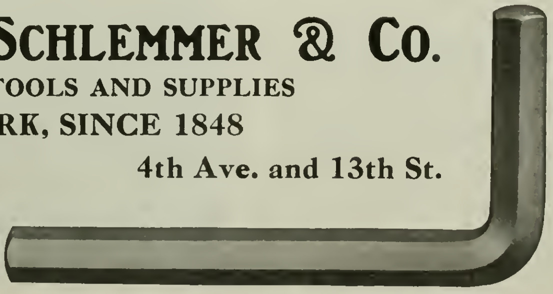


FREDERICK W. TAYLOR'S WORK

In harmony with the request of Mrs. Frederick W. Taylor, Messrs. Carl G. Barth, Morris L. Cooke, James Mapes Dodge and H. K. Hathaway have taken steps to conserve his work and have arranged the following:

1. To provide for the continuation and extension of the Taylor system of management
2. To gather together such materials as may be of use to his biographer.
3. To answer the correspondence which of late years has been coming in increasing volume from all parts of the world.
4. To complete the collection of books, data, etc., which would supply material for any memorial to Mr. Taylor.

These co-workers request all friends of Mr. Taylor and acquaintances who have correspondence or material of any kind which would be useful in carrying out the above purposes to send it to them. When requested, the material so sent will be returned to the owners. Correspondence with regard to this work should be addressed to Miss Frances Mitchell, Boxly, Highland Station, Chestnut Hill, Philadelphia.

* * *

PERSONALS

R. E. Ellis, sales manager of the Steinle Turret Machine Co., Madison, Wis., has resigned his position.

Frank H. Seng, Jr., of Waterbury, Conn., has become sales manager of the Whitcomb-Blaisdell Machine Tool Co. of Worcester, Mass.

E. E. Winship, formerly manager of the Cincinnati branch of Manning, Maxwell & Moore, Inc., has been appointed manager of the Cleveland branch.

Fred A. Bigelow has been appointed general sales manager of the Carpenter Steel Co., with headquarters at Reading, Pa. Mr. Bigelow succeeds John E. Sullivan, resigned.

C. H. Overkamp, formerly of the Conover-Overkamp Machine Tool Co., Dayton, Ohio, has been made manager of the Cincinnati office of Manning, Maxwell & Moore, Inc.

J. M. Riordan, formerly with the Fellows Gear Shaper Co., with headquarters at Cleveland, Ohio, is now associated with the Grant Lees Gears Co. of Cleveland, Ohio, as sales engineer.

Samuel Insull was presented with the sculptor's model of the Franklin medal, by the Franklin Institute, May 19. Mr. Insull delivered an address, "Electricity and Modern Industrial Growth."

Louis S. Jones, for several years connected with the Lumen Bearing Co., Buffalo, N. Y., and well known in the machinery trade, has been appointed sales manager. Mr. Jones will make his headquarters at Buffalo.

John Calder presented a paper: "Metal Spraying Processes in Engineering and Art," at the monthly meeting of the American Society of Mechanical Engineers in the Engineering Societies Bldg., New York City, Tuesday evening, May 11.

George A. Wheeler, deceased, was recently awarded the Edward Longstreth medal of merit for his escalator, an inclined elevator for transporting persons from one level to another. The basic invention was first disclosed in the patent granted to Mr. Wheeler in 1892.

Thomas A. Edison was presented with the Franklin Medal, May 19, in recognition of "the value of numerous basic inventions and discoveries forming the foundation of world-wide industries, signally contributing to the well-being, comfort and pleasure of the human race."

Herbert Alfred Humphrey of London, England, and Cav. Ing. Alberto Cerasoli of Rome, Italy, were recently awarded the John Scott Legacy medal and premium for the invention and development of the Humphrey pump, a device for raising water by the direct application of the explosive energy of a mixture of combustible gas and air.

Alonzo B. See, of the A. B. See Electric Elevator Co., New York City, delivered an address on patents before the Elevator Manufacturers Association of the United States, at their banquet held at the Waldorf-Astoria Hotel, April 15, 1915. Mr. See referred caustically to some of the inconsistencies of the decisions in patent infringement cases.

A. W Van Buren has joined the sales force of the E. L. Essley Machinery Co., Chicago, Ill., dealer in iron and brass-working machinery. Mr. Van Buren was connected with the Chicago office of the Niles-Bement-Pond Co. for about seventeen years and represented the company in Wisconsin, Minnesota and parts of Illinois. He will represent the E. L. Essley Machinery Co. in the Chicago territory.

Charles Spalding, sales representative of the Gisholt Machine Co., Madison, Wis., who has heretofore made his headquarters at the company's Chicago office, is now located at Detroit and will make his headquarters there, taking care of the Chicago territory, the same as heretofore. Mr. Spalding's home address is 2161 West Grand Blvd., and his mail address is care of Detroit Athletic Club, Detroit, Mich.

H. E. Preston, formerly with the American Can Co., and prior to that with the Felt & Tarrant Mfg. Co., Chicago, has joined the sales force of the Gisholt Machine Co., Madison, Wis., periodograph department, his headquarters being at the Chicago office, 208 S. La Salle St. Mr. Preston will look after the company's periodograph interests in the Chicago district.

Alex Schwalbach, advertising and publicity man for the F. & S. bearings imported by the former J. S. Bretz Co., and their successor, the Bearings Co. of America, leaves the employ of the Bearings Co. of America June 1, after six years' service. Mr. Schwalbach is an all-around newspaper man and also has had a long selling experience in the bicycle, motorcycle and automobile lines.

Frederick Haynes Newell was recently appointed professor of civil engineering and head of the department of civil engineering of the University of Illinois, Urbana, Ill. Prof. Newell comes from actual professional work, having been for twenty-six years in the government service, principally as chief engineer and later as director of the United States Reclamation Service.

Heike Kamerlingh Onnes was awarded the Franklin Medal, May 19, in recognition of his "long continued and indefatigable labors in low-temperature research which has enriched physical science, not only with a great number of new methods and ingenious devices, but also with achievements and discoveries of the first magnitude." Prof. Onnes is director of the physical laboratory of the University of Leiden, Holland.

Douglas T. Hamilton, associate editor of MACHINERY, spoke at the meeting of the American Society of Swedish Engineers, Brooklyn, N. Y., Saturday evening, May 8, on "Shrapnel and Shrapnel Manufacture." The subject created considerable interest, as several of the engineers present are engaged in this line of manufacture, and a discussion which brought out several interesting points followed Mr. Hamilton's presentation.

* * *

OBITUARIES

Daniel W. Edgecomb, inventor, astronomer and manufacturer of telescopes, died at his home in Fairfield, Conn., aged seventy-five years.

John Birkinbine, a noted mining engineer and ex-president of the American Institute of Mining Engineers, died at his home in Philadelphia May 14, aged seventy-one years.

Horace L. Arnold, a well-known contributor to the technical journals, author of several books, inventor and all-around mechanic, died in Detroit, Mich., recently, aged about seventy-five years. Mr. Arnold lately made a notable contribution to the *Engineering Magazine*, it being a description and analysis of the methods and conditions found in the plant of the Ford Motor Co., Detroit.

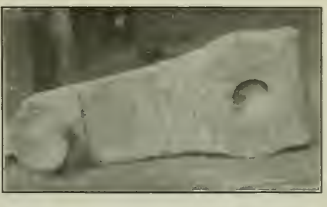
David M. Parry, ex-president of the National Association of Manufacturers, died at his home in Indianapolis, May 12, aged sixty-three years. He was born on a farm near Pittsburg, Pa. In the early seventies he was a reporter on the *New York Herald*, and later became an owner of a newspaper published in Montana. In 1882, he acquired a wagon shop in Rushville, Ind., and removed the business to Indianapolis, where it developed into one of the largest of its kind in the world, having an output of one thousand vehicles a day. Mr. Parry founded the Overland Automobile Co., which he later sold to his former superintendent, John Willys, for $250,000. He is alleged to have given Henry Ford his first financial assistance when starting in the automobile business. In 1903 he was elected president of the Industrial Association of America, which consisted of a federation of the employers' associations and citizens' alliances throughout the country, formed to resist the demands of organized labor. He had many interests besides his vehicle business, and was an author of some note. He is survided by a widow and nine children.

George T. Reiss, vice-president of the Niles Tool Works Co., Hamilton, Ohio, and a director of the Niles-Bement-Pond Co., New York City, died May 5 at his country home near Hamilton, aged sixty-five years. Mr. Reiss was born in Cincinnati and moved to Hamilton in 1877. He was first employed as a draftsman at the old Cope and Maxwell shops, and in 1878 was placed in charge as the master machinist of the engineering department of the Niles Tool Works which had removed from Cincinnati to Hamilton in 1871. He was the chief mechanical engineer of the concern and later became superintendent of the drafting department and was subsequently elected a member of the board of directors, of which he was also secretary. Upon the death of the late Col. Alexander Gordon and the accession of James K. Cullen to

SAVING HALF on Machine Work

The cost on this machine part made by hand methods in a large Chicago shop was $25.60. A large part of this cost was in machining the rough stock.

Today the machining cost has been cut in half by forging the piece to nearly the correct dimensions on



A rectangular billet, 5 x 7 at the large end, 4 x 7 at the smaller, is placed with the large end in a vertical press and squeezed to shape 10½ inches wide by 4 inches thick. The body is squeezed to a thickness of 2 inches, leaving a lump on the lower end. The lower end is heated and tapered on a steam hammer and placed in the dies and upset.

AJAX Universal Forging Machine

Trade Mark Registered

This machine is a 6-inch size, one of the largest manufactured, and has been used for many other remarkable jobs.

But this is only an average example of the work that can be done in any shop equipped with Ajax machinery.

Ajax engineers will take the entire responsibility of investigating and telling you just what can be done on any pieces you may select. We stand behind them on any production rate they promise.

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The Ajax Universal Forging Machine

In addition to the forging machine, this Ajax machine is equipped with a powerful vertical press for accessory operations, such as squeezing and forming or welding scrap stock to produce pieces required for large forgings.

the presidency of the directorate, Mr. Reiss became vice-president, which position he retained until his death. Mr. Reiss was a prolific inventor and many patents for tools and machinery were granted him.

Albert D. Goodell, one of the founders of the Goodell-Pratt Co., Greenfield, Mass., manufacturer of mechanical tools, died at his home in Shelburne Falls, Mass., aged sixty-nine years. He learned the trade of a carpenter in his youth and followed it about five years. In this work, he displayed unusual ingenuity and mechanical ability. In 1870 he was called to Millers Falls to take a position with the Millers Falls Co. as superintendent and master mechanic, and during his connection with that concern he made many valuable inventions. Mr. Goodell formed the company known as Goodell Bros. with his brother, Henry G. Goodell, now of Greenfield. In 1888 he engaged in the manufacture of mechanical tools in Shelburne Falls. After four years of partnership, he sold his interest to his brother Henry, who moved the business to Greenfield, where it still continues greatly enlarged under the name of the Goodell-Pratt Co. After disposing of his interest in this business, Mr. Goodell moved to Worcester, where he and his son, Frederick A. Goodell, established the Goodell Tool Co. In 1893, the business was transferred to Shelburne Falls.

COMING EVENTS

June 3-5.—Joint convention of the American Supply & Machinery Manufacturers' Association and the National Supply & Machinery Dealers' Association. Hotel Bellevue-Stratford, headquarters, Philadelphia, Pa.

June 7-11.—Third annual convention of the National Association of Corporation Schools at Worcester, Mass. H. W. Dunbar, general chairman of the convention committee, Norton Co., Worcester, Mass.

June 9-11.—Annual convention of the American Railway Master Mechanics Association, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

June 14-16.—Master Car Builders' annual convention, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

June 14-17.—Summer meeting of the Society of Automobile Engineers on board the steamer "Noronic" of the Northern Navigation Co., leaving Detroit June 14. Coker F. Clarkson, secretary, 1745 Broadway, New York City.

June 19-26.—Annual convention of National Graphic Arts Exposition in the Coliseum, Chicago, Ill. Publicity manager, A. D. V. Storey, National Exposition Co., 200 Fifth Ave., New York City.

June 20-24.—Eleventh annual convention of the Associated Advertising Clubs of the World, Chicago, Ill. The program includes a notable list of speakers, many of them being of national prominence.

June 22-25.—Spring meeting of the American Society of Mechanical Engineers at Buffalo, N. Y. David Bell, chairman of the general committee, Buffalo; C. W. Rice, secretary, 29 W. 39th St., New York City.

June 22-26.—Annual convention of the American Society for Testing Materials. Hotel Traymore, Atlantic City, N. J., headquarters. Edward Marburg, secretary, University of Pennsylvania, Philadelphia, Pa.

July 19-21.—Seventh annual convention of the American Railway Tool Foremen's Association, Chicago, Ill. Hotel Sherman, headquarters, Owen D. Kinsey, secretary and treasurer, 7223 Ridgeland Ave., Chicago, Ill.

August 17.—Annual meeting of the International Railroad Blacksmiths' Association, Philadelphia, Pa. A. L. Woodworth, secretary-treasurer, C. H. & D. Railway, Lima, Ohio.

September 7-10.—Twenty-third annual convention of the Traveling Engineers' Association, Hotel Sherman, Chicago, Ill. W. O. Thompson, secretary, East Buffalo, N. Y.

September 9-11.—Swedish engineering convention in the United States; meeting in Chicago. Secretary, Eastern organization committee, E. Oberg, 183 68th St., Brooklyn, N. Y.; secretary Western organization committee, C. G. Axell, 601 City Hall Square Bldg., Chicago, Ill.

September 25-October 2.—Annual exhibit of the Foundry and Machine Exhibition Co., Atlantic City, N. J., in conjunction with the American Foundrymen's Association convention. Foundry & Machine Exhibition Co., 1949 W. Madison St., Chicago, Ill.

September 27-October 1.—Annual convention of the American Foundrymen's Association, Atlantic City, N. J.

NEW CATALOGUES AND CIRCULARS

Sanitary Fountain & Specialty Co., 176 Federal St., Boston, Mass. Circular of sanitary bubbling fountains for offices, shops, mills, factories, etc.

B. C. Ames Co., Waltham, Mass. Catalogue illustrating and giving prices of the line of dial gages manufactured by this company.

Crescent Tool Co., Jamestown, N. Y. Circulars of the "Crescent" hammer handle screw-driver and the "Crescent" adjustable single- and double-end wrench.

Schum Bros., Metropolitan Tower, New York City. Circular on the Schum "Absolutely Positive" nut lock, which is automatically locked by means of a set screw.

Link Belt Co., 39th St. and Stewart Ave., Chicago, Ill. Circular No. 210 on Link Belt wagon and truck loaders for handling coal, coke, stone, sand, and similar loose materials from storage.

W. Robertson Machine & Foundry Co., Buffalo, N. Y. Folder illustrating "Economy" high speed power saws in various sizes. The claims made for these tools are speed, accuracy and economy of blades.

Hisey-Wolf Machine Co., Cincinnati, Ohio. Bulletin 103 on Hisey portable electric hand and breast drills, describing twenty styles and sizes for operation on direct current and alternating current, and the universal motor type for operation on direct and alternating current of the same voltage.

Gould & Eberhardt, Newark, N. J. 1915 catalogue on high-duty shapers and attachments, containing detailed description of the shapers of this company's manufacture, and illustrating tool-room shapers, extension base shapers, "Invincible" type shapers, etc.

Mortimer J. Silverberg, Peoples Gas Bldg., Chicago, Ill. Circular of a time study watch which gives direct reading in operations per hour, eliminating mental and pencil computations. It has a decimal dial with "take out time" feature and stem actuated set back. The price of the watch is $15.

Dodge Sales & Engineering Co., Mishawaka, Ind., distributor of the product of the Dodge Mfg. Co., of Mishawaka, has issued a new catalogue covering the full line of Dodge gearing. For a number of years the Dodge Mfg. Co. has made a specialty of transmission gearing, and the line embraces many thousands of patterns.

Vulcan Process Co., Minneapolis, Minn. Catalogue 4 of the "Vulcan" process of oxy-acetylene welding and cutting of metals, describing torches, acetylene gas generators, regulators, cutting and welding portable plants, examples of work repaired, and general information of interest to garages, repair plants and manufacturing concerns that can make apparatus of this sort useful.

National Twist Drill & Tool Co., Detroit, Mich. Catalogue 8, 176 pages, 4½ by 7½ inches, on carbon and high-speed twist drills, reamers, counterbores, milling cutters, end mills, hollow mills, and involute gear cutters. The tabular matter giving data on B. & S. tapers, Morse tapers, speed and feed of drills, decimal equivalents, weights of round and square steel and sizes of tap drills will be found of value.

Cincinnati Iron & Steel Co., Cincinnati, Ohio. Illustrated booklet showing views of the plant, warehouses and facilities for handling and fabricating structural steel, beams, angles, channels, tees, plates, bars, etc. The "Cisco" lathe is also illustrated. The next is entitled "Lucid Lucubrations of Luke McLuke" and consists of aphorisms intended to relieve the monotony of life of the "tired business man."

Rockford Iron Works, Rockford, Ill. Folder entitled "There With The Punch," illustrating Rockford straight-side flywheel press, straight-side double crank geared press, straight-side flywheel press with side shear, and inclinable flywheel press. Rockford straight-side presses are furnished in sizes of from 50 to 300 tons pressure. The folder has an illuminated cover and the illustrations are made to a large scale, giving an excellent idea of these presses.

George Shipper, Aurora, Ind. Circular of the Shipper automatic gear planing machine, designed for planing spur gears with formed cutters. The cutter slide operates horizontally and the gear blanks are rigidly supported, the design being worked out with the view of making a high-production machine. Means are provided for quickly changing speeds and feeds without removing change gears. The machine has a capacity for spur gears up to twenty-eight inches diameter by eight inches face.

Watson-Stillman Co., 192 Fulton St., New York City. Sectional catalogue 92 of hydraulic forcing and miscellaneous presses, comprising wheel presses, crank-pin presses, armature presses, broaching presses, reversed cylinder forcing presses, die presses, horizontal forcing presses, multiple cylinder projectile banding presses, projectile capping and banding presses, spring banding presses, baling presses, sheet steel scrap baling presses, box baling presses, auto truck tire forcing presses, briquetting presses, lead presses, bulldozers, etc.

Beaudry & Co., Inc., 141 Milk St., Boston, Mass. Pamphlet descriptive of Beaudry motor-driven hammers, made in two styles, viz., the "Peerless" with rams weighing from 25 to 200 pounds, and the "Champion" with rams weighing from 50 to 500 pounds. The "Champion" hammer is equipped with a friction clutch pulley on the hammer, pressure on the foot treadle engaging the clutch and starting the hammer, the same variation in speed and force of blow being obtained as with the loose belt and idle pulley of the belt-driven type.

Hoover Steel Ball Co., Ann Arbor, Mich. Consolidated price list of micro-chrome steel balls, chrome-nickel steel balls, special carbon crucible steel balls, steel burnishing balls, solid brass, bronze and bell metal balls, acid resisting hollow bronze balls and aluminum balls. Miscellaneous data are given on weights of steel balls, rules for finding diameter and radius of enclosing circle of a ring of balls, decimal equivalents of parts of an inch, decimal equivalents of millimeters and fractions of millimeters, and allowable loads for chrome and special steel balls.

J. H. Williams & Co., 61 Richards St., Brooklyn, N. Y. General catalogue on drop-forgings and drop-forged tools. 160 pages, 6 by 9 inches. The tools shown are: drop-forged wrenches, new improved line of "Agrippa" tool-holders, lathe dogs, clamps, caliper gages, thumb-nuts and screws, eye-bolts, swivels, hoist hooks, wire rope sockets, handles, pipe-fitters' tools and gas engine forgings. The wrenches listed in this catalogue include about 800 sizes and 40 patterns, with a range of openings from 5/16 inch to 7 5/8 inches, accommodating every size of nut and screw.

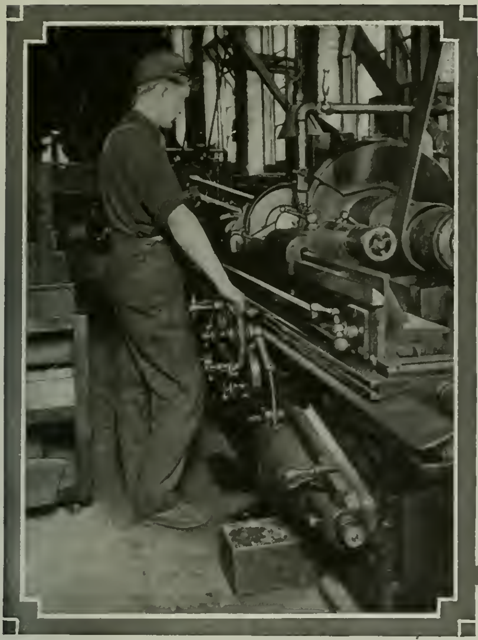
Peerless Piston Ring Co., 91-107 Lafayette St., Newark, N. J. Circular of the "Peerless" positive triple eccentric "leak-proof" piston ring for automobile, marine, motorcycle and steam engines, air compressors, pumps, refrigerating machines, etc. The "Peerless" piston ring consists of three eccentric rings—two narrow and the third broad, equal in width to the other two; these are arranged with the broad ring inside of the two narrower rings which contact with the cylinder bore. The exterior rings are secured in a fixed position relative to the inner ring so that leakage under the rings is prevented.

S. K. F. Ball Bearing Co., 50 Church St., New York City. Catalogue of S. K. F. self-aligning ball bearings, dealing with bearing construction, design of ball bearings, manufacture of ball bearings, instructions for mounting S. K. F. radial bearings, mounting thrust bearings, housings for S. K. F. ball bearings, bearing locking nuts, inspection and lubrication, selecting proper size and bearings, tables of S. K. F. ball bearings, tables of S. K. F. ball bearing hangers, applications in machine tools, automobiles, railway cars, textile machines, grain milling machinery, paper making machinery, electric motors and wood-working machinery.

Gleason Works, Rochester, N. Y. Folder illustrating and describing the spiral type bevel gear generator. This machine cuts bevel gears and pinions with spiral type teeth and is especially adapted to meet the demands of the automobile trade. The machine is regularly equipped for finish cutting only, but can be used for stocking out by changing the feed cam and the cutter. If a cam for rough cutting is wanted, this should be specified in the order as it is not part of the regular equipment. The folder includes spiral gear calculations of considerable value, for generating spiral gears in connection with the Gleason machine.

J. T. Slocomb Co., Providence, R. I. Pamphlet on accurate and economical measuring in machine construction by the use of micrometer calipers, entitled "The Measuring Book." The principle of the micrometer caliper is explained, and directions are given for reading micrometer calipers that are so simple that an apprentice can quickly comprehend them. Measuring with a scale and an ordinary caliper is compared with micrometer measurements, and the crudeness of the former method is pointed out. The special features of the Slocomb micrometer and the various sizes and combinations in sets are shown. The chapter on reliable measurements describes and illustrates the apparatus owned by the J. T. Slocomb Co. for fixing its standards. The pamphlet is one that can be read with interest and profit by all concerned with mechanical production.

S. K. F. Ball Bearing Co., 50 Church St., New York City. Pamphlet entitled, "Machine Tools and Shop Equipment employing S. K. F. Ball Bearings"—a treatise of interest to mechanical engineers, designers, and users of machinery and machine tools in particular. In the foreword, the author calls attention to the importance of ball bearings, and to the changes made in the past decade by their introduction into machine tools and other machinery. Following this, ball bearing construction is taken up, and the importance of the construction which permits a ball bearing to adjust itself to deflections of the shaft is pointed out. Examples of the application of ball bearings to machine tools include drilling machines of the radial, multiple, and special types, heavy-duty turret lathes, automatic lathes, engine lathes, turning machines, milling machines, boring, drilling and milling machines, grinding machines, grinders and buffers, portable grinders, broaching machines, special machine tools, lineshafts, electric motors, etc. One notable example is an internal grinder, the spindle of which runs at 82,000 R. P. M. Ball bearings enable the spindle to be driven at a rate that yields a speed of 5500 feet per minute to the periphery of the grinding wheel. This, and many other examples, illustrate what a change is being made in machine tools by the introduction of efficient bearings. They make higher speeds possible, reduce friction losses and require less space in the length of the shafts.



Plain Cylindrical External Grinding[*]

Development, Methods of Handling and Examples of Work

by Douglas T. Hamilton[†]

PLAIN cylindrical grinding is regarded quite differently today from what it was years ago when grinding was first accomplished. The first commercial grinding machine, built in 1864-1865, was used only as a precision machine for grinding hardened parts and correcting slight errors due to warping in hardening. From this small beginning, the grinding machine has passed through a remarkable development which has resulted in greater stability and convenience of operation. Generally speaking, there are two classes of plain cylindrical grinding; one is the occasional grinding of a hardened part in the tool-room, and the other the manufacturing of parts in large quantities to accurate dimensions. In the first case, the question of cost is not a vital factor of the problem, although it should always be considered, but accuracy is of paramount importance. In the second case, the cost is vital, and when we consider that the work also has to be manufactured within certain limits—in most cases extremely close—the importance of the problem is appreciated.

A grinding machine that would be suitable for grinding work in the tool-room would, in many cases, be entirely unsuited for manufacturing parts in large quantities. A tool-room machine is more adapted to universal requirements, and consequently is provided with features that are not needed in straight manufacturing work, where sufficient quantities of one part are required to demand the use of a special machine for the work. At present, far more manufacturing work is being done, of course, than tool work, and consequently greater interest is taken in what might be termed "manufacturing grinding operations." In the following article, therefore, certain phases only of tool-room grinding will be briefly touched upon, the greater portion of the data covering operations dealing principally with work that must be made in large quantities and to accurate dimensions.

The grinding of machine and automobile parts in large quantities brings up several interesting problems in interchangeable manufacture. In the first place, accurate finish must be obtained, and in the second place a large production is generally, if not always, necessary. It is therefore essential that the very best and most practical method be adopted. In practice, for grinding cylindrical work, the wheel is traversed past the work—in some machines the work is traversed past the wheel—and a comparatively wide face grinding wheel is used. The development in grinding has been along the lines of increasing the strength and rigidity of the machine and in the use of increased widths of faces of grinding wheels. Improvements have also been made in the abrasive materials used in the manufacture of grinding wheels. When grinding was first done, emery was used almost exclusively for grinding wheels, but at the present time artificial abrasives which are products of the electric furnace are used almost exclusively for automatic machine grinding. The abrasives used, however, depend largely on the character of the work being ground.

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[*] For additional information on grinding, grinding wheels, and allied subjects, see the following articles previously published in MACHINERY: "Holding Roller Bearing Races for Internal Grinding," May, 1915; "Grinding Practice," February, 1915; "Selection of Wheels for Cylindrical Grinding," January, 1915; "The Tolford Ball Grinding Machine"; "Grinding vs. Milling"; "Operation of Grinding Wheels in Machine Grinding"; "Data on Surface and Cylindrical Grinding," December, 1914; "Ring Wheels and Solid Wheels for Disk Grinding"; "Wheels for Cylindrical Grinding," November, 1914; "Grinding and Lapping Small Work"; "Selection of Wheels for Cylindrical Grinding," October, 1914; "Making Aloxite Grinding Wheels," September, 1914; "Lobdell Calender Roll Grinding Machines"; "Work-holding Fixtures for the Vertical Surface Grinder"; "Crankshaft Grinding," August, 1914, engineering edition; "Safety as Applied to Grinding Wheels," July, 1914, engineering edition, and other articles there referred to; "The Use of Photographs in Grinding and Polishing Departments," July, 1914; "Work Speeds in Grinding," April, 1914; "Machining Armature Shafts," February, 1914; "Grinding Wheel Protection Devices," January, 1914, engineering edition; "Fixture for Grinding Valve Push Rods," June, 1913; "Exhaust System for Grinding, Polishing and Buffing Wheels"; "A Three-Point Micrometer and Its Use," May, 1913; "Efficient Grinding of Cylindrical Work," December, 1912; "Commercial Grinding," October, 1912; "Grinding Calender Rolls," August, 1912; "Grinding and Corrugating Flour Mill Rolls," July, 1912; "Internal Grinding Practice in Hardinge Bros. Shop," May, 1912; "Holding Work for Grinding"; "Efficiency in Cylindrical Grinding," March, 1912; "Grinding Aluminum Castings on a Vertical Spindle Disk Grinder," January, 1912; "Grinding Hardened Gears," September, 1911; "The Field for Grinding—A Comment," July, 1911; "Rough-turning vs. Rough-grinding of Crankshaft Pins," March, 1911; "The Field for Grinding"; "Precision Grinding," January, 1911; "Grinding Adding Machine Side Frames," December, 1910; "Grinding Economy," July, 1910; "History of the Invention of the Universal Grinding Machine," July, 1910, engineering edition; "Grit and Grinding Chips," June, 1910, engineering edition; "Economy in Grinding," May, 1910; "Errors in Grinding Tapered Reamers and Milling Cutters," December, 1909; "Form Grinding Operations in the Shop of the Landis Tool Co.," August, 1909; "Twist Drill Grinding," June, 1909; "Cylindrical Grinding," May, 1909; "Grinder Kinks," December, 1908; "Grinding Threading Chasers for Brass Work," November, 1908; "Devices for Grinding Fluting Cutters," October, 1908; "Helps and Don'ts for Grinding," August, 1908; "Grinding Threading Dies," December, 1907; "Grinding Threading Die Chasers," November, 1907; "Precision Grinding," September, 1907, engineering edition; "The Cost of Grinding," October, 1906.

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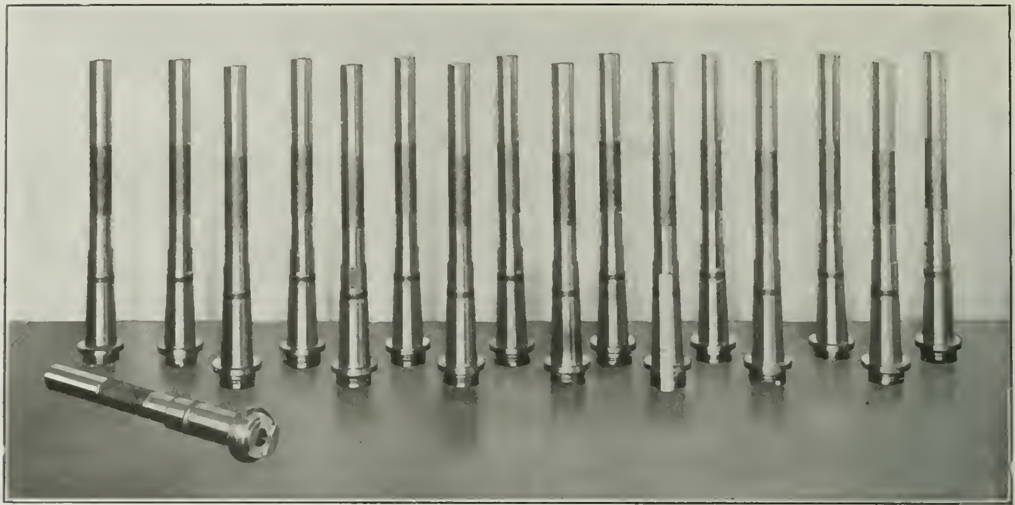

This Group of Seventeen Milling Machine Spindles was rough- and finish-ground all over in Twenty-six Hours to Limits of 0.0005 inch, except Two Diameters, which were ground to 0.00025 inch Limits. The Tapers are ground to a Gage

Different Methods of Cylindrical Grinding

Broadly speaking, there are four different methods of applying the wheel to the work when grinding cylindrical work; the first, known as traverse grinding, is shown at *A* and *B* in Fig. 1, and refers to the traversing of the work or wheel by hand or power feed and automatically feeding the wheel in a certain distance at the end of every traverse or at the end of each traverse and return stroke.

The second method, shown at *C*, is known as the "fixed wheel" method. By this method, instead of feeding the wheel in on the work at each traverse, it is fed in to the correct depth determined by a previously set stop, and two traverses made over the work, one being a roughing cut and the other a finishing. This method is also accomplished by leaving the wheel slide "fixed," that is, instead of feeding the wheel in on the work each time a fresh piece is put on the centers, the wheel slide is not adjusted until truing of the wheel has reduced its diameter, necessitating resetting.

The third method, shown at *D*, is known as the "step-in" method of grinding. By this method a comparatively wide face wheel, varying from 2 to 4 inches wide, is stepped-in along the work at intervals, the width of the wheel overlapping until the entire length to be ground has been covered. The wheel is fed in to within from 0.002 to 0.003 inch of the final diameter, and then two rapid traverses are made over the work to complete it.

The fourth and last method is known as "straight-in" or form grinding. This term indicates that the wheel and work remain stationary, as far as lateral adjustment is concerned, and the wheel is fed directly in on the work without any traversing motion. This method of grinding can be used both for the grinding of straight plain surfaces and irregular-shaped form surfaces.

Each of these four methods of grinding has its advantages and limitations. Traverse grinding is recommended on long shafts, say over 2 feet in length, of comparatively small diameter; up to within the last few years this was the only recognized method of plain cylindrical grinding. When the work is short in proportion to its diameter, however, other methods of grinding about to be described have certain advantages over the traversing method. The traversing method, however, is used almost exclusively on grinding machines of light construction and on light accurate work. There are two methods of feeding the wheel in on the work for traverse grinding; one is to feed the wheel in from about 0.0005 to 0.001 inch for every traverse of the wheel past the work, or the work past the wheel, depending on the type of machine used, and the other is to make two traverses of the wheel or work for each feeding-in movement. In rough-grinding, the wheel is fed in a distance varying from 0.0015 to 0.003 inch at each forward stroke, the spring in the material being depended upon to provide for a light cut on the return stroke. For finishing, the wheel is generally fed in about 0.0005 inch at every traverse of the wheel past the work or the work past the wheel, and usually from one to two traverses are made at the finish without any in-feeding of the wheel at all.

The "fixed-wheel" method of grinding on many classes of work supersedes traverse grinding from a production standpoint; for example, short lengths of work—not shoulder shafts—such as bushings, etc., can be economically ground by this method. The practice is to start by feeding the wheel in and traversing over the work until the work has been ground to the final size; then the position of the wheel is fixed, that is, it remains stationary as far as in-feeding is concerned, and for the next piece the wheel is fed straight across the work, taking a heavy cut; then it returns with a light cut, finishing the work to the required diameter.

This method of grinding is hard, of course, on the corner of the wheel, and the practice is generally to true the "feeding side" of the wheel to a slight angle. The extreme edge of the wheel is reduced about 0.030 inch in diameter and the face gradually tapered for about ¼ to ½ inch. As the examples in Figs. 25 to 29, inclusive, will show, this method of grinding is a highly productive one on classes of work for which it is adapted, but it could not be used with any degree of success on extremely long slender shafts because of the liability of chatter and springing of the work, even though it were rigidly supported by steady-rests. It also has a tendency to wear the wheel down rapidly, and difficulty is sometimes experienced in getting a wheel that will not clog or glaze and will still be hard enough to stand up to grind several pieces without retruing or resetting of the wheel slide. This method, however, is par-

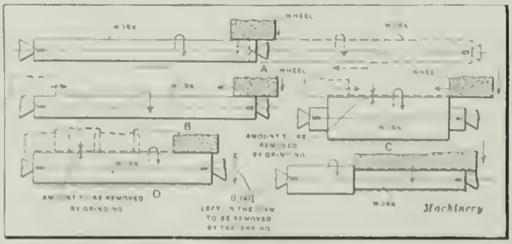

Fig. 1. Diagram Illustrating Different Methods of applying Wheel to Work for Cylindrical External Grinding

ticularly adapted to the grinding of bronze and cast-iron bushings, and work of a similar character. As far as the allowance for grinding is concerned, less metal is left on the diameter of the work to be removed by the grinding wheel when the fixed wheel method of grinding is used than when the regular traverse method is employed.

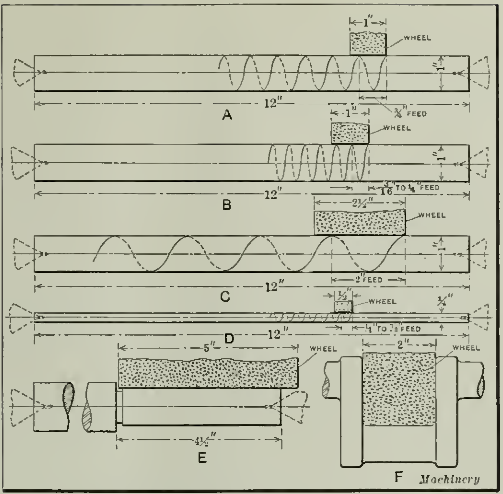

Fig. 2. Diagram illustrating Conditions which govern Width of Face of Grinding Wheels for External Cylindrical Grinding

The step-in method of grinding, as previously explained, consists in stepping the wheel in at intervals along the surface of the work to within about 0.001 to 0.003 inch of the finished size, and then making several rapid traverses, generally about two. This method can be used advantageously on comparatively long shafts that are either hard or soft when ground, but is of very little advantage on shoulder shafts or extremely long slender work. Some manufacturers are using this method for grinding parts that others are producing by the straight-in or form method. The step-in method can be used on comparatively light grinding machines that would not stand up to the form wheel proposition; furthermore, wheels of comparatively narrow face as regards those used for form grinding can be used. Generally for step-in grinding, the wheel used is about 2½ to 3 inches width of face, and about ¼ to ½ inch overlapping of the wheel is used for stepping-in along the work. The comparative production figures of work ground by the regular traverse method and that ground by stepping-in along the work show that the step-in method from a production standpoint is superior to the traverse method for certain classes of work. In the illustrations which follow, several very good examples of step-in grinding are given. These will serve to show the classes of work on which this type of grinding can be used to advantage.

Form or straight-in grinding is a comparatively recent development of the grinding art, and while form grinding was done about ten years ago, it is only within the last five or six years that it has come into commercial use. To accomplish this work, it has necessitated the entire re-designing of grinding machines and also required considerable investigation into the subject of grinding wheels. This subject is at the present time such an extensive one that it has been thought best to cover it separately, and the reader is referred to the article under this heading. Form grinding has its limitations, of course, as well as its advantages. On work over 10 inches in length, it cannot be used to advantage, and in fact on work of small diameter up to about 6 inches in length, it shows very little advantage as far as production is concerned over traverse grinding. On one particular example of work on which both methods were tried, the following results were obtained. The part ground was 3⅜ inches long and ⅜ inch in diameter. On forty of these pieces the total grinding time was 26 minutes, 26 seconds by the regular traverse method, and 21 minutes, 12 seconds by the straight-in or form method. This is a gain of a little over 5 minutes on forty pieces, but when we take into consideration the comparative cost of the wheel and the greater rigidity required in the machine for form grinding, which of course increases its cost, we find that from an actual cost standpoint, the form method has very little advantage over the regular traverse method on this particular piece of work. The chief reason for this was that the work was slender, of a small diameter and required very careful handling to get the required accuracy, which was 0.00025 inch plus—nothing under. This, of course, is an exceptional case, as will be shown in connection with the article on form grinding which presents many examples that clearly show the advantages of form grinding.

Allowances for External Cylindrical Grinding

The amount of metal to leave on the diameter of a piece for finish by grinding is governed by several conditions, among which might be mentioned: first, finish secured in lathe turning operation; second, condition of work when being ground, whether hard or soft; third, shape of work, whether in the form of a solid shaft or in the form of a thin wall bushing; fourth, when casehardened, the depth to which the casehardening scale penetrates; fifth, length of portion ground in proportion to its diameter; sixth, shape of work, whether plain cylindrical, or having a number of shoulders.

The character of the lathe turning operation preceding grinding has probably more to do with governing the allowance on the diameter for grinding than any other one factor. If the work is turned too close to the finish size before grinding, it is evident that less material will have to be removed by the grinding wheel; but light cuts and fine feeds in turning are not always the most economical way of manufacturing any particular part. On the other hand, if too large an allowance is left for grinding, this also is not economical because a large amount of stock could be more economically removed by rough-turning. In general practice, the part is rough-turned in the lathe, using a round-nose tool at a very coarse feed, of say 1/16 to 1/10 inch per revolution of the work, thus leaving a rough ridged surface. By this method of turning, quite a large limit is allowed because of the coarse feed used, which increases the difficulty of measuring the smallest diameter turned, the measuring tool taking the reading on the tops of the ridges.

Where the work is to be hardened, however, after turning, this method of roughing out is not satisfactory because the piece cannot be depended upon to harden evenly if it has a comparatively rough finish. When the part is to be hardened, therefore, it is necessary to get a smoother finish so that no extra allowance need be made in most cases whether the part is to be hardened or left soft previous to grinding.

The amount of stock that can be economically removed by grinding also depends to a certain extent upon the size and power of the grinding machine used. Where a very powerful and rigid grinding machine is used, carrying a comparatively wide-face wheel, considerable stock can be removed by the grinding machine. For ordinary commercial grinding on shaft work, the work is generally reduced in the lathe to within somewhere between 1/64 and 3/64 inch of the required diameter. When the diameter has been rough-turned to these dimensions, it is much more economical to remove the stock by grinding

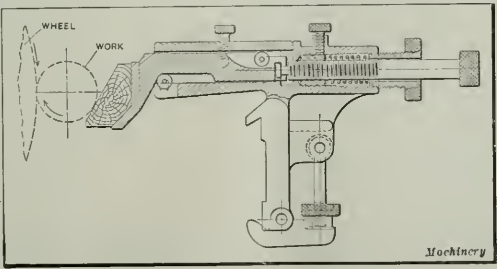

Fig. 3. Plain Type of Steadyrest used principally on Universal Grinding Machine

TABLE I. ALLOWANCES FOR EXTERNAL CYLINDRICAL GRINDING—ALL MATERIALS

Diameter of Work in Inches	Length of Work in Inches													
	2	4	6	8	10	14	18	24	30	36	42	48	54	60
1/8	0.006	0.007	.....	.....	.....	.....	.....	.....	....	..	.....	.....	...	....
1/4	0.006	0.008	0.010	.....	.....	.....	....	.....	.....	.....	.....	.....	....	...
3/8	0.007	0.008	0.010	0.012	0.013	.....	.....	.....	.....	.....	.....	.....	....	...
1/2	0.008	0.009	0.011	0.012	0.013	0.015	0.016	.....	.....	.....	.....	.....	.....	.....
3/4	0.008	0.009	0.011	0.013	0.014	0.016	0.017	0.018	.....	.....	.....	.....	.....	.....
1	0.009	0.010	0.012	0.013	0.014	0.016	0.018	0.019	0.020	....	.....	.....	.....	.....
1¼	0.009	0.011	0.012	0.014	0.015	0.017	0.018	0.019	0.020	0.022	.....	.....	.....	.....
1½	0.010	0.011	0.013	0.014	0.016	0.017	0.018	0.019	0.021	0.023	0.024	.....	.....	.....
1¾	0.011	0.012	0.013	0.015	0.016	0.018	0.019	0.020	0.022	0.023	0.025	0.026	.	.....
2	0.012	0.013	0.014	0.016	0.017	0.018	0.019	0.021	0.022	0.024	0.026	0.027	0.028	.....
2½	0.013	0.015	0.016	0.017	0.018	0.019	0.020	0.022	0.023	0.025	0.027	0.028	0.030	0.032
3	0.015	0.016	0.017	0.018	0.019	0.020	0.022	0.024	0.025	0.027	0.028	0.030	0.032	0.034
3½	0.016	0.017	0.018	0.019	0.020	0.022	0.023	0.025	0.027	0.028	0.030	0.032	0.034	0.035
4	0.017	0.018	0.019	0.020	0.021	0.023	0.025	0.027	0.028	0.030	0.032	0.033	0.035	0.037
5	0.018	0.019	0.021	0.022	0.023	0.025	0.027	0.029	0.031	0.032	0.034	0.036	0.037	0.039
6	0.020	0.021	0.023	0.024	0.025	0.027	0.029	0.031	0.033	0.035	0.037	0.039	0.041	0.043
7	0.022	0.023	0.025	0.026	0.027	0.029	0.031	0.033	0.035	0.037	0.039	0.041	0.042	0.044
8	0.024	0.025	0.027	0.028	0.029	0.031	0.033	0.035	0.037	0.039	0.041	0.043	0.044	0.045
9	0.026	0.027	0.028	0.029	0.030	0.032	0.034	0.036	0.038	0.040	0.042	0.044	0.045	0.045
10	0.027	0.028	0.030	0.031	0.032	0.033	0.035	0.037	0.040	0.042	0.044	0.045	0.045	0.045
11	0.029	0.030	0.031	0.032	0.033	0.035	0.036	0.038	0.041	0.043	0.045	0.045	0.045	0.045
12	0.030	0.031	0.032	0.033	0.034	0.036	0.038	0.040	0.042	0.045	0.045	0.045	0.045	0.045

Machinery

than by taking a light finishing cut in the lathe, provided, of course, that a grinding machine of sufficient power is available.

Table I gives the allowance to be left on the diameters for grinding average work, but does not take into consideration special cases such as an extremely rough finish before grinding, hardened thin wall bushings that are liable to warp out of shape to a greater or less extent, or long shaft work that has been considerably sprung out of shape in hardening. Of course, long hardened shaft work, as a rule, requires straightening previous to grinding, but it is difficult to anticipate what will happen when the hardening scale is removed.

There are two distinct methods recommended for roughing out the work previous to grinding; one is to carefully turn the work to within from 0.010 to 0.015 inch of the finished size, and then finish by grinding; the other is to rough out the work quickly, taking light cuts (when the work is slender) with comparatively coarse feeds and high work-speeds, leaving a greater amount to remove by grinding; but as the tool "cuts a thread" on the work only the high points have to be removed by the grinding wheel over and above the amount left for grinding when the work is turned smooth. There are advantages in both methods, depending on the class of work being machined. Where the work is large in diameter in proportion to its length and will stand heavy lathe cuts, the latter method can be used to advantage. But where the work is light or small in diameter in proportion to its length, the first mentioned practice seems to be the safest one to follow. It is therefore evident that the amount to leave on the diameter for grinding is governed almost entirely by the character of the work and the other requirements mentioned.

Preparation of Work for Grinding

The preparation of soft work for grinding has been covered in the section dealing with the allowances for external cylindrical grinding, but much can be said regarding the preparation of work that must be hardened prior to grinding. Work that is hardened may be so bent or distorted as to require straightening, and there is always the chance that it may resume its crooked form after considerable time has been spent in grinding it. As a rule, this results from lack of care in preparing the steel previous to the machining operations. Steel, as it comes from the mill or forging machine, is likely to contain hidden strains that can only be released by reheating or annealing. If the annealing operation is carefully handled, it is possible to remove these strains and put the steel in such a condition that warping in hardening is reduced to a minimum.

If the piece of work to be machined is made from bar stock, it should be carefully centered and straightened as true as possible, previous to turning. This is necessary because the bar in its roughened condition is decarbonized on the surface, as well as for a slight distance below it, and this material, of course, must be removed in order to make the piece harden evenly. The straightening of the bar should not be done cold, as the bar will resume its original condition when heated. It is preferable to straighten the bar after it has been heated, and after this it can be roughed out in the lathe and then carefully annealed after the roughing cut has been taken. Should it come out crooked after the second annealing operation, it should be again straightened while hot and another cut taken. As a rule, this leaves it in a satisfactory condition for grinding.

In grinding shoulder shafts where the grinding machine is not provided with locating stops, it is generally advisable to neck the shaft at the shoulder previous to grinding, if a sharp corner is required on the work; then the operator does not need to be as careful in bringing his wheel in to the shoulder as he would if no necking were provided. When shoulder shafts are to be hardened previous to grinding, however, it is advisable where possible to have the corner rounded, having a liberal fillet to prevent warping and water cracks developing. Another point that should be observed in the grinding of shoulder shafts is to have the center holes all of the same depth in order that the stop for governing the location of the shoulders need not be changed for each shaft. It is necessary to give particular care to the centers in the work, especially when a large number of duplicate pieces are to be turned out.

When the shaft to be ground is provided with keyways, the best procedure is to first turn the shaft to the roughing size, then cut the necessary keyways and do the grinding last. Work cannot be finished satisfactorily in the lathe with a keyway cut in it, and if the grinding is done after the keyway is cut all objectionable burrs are removed and the work is finished without filing. In work that is hardened, the centers should be cleaned out and care taken to see that no burrs have been formed or that they have been otherwise deformed. It is impossible to get true cylindrical work on a poor center. A good lubricant for grinding machine centers is a mixture of powdered red lead (oxide of lead) and lard oil. When using this lubricant, if the lead dries out, the centers do not cut, but simply take on a high polish.

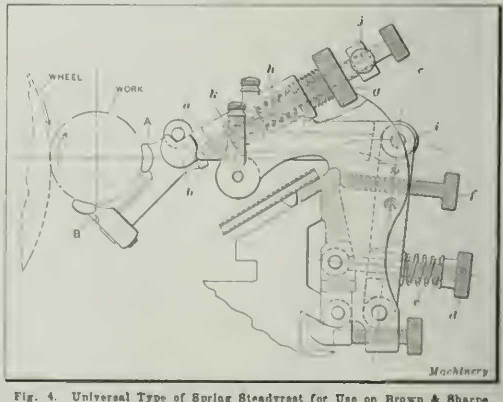

Fig. 4. Universal Type of Spring Steadyrest for Use on Brown & Sharpe No. 1 Universal Grinding Machine

Conditions Governing Width of Face of Grinding Wheels for External Cylindrical Grinding

The width of face to use for a grinding wheel is governed largely by the work to be ground and to some extent by the machine in which the operation is to be accomplished. In the first grinding machines, which were built for performing cylindrical grinding operations, narrow face wheels were used, because of the fact that the grinding machine was designed for finishing only and consequently was lightly constructed. Wide face wheels could not be used on the machine because of the liability of chatter from vibration, and wheels much wider than ½ inch were uncommon. In fact, a ½-inch wheel was at first the standard width for most work.

Following closely on the improvements made in the design of grinding machines, the width of wheel face was gradually increased for cylindrical grinding, until at the present time wheels as wide as 12 inches are used for some grinding operations. For traverse grinding, there are certain conditions that govern the width of the wheel. Referring to *A* and *B* in Fig. 2, a 1-inch face wheel is shown taking a roughing and finishing cut, respectively. When rough-grinding, a traverse feed is used that will enable the bulk of the material to be quickly removed. In theory, this traverse feed is supposed to be about equal to the width of the wheel, that is, the wheel would be advanced an amount equal to its width at each revolution of the work. In practice, however, this is very seldom used and a feed of from two-thirds to nearly the full width of the wheel per revolution of the work has been found to give the best results. In finish-grinding, the traverse feed of the wheel is somewhat reduced and is generally about one-third to one-quarter of the roughing feed.

There are two methods in use for rough- and finish-grinding cylindrical work, one of which is to increase the work speed for finishing and thereby decrease the traverse feed, and the other is to decrease the work speed as well as the traverse feed. Both methods are used to advantage in grinding practice, and the one to be employed depends on several conditions. Take a certain job upon which a comparatively soft free-cutting wheel is used. For rough-grinding, the work speed would be about 25 feet per minute, and if this same wheel were used for finish-grinding, it would be necessary to reduce the work speed about 25 per cent to get the desired finish. Should a harder and more compact wheel be used for finishing, the speed would be increased over that used for roughing. In modern grinding practice, when rough-grinding it is generally advisable to use a fairly coarse wheel of a soft enough grade to cut freely, and a comparatively slow work speed in conjunction with a coarse side feed of the wheel or work. This method can be used to the best advantage on machines that are heavily constructed and provided with sufficient driving power to enable these broad cuts to be taken without excessive vibration. With a light grinding machine, however, this coarse feed is not advisable, owing to the lack of rigidity and the low driving power, so that the question as to whether a high or low work speed for finishing is better is dependent in most cases upon the wheel used and to a certain extent upon the machine that carries it. As a general rule, however, the harder the bond and finer the grain of the wheel used, the higher should be the work speed.

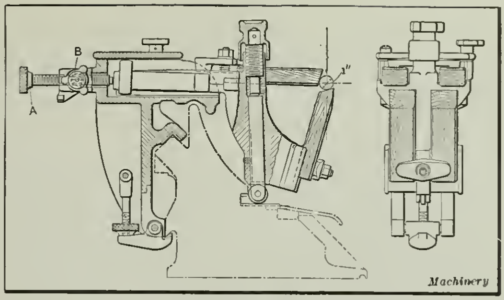

Fig. 6. Solid Type of Steadyrest adapted to 14-, 18- and 20-inch Norton Plain Grinding Machines

Two of the chief requirements are production and accuracy. In some cases one is sacrificed for the other, whereas in others both may be necessary. Usually, however, production is the factor that is most sought; consequently anything that tends to increase production is of value. One of the factors that assists in increasing production is increasing the width of the wheel face. This, as is shown by *C* in Fig. 2, enables greater traverse feeds to be taken, and where the machine is of sufficient power and rigidity, the wide face wheel is capable of greatly increasing production over a narrower face wheel. In other words, a greater number of pieces could be turned out by the wheel shown at *C* than by that at *A* because of the possibility of increasing the traverse feed per revolution of the work. The most advanced practice, therefore, is to use a wide face wheel varying in width from about 1½ to 4 inches (for traverse grinding) and a comparatively coarse feed and slow work speed. In this way, the excess material on the diameter of the work can be most economically removed. Of course in using a wide face wheel it is necessary that the work be properly supported, and for this reason a liberal use of steadyrests is advisable. In many cases, the greater the number of back-rests used, the greater will be the accuracy and production.

There are cases where the advantage of a wide face wheel is questionable. Take, for instance, a small slender shaft ¼ inch diameter and 12 inches long (see *D* Fig. 2) which has been hardened. On hardened work a harder bond wheel is used than for soft work, and consequently there is a slightly greater pressure on the work when grinding it. For this reason it is sometimes advisable to cut down the width of the face of the wheel in order to reduce the wheel pressure. The practice with some manufacturers is to use an elastic wheel about ½ inch face for both roughing and finishing cuts, using a softer bond wheel for roughing than for finishing. In addition to this, the work must also be rigidly supported by means of steadyrests, and light cuts with rough traverse feeds and high work speeds are used. There are cases, however, when a slender shaft can be ground with a comparatively wide face wheel, but this is recommended more for the grinding of soft work than for hardened work. Practice differs to some extent in the grinding of small slender shafts, depending on the condition of the work and the finish desired. On machine tool work where a shaft is to be held to close limits, great care is exercised both in roughing and finishing, in order to get the desired results.

In "straight-in" grinding still another condition is presented which governs the width of the face of the wheel, as shown at *E* in Fig. 2. Here the wheel must be of a width slightly greater than the length of the portion to be ground, because it is fed straight in on the work without any lateral traverse. The usual practice is to have the

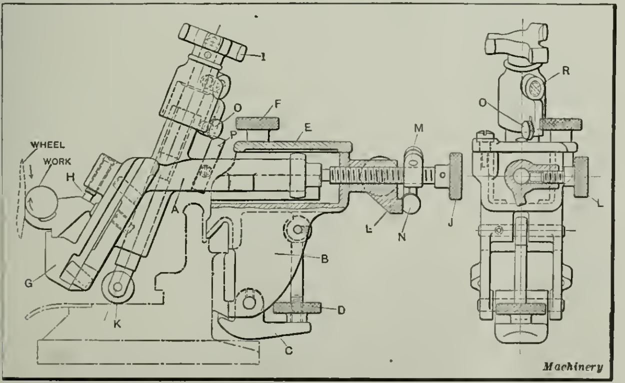

Fig. 5. Solid Type of Steadyrest adapted to 6- and 10-inch Norton Plain Grinding Machines

TABLE II. GRINDING WHEEL SPEEDS

Diam. of Wheel in Inches	Surface Speed of Grinding Wheel in Feet per Minute								
	4000	4500	5000	5500	6000	6500	7000	7500	8000
	R. P. M. of Grinding Wheel								
4	3820	4297	4775	5252	5730	6207	6684	7162	7639
5	3056	3438	3820	4202	4584	4966	5348	5730	6112
6	2546	2865	3183	3501	3820	4138	4456	4775	5093
7	2183	2455	2728	3001	3274	3547	3820	4092	4365
8	1910	2148	2387	2626	2865	3103	3342	3581	3820
10	1528	1719	1910	2101	2292	2483	2674	2865	3056
12	1273	1432	1592	1751	1910	2069	2228	2387	2546
14	1091	1227	1364	1500	1637	1773	1910	2046	2183
16	955	1074	1194	1313	1432	1551	1671	1790	1910
18	849	955	1061	1167	1273	1379	1485	1592	1698
20	764	859	955	1050	1146	1241	1337	1432	1528
22	694	781	868	955	1042	1128	1215	1302	1389
24	637	716	796	875	955	1034	1114	1194	1273
26	587	661	734	808	881	955	1028	1101	1175
28	546	614	683	751	819	887	955	1022	1091
30	509	573	637	701	764	827	891	955	1019
32	477	537	597	656	716	775	835	895	955
34	449	505	561	617	674	730	786	842	898
36	424	477	531	584	637	690	743	796	849

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wheel anywhere from ¼ to 1 inch wider than that portion of the work covered by it.

In grinding the throws of crankshafts, as shown at *F* in Fig. 2, the width of face of the wheel is governed by the distance between the cheeks of the crank. In this case the wheel has to be held down to fairly accurate dimensions as regards width, and usually is slightly less in width than the distance between the cheeks, the sides of the cheeks being finished previous to grinding in an engine lathe. There are, of course, other conditions met with in cylindrical grinding that call for specified widths of wheel faces, but those given in the foregoing cover general practice.

Wheel and Work Speeds for External Cylindrical Grinding

The recommended peripheral speeds for wheels for external cylindrical grinding vary from 5000 to 7000 feet surface speed per minute. Wheels softer than grade K should not be operated at a speed above 6000 feet, whereas hard bond wheels can be operated up to 8000 feet, although a speed as high as this is not recommended for general work. Wheels made from corundum, alundum or like abrasives are generally operated at 6000 feet surface speed, whereas wheels made from carbolite, crystolon, carborundum, etc., are generally operated at 5500 feet surface speed.

The speed of the wheel, however, is governed largely by the character of the work and the machine on which it is being used. For instance, other conditions being equal, a grinding machine of massive construction can successfully use soft wheels and run at lower speeds than a grinding machine of a lighter type. The greater mass of the heavy machine reduces vibration and makes the soft wheel work efficiently, where a harder wheel and a higher speed would be necessary to get good results on a lighter machine. Table II gives the corresponding revolutions per minute for grinding wheels from 4 to 36 inches in diameter when operated at peripheral speeds of 4000 to 8000 feet per minute.

The efficiency of a grinding wheel is dependent upon the relative speeds of the wheel and work. In order to have some constant to work from, it is advisable to have the wheel speed fixed and the work speed varied until satisfactory results are obtained, assuming that the proper wheel for the work has been selected. After deciding upon the wheel and wheel speeds, the next factors to take into consideration are the relations between the work speed and side feed of the wheel or work. These factors, in turn, have a direct bearing upon the wheel wear. For instance: the higher the work speed—other factors remaining the same—the greater the wheel wear; the greater the depth of cut the greater the wheel wear; and the more the vibration the greater the wear on the wheel.

At the present stage of the grinding art there are in use two general conditions or groups of combinations of wheel speeds, work speeds, feeds, etc. The first group includes soft wide wheels, slow wheel and work speeds, and greater side traverse with a comparatively shallow depth of cut, whereas, the second includes narrow and hard wheels, high work and wheel speeds and slow side traverse or fine feeds. The depth of cut bears an inverse ratio in either case to the traverse speed and can be increased without any marked change of results, provided the side traverse is correspondingly decreased. The conditions just mentioned refer more directly to roughing out, and obtaining a commercial finish. To obtain a fine finish, most authorities agree that a higher work speed and finer traverse feed is desirable, together with the use of a finer grain, harder bond wheel.

The question of work speeds is therefore a broad one. In the first combination of conditions previously mentioned, the

TABLE III. WORK SPEEDS FOR CYLINDRICAL GRINDING

Diameter of Work in Inches	Surface Speed of Work in Feet per Minute																	
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	90	100
	R. P. M. of Work																	
¼	76.4	152.8	229.0	305.0	382.0	458.0	535.0	611.0	688.0	764.0	851.0	917.0	994.0	1070.0	1147.0	1222.0	1376.0	1528.0
⅜	50.9	101.8	153.0	204.0	255.0	306.0	357.0	408.0	458.0	509.0	560.0	611.0	662.0	713.0	764.0	815.0	916.0	1018.0
½	38.2	76.4	114.0	153.0	191.0	229.0	268.0	306.0	344.0	382.0	420.0	459.0	497.0	535.0	573.0	611.0	688.0	764.0
⅝	30.6	61.2	92.0	122.0	153.0	184.0	214.0	245.0	276.0	306.0	337.0	367.0	398.0	428.0	459.0	489.0	552.0	612.0
¾	25.4	50.8	76.5	101.0	127.0	153.0	178.0	203.0	229.0	254.0	279.0	306.0	330.0	357.0	381.0	408.0	458.0	508.0
⅞	21.9	43.8	65.5	87.5	109.0	131.0	153.0	175.0	196.0	219.0	241.0	262.0	285.0	306.0	329.0	349.0	392.0	438.0
1	19.1	38.2	57.5	76.5	95.5	115.0	134.0	153.0	172.0	191.0	210.0	229.0	258.0	267.0	287.0	306.0	344.0	382.0
1⅛	17.0	34.0	51.0	68.0	85.0	102.0	119.0	136.0	153.0	170.0	187.0	204.0	221.0	238.0	255.0	272.0	306.0	340.0
1¼	15.3	30.6	45.9	61.5	76.3	91.8	107.0	123.0	137.0	153.0	168.0	183.0	199.0	214.0	230.0	245.0	274.0	306.0
1½	12.7	25.4	38.1	51.0	63.7	76.3	89.2	102.0	115.0	127.0	140.0	153.0	165.0	178.0	191.0	204.0	230.0	254.0
1¾	10.9	21.8	32.7	43.6	54.5	65.5	76.4	87.3	98.2	109.0	120.0	131.0	142.0	153.0	164.0	175.0	196.0	218.0
2	9.5	19.1	28.6	38.2	47.8	57.3	66.9	76.4	86.0	95.5	105.0	115.0	124.0	134.0	143.0	153.0	172.0	191.0
2¼	8.5	17.0	25.5	34.0	42.2	51.0	59.4	68.0	76.2	85.5	93.5	102.0	111.0	119.0	128.0	136.0	153.0	170.0
2½	7.6	15.3	22.9	30.6	38.2	45.8	53.5	61.2	68.8	76.3	84.2	91.7	99.5	107.0	114.0	122.0	138.0	153.0
2¾	6.9	13.9	20.8	27.8	37.4	41.7	48.6	55.6	62.5	69.5	76.5	83.4	90.4	97.2	104.0	111.0	125.0	139.0
3	6.3	12.7	19.1	25.5	31.8	38.2	41.6	51.0	57.3	63.7	69.9	76.4	82.6	89.1	95.3	102.0	114.0	127.0
3½	5.4	10.9	16.3	21.8	27.3	32.7	38.2	43.6	49.1	54.5	60.0	65.5	70.8	76.4	81.8	87.4	98.1	109.0
4	4.8	9.5	14.3	19.1	23.9	28.7	33.4	38.2	43.0	47.8	52.6	57.3	62.1	66.9	71.7	76.4	86.0	95.6
4½	4.2	8.5	12.7	17.0	21.2	25.4	29.6	34.0	38.2	42.4	46.6	51.0	55.1	59.4	63.6	67.9	76.3	84.8
5	3.8	7.6	11.4	15.8	19.1	22.9	26.7	30.6	34.4	38.2	42.0	45.9	49.7	53.5	57.3	61.1	68.8	76.4
5½	3.4	6.9	10.4	13.9	17.4	20.8	24.8	27.8	31.3	34.4	38.2	41.7	45.1	48.6	52.0	55.6	62.5	69.4
6	3.2	6.3	9.5	12.7	15.9	19.1	22.3	25.5	28.7	31.8	35.0	38.2	41.3	44.6	47.7	51.0	57.2	63.6
7	2.7	5.4	8.2	10.9	13.6	16.4	19.1	21.8	24.6	27.3	30.0	32.7	35.5	38.2	41.0	43.7	49.1	54.6
8	2.4	4.8	7.6	9.5	11.9	14.3	16.7	19.1	21.1	23.9	26.8	28.7	31.0	33.4	35.9	38.2	43.0	47.8
10	1.9	3.8	5.7	7.6	9.5	11.4	13.3	15.3	17.2	19.1	21.0	22.9	24.8	26.7	28.6	30.5	34.4	38.2
12	1.6	3.2	4.7	6.3	7.9	9.5	11.1	12.7	14.3	15.9	17.5	19.1	20.6	22.3	23.8	25.5	28.6	31.8

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work speed is taken at from 5 to 20 feet surface speed per minute, for roughing out, and 25 to 40 feet surface speed for finishing, and a traverse of from two-thirds up to the full width of the wheel per revolution of the work.

The second combination calls for a work speed of from 25 to 60 feet per minute for roughing and 60 to 100 feet for finishing, with a side traverse of from one-quarter to one-half the width of the wheel per revolution of the work. For average work, the Brown & Sharpe Mfg. Co. recommends a speed for roughing of from 25 to 65 feet and from 10 to 20 feet higher in all cases for finishing. Table III gives the surface speeds of work for various diameters ranging from 5 to 100 feet surface speed per minute.

The character of the material being ground also has a considerable bearing upon the speed of the work, and assuming that a satisfactory wheel for the work in each case has been selected, the surface speed for the work can then be more easily determined. The work speeds given in Table IV are taken from general practice, and do not cover special conditions, or take into consideration the diameter of the work, which also is a deciding factor in the selection of the proper work speed to use. The depth of cut per traverse of the wheel or work, as has been previously mentioned, varies from 0.0005 to 0.003 inch. For roughing out, the depth of cut (on the radius of the work) varies from 0.0015 to 0.003 inch, and for finishing, from 0.0005 to 0.001 inch.

Methods of Preventing Chatter

Chattering is generally attributed chiefly to vibration. It was not at first recognized that chatter marks were caused by the vibration of the work itself, but the fault was laid to vibration of the machine and the foundation upon which it was placed. Considerable time and money was spent on foundations before the true cause of chatter was ascertained. It is now a comparatively well-known fact that practically all work that is ground will vibrate to a greater or less extent under the cut of the wheel, regardless of the machine in which it is ground. Chatter is usually caused by the work not being properly supported and by the use of incorrect work speeds. By selecting the correct work speed and properly supporting the work, it is possible to grind cylindrical work round and smooth and produce an accurate surface.

Chatter in the work is sometimes attributed to imperfect gearing in the machine, where the machine is of the gear-driven type. As a rule, however, it will be found that the gearing is correct and the marks are caused by the vibration of the work. It is probable in some cases that the driving dog sets up vibration owing to the fact that there is torsion in the dog when a heavy cut is taken and when the work is not properly supported. Chatter marks usually take the form of small flats that appear on the surface of the work, and it is sometimes possible to locate the trouble from the appearance of these flats. They also assume in some cases a spiral form of coarse pitch, which generally indicates that the wheel is untrue or not of homogeneous structure. When they are of a fine pitch in spiral form, the cause is generally vibration of the wheel spindle, which may be either too weak or loose in its bearings. Driving belts that are of unequal thickness may vibrate the wheel spindle to such an extent as to cause chatter of the work. Another method to obviate chatter on large work is to provide the work with larger center holes so as to have as large a support as practicable on the centers. Chattering can sometimes be avoided by giving particular attention to the relation of the wheel and the work speed, by having these speeds so adjusted that the wheel will not have a tendency to glaze but will at all times be free cutting.

Chatter marks are likely to develop in the grinding of crankshafts or other work that is of irregular shape or eccentric at various portions along its length. This is due to the eccentricity of the revolving mass, throwing the work out of balance and causing vibration. One way to avoid this is to reduce the speed of the work, but the most satisfactory way is to balance the work properly so as to reduce the vibration to a minimum. Assuming that the grinding machine is in perfect running condition, and that the wheel is perfectly balanced and properly dressed, if chatter marks develop it is a sure indication that the work is improperly supported. Therefore, one of the best ways of overcoming chatter is to support the work properly by means of steadyrests. There is practically no job of cylindrical grinding of any length where a steadyrest is not an advantage, no matter how heavy the piece of work or of what shape or length. A steadyrest is always an advantage and will increase production if used with a correct speed of wheel and work. The combination of proper steadyrest and slow work speed is one of the best ways of overcoming chatter and securing a good finish on accurate work.

Different Types of Steadyrests

Steadyrests properly applied will, in most cases, obviate chatter marks on the work. There are some classes of work, of course, for which a steadyrest is of very little advantage, but on long slender work a steadyrest is necessary to reduce vibration and enable accurate work to be turned out rapidly. The type of steadyrest to use depends largely on the character of the work, type of machine, and to a certain extent on personal preference. Most authorities on this subject, however, advocate the use of spring steadyrests for light slender

TABLE IV. WORK SPEEDS FOR ROUGH- AND FINISH-GRINDING VARIOUS MATERIALS

Work speeds based on 6000 feet surface speed for Alundum, Aloxite and Corundum wheels, and 5500 feet for Carbolite, Carborundum and Crystolon Wheels

Material	Abrasive	Process of Manufacture	Grain	Grade	Surface Speed of Work in Feet per Minute	
					Roughing	Finishing
Aluminum (Cast)	Carbolite, Carborundum or Crystolon	Elastic	36 to 40	2 E to 2½ E 2 4	60 to 70	60 to 70
Brass or Bronze (Cast)	Corundum, Carborundum or Crystolon	Vitrified	24 to 30	M to N L to M P	60 to 70	60 to 70
Iron (Cast)	Carbolite, Carborundum or Crystolon	Vitrified	40 to 46	K to M L to N L to M	50 to 55	50 to 55
Steel-Alloy, Heat-treated	No. 38 Alundum No. 58 Corundum Aloxite	Vitrified	24 Comb. 40	L J	20 to 25	30 to 40
Steel 0.20 to 0.50 Per Cent Carbon (Soft)	No. 38 Alundum No. 58 Corundum Aloxite	Vitrified	24 to 36 Comb. 36	L to M M to O	25 to 30	40 to 45
Steel 0.20 to 0.50 Per Cent Carbon (Hardened)	Alundum, Corundum or Aloxite	Vitrified	46 36	K P	30 to 35	50 to 55

Machinery

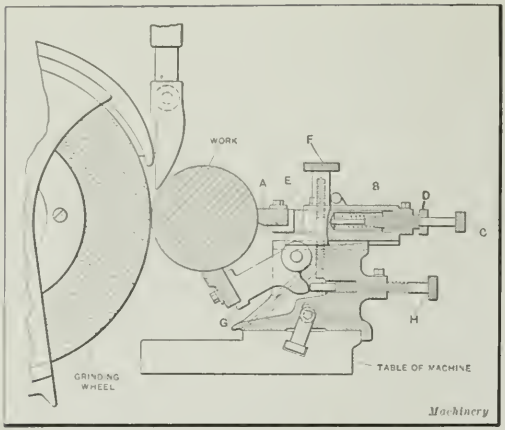


Fig. 7. Stationary Type of Steadyrest for Use on All Sizes of Landis Plain and Universal Grinding Machines

work, and rigid rests for heavy work. Practically all spring steadyrests, however, are capable of being locked, so that they are rigid enough in most cases to be applied to both heavy and light work.

Spring Steadyrests of Plain and Universal Types

One of the simplest types of steadyrests is shown in Fig. 3. This is called a plain steadyrest, and is only used where the work can be more conveniently ground with a slight additional support. It is not universally adjustable and consequently its range is limited. In steadyrests of this kind, shoes of both metal and wood are used; for hardened work, as a rule, shoes made from bronze are found to give the best results. The shoes are shaped to suit the work, and usually, instead of having a bevel as shown, the surface is curved to fit the diameter of the work being ground. When only a few pieces of one size are being turned out, however, the shoes for steadyrests of this type are generally made from wood because they can be more easily made and fitted than metal shoes.

A steadyrest of the universal type adapted for use on the No. 1 Brown & Sharpe universal grinding machine is shown in Fig. 4. This steadyrest is universal in all its movements, and capable of very delicate adjustment. The solid shoe used in this rest is generally made of bronze and a different size is required for each variation in diameter of the work. This type of rest is particularly adapted to work requiring a high degree of accuracy, and especially for shafts that are keyseated or under 1 inch in diameter. Its use is recommended where a large volume of work of one diameter is to be done. The same steadyrest, however, with adjustable shoes can be used for work on which a few pieces only are required.

The method of operating this steadyrest is as follows: First, select a shoe of the size of the work being ground, and hook the trunnion *a* in the V-support *b*. Then turn screw c back far enough to allow the shoe to clear the work, and loosen nut *d* to relieve the pressure on spring c. Then turn back screw *f*. Next turn screw *g* forward until a light pressure is given to spring *h*.

Screw c should now be turned forward and if spring *e* is wholly relieved and screw *f* is back far enough, the shoe will come in contact with the work at both points *A* and *B*. A slight pressure should now be exerted on trunnion *i* to hold the shoe in contact with the work, and screw *f* should be carefully tightened, noting the slightest touch of the end of the screw against the stop so that none of the parts will be moved. With this screw still in contact with the stop, the shoe should bear equally at both points *A* and *B*. Nut *d* should then be tightened to increase the pressure on spring *e*. The combined pressure on springs *e* and *h* should be just sufficient to resist the pressure of the wheel when taking the last cut on the work and to prevent vibration of the work under any cut that it may be desired to take. After the proper adjustments have been made, clamping screw *j* should be tightened to prevent screw c from loosening.

The next step is to grind a trial piece of work; at this time screw c is moved to maintain the contact of the shoe with the work, and screw *f* is adjusted to preserve the relative diameters at the various points. As the work approaches the finished size, it should be measured where the different steadyrests contact with it after each cut. After the trial piece is finished with the diameters alike at all points, the shoe should bear equally at points *A* and *B* and the sliding nut *k* should rest against the shoulder. The parts should now be left in this relation and another piece of work ground, adjusting the screw c only as the shoe wears and screw *f* for slight changes of the diameter. The effect of this adjustment should be noted on the work by the sparks from the wheel.

With the various screws properly adjusted, the springs of this steadyrest cannot push the work beyond the required size. When the work is finished to size, nut *k* and screw *f* should rest against the shoulder and stop, respectively, so that further pressure of the springs is impossible. The shoe and wheel will then be left in the proper position for sizing duplicate pieces. It is necessary, however, to get the relative pressures of springs *e* and *h* correct. When unground work is placed on the centers of the machine and in the shoe bearings, the nut *k* and screw *f* will be forced away from the shoulder and stop, thus compressing the springs *e* and *h*. Should the shoe bear unequally at points *A* and *B*, tighten screw *d* to increase the pressure at *A*, and screw *g* to increase the pressure at *B*. The combined pressure of springs *c* and *h*, however, should not be greater than is necessary to support the work, as long, slender work, although of uniform diameter, may not be straight when released from the shoes unless some allowance is made for the elasticity of the material. When adjustable bronze shoes are used to support pieces of various diameters, first loosen the screw which clamps the lower bearing shoe, and adjust it until the work bears centrally on both shoe surfaces, then retighten the set-screw.

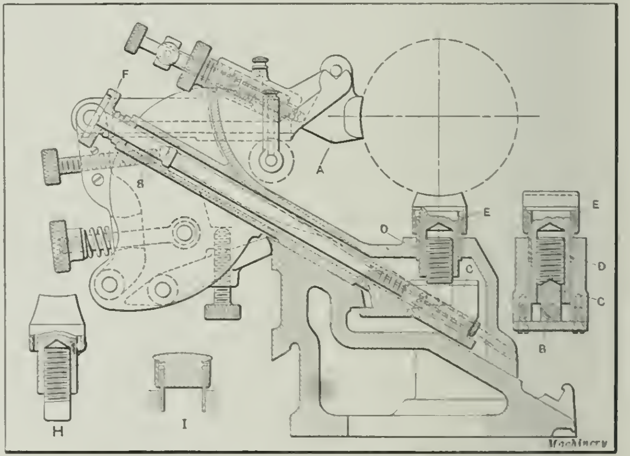


Fig. 8. Combination Type of Plain and Rigid Steadyrest adapted to Brown & Sharpe Plain Grinding Machines

Solid Type of Steadyrests

The steadyrest shown in Fig. 5 is known as the solid type of steadyrest and is used wherever possible on Norton 6-inch and 10-inch machines. It is particularly adapted for carrying hardened and ground work-shoes and is used especially where exact duplication of work is required, say to limits of 0.0005 inch. For the 6-inch machine, this steadyrest has a range of from ¼ to 2½ inches in diameter, and for the 10-inch machine from ¼ to 4 inches in diameter. Hardened work-shoes are used only when the work is standard, that is, where a number of pieces of the same size are being made, but for jobbing work wooden shoes are used in place of the hardened ones.

In applying the solid type of steadyrest, the shoe should be brought up firmly against the work while in the rough, whether the work be out of round or not. Grinding machine operators, as a rule, hesitate to do this because they see the shaft sprung out of line and wabbling back and forth. The irregularity of contour, however, which causes displacement, does not appreciably affect the final accuracy of the ground part. The reason for this is that as the roughness is removed the lateral displacement becomes less and less and finally disappears altogether when the work is true. Then the steadyrests that support the work longitudinally may be adjusted for the finish-grinding.

The method of applying and operating the steadyrest shown in Fig. 5 is as follows: The adjustable support *A* can be raised, lowered or moved longitudinally, and the body *B* is quickly clamped on the machine with clamps *C* and thumb-nut *D*. The cover *E* is held in place by a thumb-screw *F*, and when this screw is released can be swung on a pivot to permit the removal of the adjustable support *A*. The work-shoe is hardened and ground to size, this shoe being quickly put in place or removed from the holder *G* by means of a screw *H*. It has a bearing in the holder on three points, thus insuring rigidity.

The vertical adjustment of the shoe is secured through knob *I* and the horizontal or back-and-forth adjustment through screw *J*. The roll *K* moves freely on the resting surface of the work-table and allows free horizontal motion of work that is not true and straight before grinding. The knob *L* is used to clamp the screw *J* when necessary. The adjustable stop *M* is threaded onto the screw *J* and allows free motion until the correct size is obtained on the first of a number of duplicate pieces that are to be ground. Then stop *M* is made fast to the screw *J* by clamping screw *N*. The screw *J* can then be turned back to allow an unground piece of work to be placed on the centers and ground. This screw is then adjusted from time to time as the grinding proceeds until the stop-screw is reached, which limits further motion of the work supports and gives accurate duplication of work; the stop-screw (not shown) in stop *M* also allows delicate adjustment for the exact size of work to be obtained. Stop-screw *O* serves the same purpose for the vertical adjustment of the rest, coming in contact with stop *P*. The clamping screw *R* fastens the stop firmly to the shoulder on knob *I*. Wooden work-shoes can be used in this steadyrest instead of hardened shoes where only a small number of pieces are to be ground.

The steadyrest shown in Fig. 6 is also of the solid type, and is used on Norton 14-, 18-, and 20-inch machines, each rest being supplied with a set of four hard wooden blocks; two on the horizontal support and two on the angular or vertical supports. This steadyrest is fastened to the machine in the same manner as that shown in Fig. 5, but the method of adjusting the supporting shoes is somewhat different. In this case the horizontal supports are not adjustable up or down from the center of the work, but of course can be adjusted back and forth, and are held in place by means of a toe clamp. The vertical shoes are adjusted in a similar manner to that shown in Fig. 5, and are controlled by the screw *A* provided with a locking nut *B*. The angle on the lower shoe is changed for different diameters of work, as will be described in connection with the diagram illustrating different types of work-shoes. This type of steadyrest, as will be described later, is also provided with shoes made from different materials. For large-diameter work, the lower shoes are made of cast iron instead of wood. This type of steadyrest is never used to support work of a long slender nature, but is used chiefly for large-diameter work, the wooden shoes being used for work up to about 4 inches diameter and the iron shoes for work of larger diameter than this, up to the full capacity of the machine.

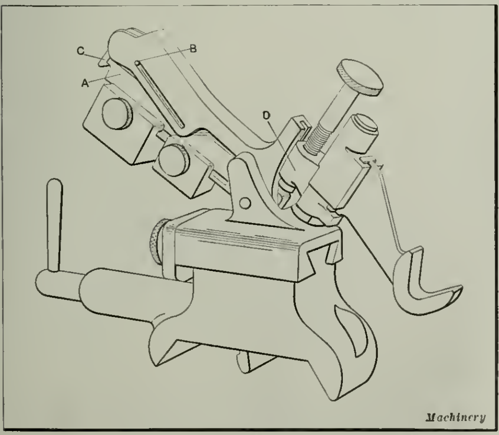


Fig. 9. Adjustable Type of Steadyrest working on the Wedge Principle and adapted to Pratt & Whitney Plain and Universal Grinding Machines

The steadyrest shown in Fig. 7 is also of the stationary type, but is constructed somewhat differently from those just described. This steadyrest is adapted to the Landis plain and universal grinding machines, and the two work-supporting shoes are operated independently. The horizontal shoe is carried in a plunger that is kept outward by means of a spring *B* and is backed up by an adjusting screw *C*. The tension of the spring is adjusted by means of screw *D*. Plunger *E* can be clamped rigidly in any position by means of the clamping screw *F*. The lower work-shoe support *G* is actuated by the adjusting screw *H*, which is operated to keep the work-shoe in contact with the work as the diameter of the latter is reduced by the grinding wheel. Where hardened work or large quantities of any particular part are being ground, the wooden blocks can be replaced by bronze or hardened steel blocks, depending on the number of pieces to be turned out.

Combination Plain and Rigid Steadyrest

Fig. 8 shows a combination plain and rigid steadyrest that is applied to the Brown & Sharpe plain grinding machines. This rest is especially adapted for supporting large heavy work. The upper member of the steadyrest is similar to the one shown in Fig. 4, and the horizontal shoe *A* is operated in a similar manner. The lower steadyrest shoe is operated by means of plunger screw *B*, in the manner shown more clearly in the sectional view to the right. Here it will be seen that screw *B* draws a tapered block *C* back and forth in a slot in screw *D*. Screw *D* also serves as a pivot upon which adjustable shoe *E* can be used for elevating above the range obtained with the adjustable wedge. As the diameter of the work is reduced, therefore, knob *F* is adjusted, the other support being taken care of by the spring or self-adjusting member of the steadyrest. Various types of shoes are provided with this steadyrest as shown at *H* and *I*. *H* shows one for comparatively small-diameter work, whereas *I* shows one adapted to large-diameter work.

Adjustable Steadyrest working on the Wedge Principle

The steadyrest shown in Fig. 9 which is adapted to the Pratt & Whitney plain grinding machine is of such construction that the work-shoe automatically follows up and supports the work as the grinding progresses. The proper relation between the work and shoe is maintained by the downward movement of the lever *A*, which raises the shoe-holder *D* and the shoe as the work is reduced in diameter. This downward movement of lever *A* causes roll *B* to advance along its path, which has sufficient inclination to permit the back pressure being taken by the roll without slipping. The pressure is governed by adjustable weights on lever *A*, which are held in place by thumb-screws. When the work has been reduced to the required diameter, the shoe is withdrawn by returning roll *B* to its original position and raising lever *A* to its upper position, where it is held by catch *C*. Both radial and vertical adjustments are provided by means of adjusting screws, and the bracket can be removed from the table by a slight inward pressure on the eccentric binding clamp.

Follow Type of Steadyrest

Fig. 10 shows a follow type of steadyrest which is applied

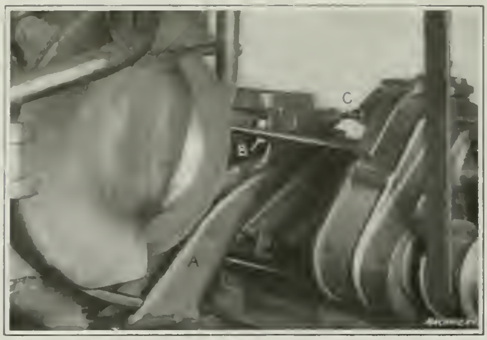


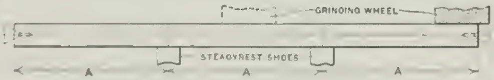
Fig. 10. Follow Type of Rigid Steadyrest applied to Brown & Sharpe No. 10 Plain Grinding Machine

to the No. 10 Brown & Sharpe plain grinding machine. This rest remains directly in front of the grinding wheel, and supports the work as it is traversed past it. The bracket *A* in which the steadyrest shoe is supported is clamped to the wheel-slide and consequently has no movement relative to the work. The work-shoe *B* is generally made with a concave or vee face to suit the work, and the pressure of the shoe is directed to hold the work up to the wheel. This shoe is adjustable by means of screw *C* and is not spring-controlled. This type of steadyrest can be used to advantage for grinding long slender work, which must be brought to accurate dimensions.

Use and Location of Steadyrests

Practically all grinding authorities agree on the fact that the more steadyrests used the greater will be the production; also that there is rarely a case where the work can be ground to good advantage without the use of steadyrests. While this may be true as a general statement, grinding machine operators have not always followed the advice given, and only use steadyrests where they cannot possibly do without them. On work, say, which is 1½ inch in diameter by 4 inches long, it is doubtful if much would be gained by using a steadyrest, but where the work is say 3 feet long and 1 inch in diameter, it would be practically impossible to grind it straight and true without a steadyrest. Therefore the number of steadyrests to use depends largely on the diameter and length of the work. No hard and fast rule can be laid down for the number of steadyrests to be used on any particular part, because this depends largely on the shape, diameter and length of the work. Usually, however, steadyrests are located about 6 inches apart on work about 1 inch in diameter; the greater the diameter, the less the number of steadyrests and the greater the distances between them. Table V gives the spacing of steadyrests as recommended by the Landis Tool Co. for work varying in diameter from ½ to 12 inches and in length from 6 inches to 84 inches.

TABLE V. MINIMUM NUMBER OF STEADYRESTS REQUIRED FOR SUPPORTING PLAIN CYLINDRICAL WORK



A = SPACING OF STEADYREST SHOES AND VARIES FROM 5 TO 36 INCHES DEPENDING UPON THE DIAMETER OF THE WORK

Diameter of Work in Inches	Length of Work in Inches										
	6	12	18	24	30	36	42	48	60	72	84
	Number of Steadyrests										
½ to 11/16	1	2	3	4	5	7	8	..	..	..	..
¾ to 15/16	.	1	2	3	4	5	6	7	..	.	..
1 to 1 3/8		1	2	2	3	4	5	5	7	..	..
1½ to 1 7/8		1	1	2	2	3	4	4	5	7	..
2 to 2 3/8		.	1	1	2	2	3	3	4	5	6
2½ to 2 7/8			1	1	2	2	2	3	4	5	5
3 to 3 7/8		..	1	1	1	2	2	2	3	4	5
4 to 4 7/8		..	.	1	1	1	2	2	3	3	4
5 to 5 7/8	..	.	..	1	1	1	1	2	2	3	3
6 to 7 7/8	.	.	..	..	1	1	1	1	2	2	3
8 to 9 7/8		..	.		.	1	1	1	1	2	2
10 to 12		.	..	..	.	.	1	1	1	1	2

Machinery

This table applies particularly to straight plain work. In the case of such pieces as armature shafts and similar work, where there are a number of sizes or diameters on the same piece, the piece is more rigid in the center on account of having a larger diameter at this point, so that the spacing of the steadyrests is dependent largely on the judgment of the operator. For instance, in case the piece should be of a certain length and certain size at the ends and much larger in the center, it might be sufficiently rigid to make the use of a steadyrest unnecessary. If, on the other hand, the work was of the same diameter along its entire length, it probably would be necessary to use one or several steadyrests in order to support it rigidly. In general, the number of steadyrests to be used should be governed largely by the smallest diameter of the work being ground, especially if the smallest diameter is located next to either the headstock or tailstock centers. Of course the point on which the grinding is being done also has a considerable bearing on the position and number of steadyrests used. In the following examples of plain cylindrical traverse grinding, the steadyrests used on each job have been indicated, and from this it will be possible to draw conclusions as to where steadyrests should be used and the number required for various classes of work.

Fig. 11 shows a good application of steadyrests and indicates just about how these should be located in relation to the work. This particular shaft is smaller on both ends than it is in the center. It is 1 inch diameter at the center, ¾ inch diameter at each end, and 48 9/16 inches long overall. One end is turned small for 5 inches and the other for 9⅜ inches. On this job five steadyrests are used. The type of shoe used is that known as a solid shoe, and the steadyrests are the Brown & Sharpe combination plain and rigid type.

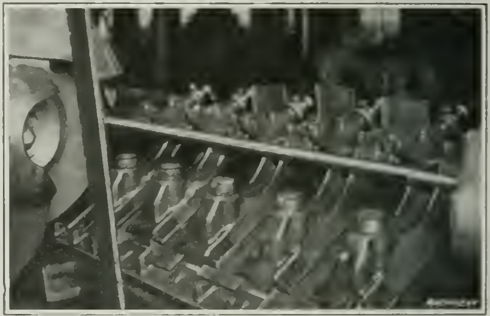


Fig. 11. Application of Brown & Sharpe Combination Plain and Rigid Type of Steadyrest

Steadyrest Work-shoes

The work-shoes used in steadyrests are made from hardened steel, cast iron, bronze, and various kinds of wood. Each material has some particular advantage on certain classes of work, and in the following an endeavor will be made to cover briefly some of the principal uses for the different types of work-shoes. *A* in Fig. 12 shows the simplest type of shoe, where only one is used. As a rule, this shoe is made from wood—generally hard maple or hickory. When the work is comparatively heavy, however, a wooden shoe is not recommended, and as a rule soft metal shoes are used instead. The wooden shoes, of course, have the advantage of being more readily adapted to the work than a metal one, and where only a few pieces are being ground a wooden shoe is recommended.

At *B* in Fig. 12 is shown another application of steadyrest shoes in which two shoes made from hard wood, either maple or hickory, are used. The best form of shoe for cylindrical grinding is that which forms two segments of an arc, and

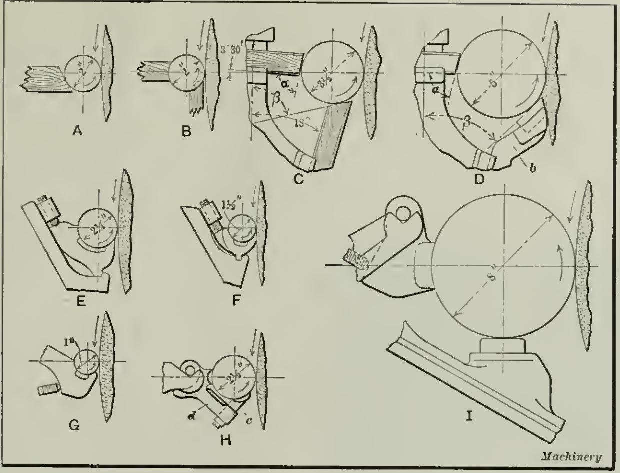


Fig. 12. Different Types of Steadyrests used and their Application

covers about half the circumference of the work being ground. Wood, of course, is the best material for a shoe of this kind; first because of its cheapness and second because of the facility with which it can be adapted to conform to the shape of the work. A shoe of the type shown at *B* in Fig. 12 should have two movements—one horizontal and one vertical. In this illustration a keyway is shown in the work, which brings up a point regarding the amount of bearing surface of the shoe on the work. This should never be less in width, of course, than any slot that is in the work. In applying the shoes to the work, the lower shoe should be placed as near the wheel as possible and the upper one on the center line as shown in the illustration.

Still another application of wooden shoes is shown at *C* in Fig. 12. These shoes are for use in the rigid type of steadyrest and the angle is changed according to the diameter of the work, as given in the following table. Hard maple shoes are used for supporting work from 1 inch up to 4 inches in diameter, but on work larger than this, and up to 8 inches in diameter, as shown at *D*, the lower shoe is usually made of bronze and is held in a special cast-iron holder *b*.

Diameter of Work, Inches	Angle α Degrees	Angle β Deg.	Angle β Min.
1 to 3½	80	77	30
3½ to 4	80	62	30
4 to 5	80	47	00
5 to 6	80	58	00
6 to 8	80	67	30

E in Fig. 12 shows another type of work-holding shoe which is used in the solid type of steadyrest and made from steel hardened and ground to size. This shoe is quickly put in place or removed from the holder and is clamped by a screw. It is recommended for use on duplicate work where a large number of pieces of one diameter are to be ground, and is of particular advantage on hardened work.

A shoe differing but slightly in construction from that shown at *E* is shown at *F*. This type of shoe is used in the production of small-diameter work on large size machines. It is made from a hardened and ground steel, and is applied to the work as shown in the illustration. This type of shoe is also recommended for hardened work and for work that must be turned out in large quantities.

Still another type of shoe is shown at *G* in Fig. 12. This shoe is generally adapted for a spring steadyrest, is made from bronze, and a different size shoe has to be provided for each variation in the diameter of the work. It is particularly adapted for work requiring a fine degree of accuracy and for shafts that are keyseated, and, in fact, for all work under 1 inch in diameter. Its use is strongly recommended where a large amount of work of one diameter is to be ground.

The steadyrest shoes shown at *H* are generally used in a spring type of steadyrest, and are known as the adjustable type. The lower shoe *c* is adjustable along the bar *d* to accommodate various diameters of work. These shoes are made from bronze and are used where only a small number of pieces of one size are being turned out.

On work of large diameter, where the ordinary spring rest is not sufficiently rigid to support it, the application of work-shoes as shown at *I* in Fig. 12 is recommended. In this illustration, it will be noticed that two shoes are used to support the work against the thrust of the wheel. The horizontal shoe can, if necessary, be spring-operated or rigid, whereas the entire weight of the work is supported on an adjustable solid shoe, mounted in a holder and capable of adjustment in an inclined plane. In this way a great part of the weight of the work is taken off the centers of the machine and carried by the lower shoe, the other shoe additionally supporting the work against the thrust of the wheel and eliminating chatter and vibration.

As previously mentioned, the type of work-shoes used de-

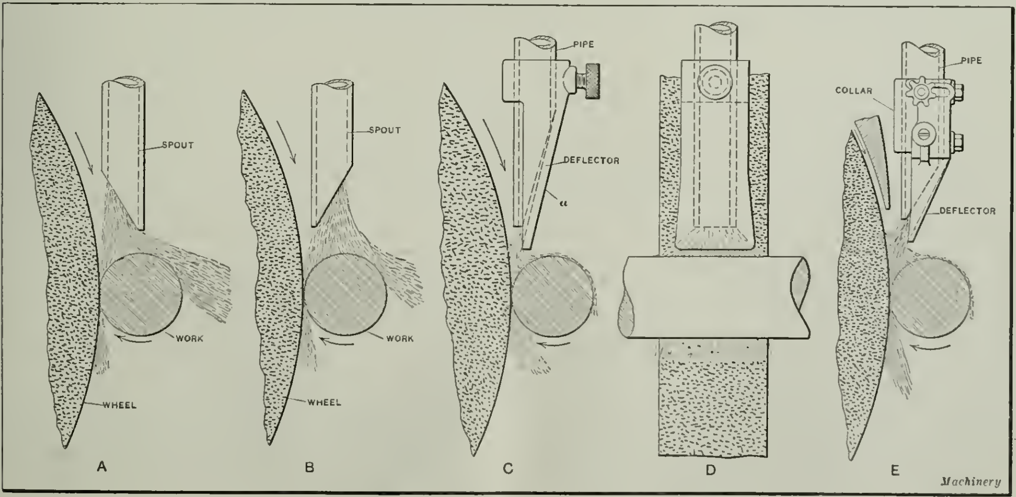


Fig. 13. Application of Water Nozzles to Cylindrical Grinding Machine

pends largely on the requirements of the work, its diameter and the number of pieces turned out. When only a few pieces of work of a certain size are to be turned out, wooden shoes made from either hickory or hard maple are recommended. When a large number of pieces of small diameter are being made, the shoes illustrated at *E*, *F*, and *G* are recommended. Where large-diameter work is to be handled, the shoes illustrated at *D* and *I* are recommended.

Lubricants for Cylindrical Grinding

The problem of finding a suitable lubricant to carry off the heat is probably more important in grinding than in any other metal cutting operation. The heat generated by the friction of the wheel on the work does not appreciably affect the wheel, but it distorts and injures the work, especially when it is hardened. The most common lubricant for grinding is plain water, but as this causes rusting of the machine parts, it is advisable to mix certain ingredients with the water to overcome the tendency to corrode. In order to prevent rusting, just enough sal-soda should be used in the water to show on the machine and the finished work when dry, and as

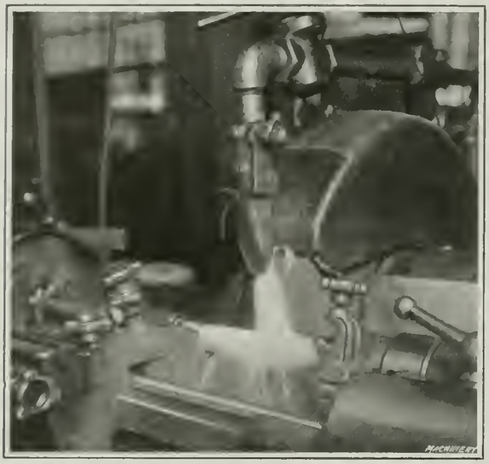


Fig. 14. Satisfactory Application of Water Nozzle shown at E in Fig. 13

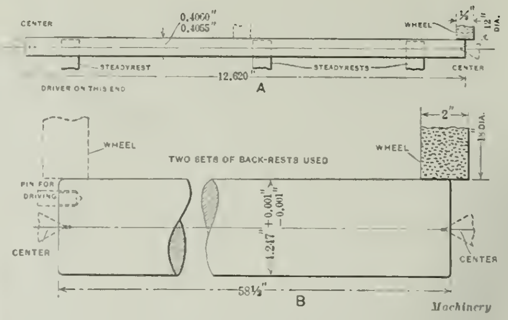


Fig. 15. Examples of Traverse Grinding illustrating Cases where Steadyrests are Necessary

A

Work:—Sewing machine shaft, 0.20 per cent carbon steel, casehardened.

Operation:—Grinding entire length of shaft with a Norton (elastic) alundum wheel, grain 36, grade 5; 12 inches diameter, ½ inch face; speed 1910 R. P. M.—6000 feet surface speed; work speed, roughing, 218 R. P. M.—23 feet surface speed; work speed, finishing, 306 R. P. M.—34 feet surface speed; amount removed from diameter, 0.006 inch.

Remarks:—Traverse method of grinding used at the rate of 30 linear inches per minute; roughing and finishing cuts taken; shaft reversed end for end; completely roughed out before finishing; 0.001 inch left on diameter for finishing; depth of cut, roughing 0.001 inch; 0.0005 inch, finishing; put through in lots of 500; approximate number of traverses, four roughing, four finishing; handled four times; production, 15 per hour, greatly limited on account of slenderness of work and care exercised so as not to remove casehardened surface; for roughing, two spring rests are used, and for finishing, a follow rest is used. (See illustration.) Machine used, No. 11 Brown & Sharpe plain grinding machine.

B

Work:—Over-arm for milling machine, 0.20 per cent carbon machinery steel, not hardened.

Operation:—Rough- and finish-grinding external diameter; roughing with a Carborundum Co.'s aloxite (vitrified) wheel, grain 2411, grade L; 18 inches diameter, 2 inch face; speed, 1273 R. P. M.—6000 feet surface speed; for finishing with a Carborundum Co.'s aloxite (vitrified) wheel, grain 40, grade M; 18 inches diameter, 2 inch face; speed 1107 R. P. M.—5500 feet surface speed; work speed, roughing, 51 R. P. M.—57 feet surface speed; work speed, finishing, 51 R. P. M.—57 feet surface speed, and 70 R. P. M.—79 feet surface speed; amount removed from diameter, 0.020 inch.

Remarks:—Traverse method of grinding used; for roughing, work is traversed past wheel six times at a traverse speed of 66 linear inches per minute, bringing work down to within 0.002 to 0.003 inch of finished diameter; 15 pieces to each truing of wheel; grinding time, 11.76 minutes; for finishing, work is traversed past wheel six times, five traverses at 66 linear inches per minute; last traverse at 25 linear inches per minute, rotated at 70 R. P. M.—70 feet surface speed; four pieces to each truing of wheel; actual grinding time, 12.12 minutes; total grinding time, 23.9 minutes; machine used, Norton plain grinding machine.

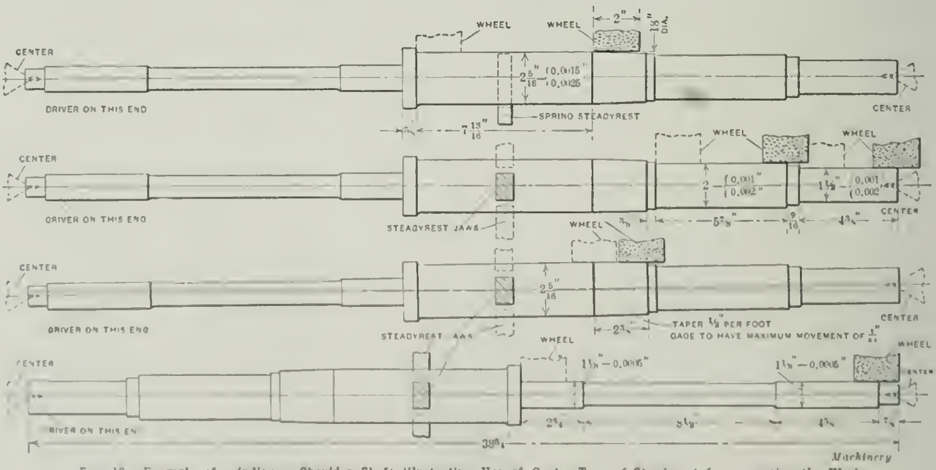


Fig. 16. Example of grinding a Shoulder Shaft illustrating Use of Center Type of Steadyrest for supporting the Work

Work:—Shaft, 0.20 per cent carbon steel, not hardened.

Operation:—Grinding six external diameters with an American (vitrified) corundum wheel, grain 46, grade K; 18 inches diameter, 2 inch face, speed, 1485 R. P. M.—7000 feet surface speed; work speed, roughing, 35 R. P. M.—25 feet average surface speed; finishing 98 R. P. M.—45 feet average surface speed, amount removed from diameter 0.015 to 0.018 inch.

Remarks:—Power traverse is used for grinding all diameters at the rate of 60 linear inches per minute; traverse cut, 0.001 inch deep for roughing, 0.0005 inch for finishing; wheel trued up after grinding each shoulder, work put through in lots of 50 pieces, handled six times before finished; difficult job to grind because of small diameter at one end, for method of supporting, see illustration; last three settings accomplished by using a standard type of center steadyrest; production, 1¼ hour per shaft; machine used, No. 12 or 14 Brown & Sharpe plain grinding machine.

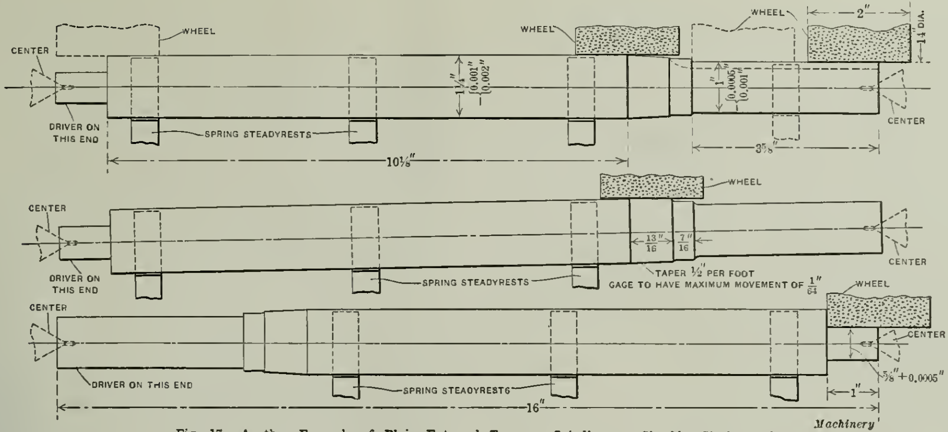


Fig. 17. Another Example of Plain External Traverse Grinding on Shoulder Shaft Work

Work:—Shaft, 0.20 per cent carbon machinery steel, not hardened.

Operation:—Grinding four external diameters with a Carborundum Co.'s (vitrified) aloxite wheel, grain 401, grade M; 14 inches diameter, 2 inch face; speed, 1910 R. P. M.—7000 feet surface speed; work speed, roughing, 172 R. P. M.—50 feet average surface speed; finishing, 258 R. P. M.—65 feet average surface speed; amount removed from diameter, from 0.010 to 0.015 inch.

Remarks:—Traverse method of grinding used at the rate of 120 linear inches per minute; roughing and finishing cuts taken from all diameters ground; 0.001 inch left on all diameters for finishing; depth of cut. roughing. 0.001 inch; 0.0005 inch, finishing; put through in lots of 50 pieces; production, 7 shafts per hour; greatly limited on account of small diameter at one end; taper bearing ground in separate setting (see illustration) and must be concentric with other diameters; four spring type steadyrests for first setting, and three spring type steadyrests for other settings (see illustration); 30 pieces turned out per each truing of wheel; machine used, No. 11 Brown & Sharpe plain grinding machine.

an extra precaution, the machine can be painted with cosmoline, but as a rule this is not necessary.

Grinding on a small variety of work in the tool-room is sometimes done dry, but for manufacturing grinding operations, dry grinding is not recommended as being satisfactory. Work that will grind smooth with water or other cutting lubricants will often develop minute vibrations when grinding dry. There is apparently a rapid fluctuation of temperature which causes the work to recede from and approach toward the wheel very rapidly, thus leaving a mottled or rough surface. In order to obtain smooth and accurate work, the water should run upon the work smoothly and not fluctuate. A fluctuating supply will sometimes cause variation in the cut of the wheel, tending to mar the work, and will, as a rule, show a change of sparks.

As was previously stated, getting rid of the heat is one of the difficult problems encountered in grinding, and in order to reduce the temperature of the work while being ground, as well as to keep the wheel clean, various cutting compounds have been devised. The aim in view, of course, is to get some liquid which will have the maximum cooling effect on the work and at the same time will not rust or gum the machine or mar the surface of the work. "Aquadag" is one of the compounds used with satisfaction for grinding. The

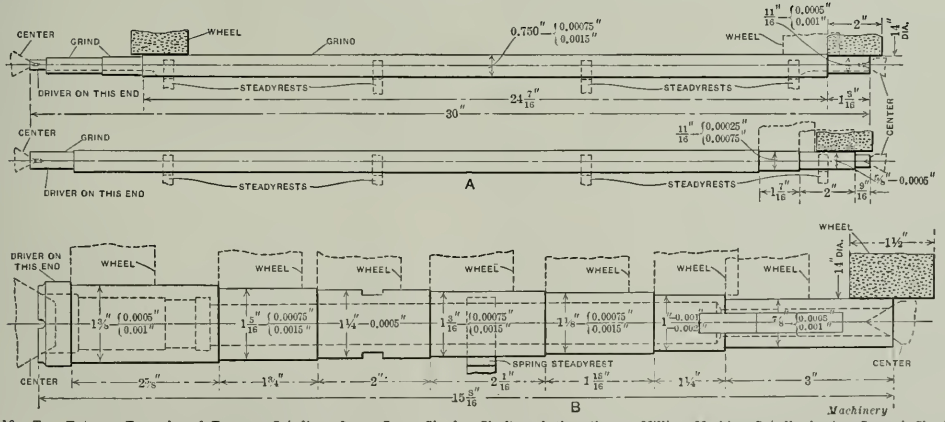


Fig. 18. Two Extreme Examples of Traverse Grinding—One a Long, Slender Shaft and the other a Milling Machine Spindle having Several Shoulders and proportionately Larger in Diameter than in Length. These illustrate Good General Applications of Steadyrests

A

Work:—Shaft, 0.20 per cent carbon machinery steel, not hardened.

Operation:—Grinding four diameters with a Norton (vitrified) alundum wheel, grain 38-36, grade L; 14 inches diameter, 2 inch face; speed 1910 R. P. M.—7000 feet surface speed per minute; work speed for roughing, 194 R. P. M.—35 feet average surface speed; work speed for finishing—300 R. P. M.—55 feet surface speed; amount left on diameters for grinding, 0.010 to 0.015 inch.

Remarks:—Power traverse is used for grinding all diameters at the rate of 96 linear inches per minute; 20 diameters turned out to each truing of wheel; traverse cut, 0.001 inch deep roughing; 0.0005 inch deep finishing; work put through in lots of 50 pieces; four steadyrests of the spring type used; (see illustration for location); production, 3 shafts finished complete per hour; machine used, No. 11 Brown & Sharpe plain grinding machine.

B

Work:—Machine spindle, "Union" drawn steel, casehardened.

Operation:—Grinding seven external diameters with a Norton (vitrified) alundum wheel, grain 38-46, grade K; 14 inches diameter, 1½ inch face; speed, 1776 R. P. M.—6500 feet surface speed; work speed, roughing, 221 R. P. M.—65 feet average surface speed; finishing 289 R. P. M.—85 feet average surface speed; amount removed from all diameters from 0.015 to 0.025 inch.

Remarks:—Power traverse is used for grinding all diameters at the rate of 80 linear inches per minute; 0.003 to 0.004 inch is left for finish-grinding; 50 pieces turned out to each truing of wheel; put through in lots of 50; production, 50 in twenty-four hours; machine used, No. 11 Brown & Sharpe plain grinding machine.

method of using this mixture is to take a No. 10 jar of "Aquadag" and mix it with ten gallons of water; then add ½ pound of borax or sal-soda to prevent the machine rusting. This should be applied to the work in the same manner as water.

The grinding of aluminum has always given more or less trouble because as soon as the work begins to heat the chips cut out by the wheel do not free themselves, but clog the wheel and the wheel glazes rapidly, producing an unsatisfactory surface on the work. Various lubricating compounds have been used for grinding aluminum, but a lubricant composed of equal parts of light spindle oil and kerosene has been found to give satisfactory results. On one particular job of grinding, which was a small spindle made from cast macadamite, practically every cutting lubricant on the market, as well as soap, soda and water, were tried without satisfaction. The operator accidentally dropped some spindle oil on the work while oiling up the machine, and when the work was ground, this part showed a better finish than any other part of the work. A mixture of spindle oil and kerosene was then used, and the results were all that could be desired.

For form grinding, the Ford Motor Co. uses soap, sal-soda, lard oil and water. This is made up in the following order: First, a mixture of soap and lard oil of equal parts is made and boiled. While this is still hot fifteen parts of water are added. The water, previous to being put in the soap and lard oil solution, is prepared with fifteen parts of water to one of sal-soda, and this proportion is varied according to the work upon which the lubricant is to be used. For form grinding vanadium steel drop-forgings, a mixture of fifteen parts of water to one of sal-soda is generally used.

The character and shape of the work has a considerable bearing on the cutting lubricant used. For instance, shoulder shafts which are not provided with recesses at the shoulders require a very thin lubricant. The reason for this is that the heavier lubricants collect in a mass at the shoulders, and thus make it difficult for the operator to see when the wheel reaches the shoulder. For work of this character, a solution of sal-soda and water has been found most satisfactory.

Shape and Action of Water Nozzles for Cylindrical Grinding

The application of water or other cooling mediums to the work when grinding is a matter that does not always receive the attention that it deserves. In rapid production work in which the same care cannot be exercised as in toolroom grinding, it is necessary that every provision be made for eliminating those factors which tend to produce poor work. One of these factors is improper cooling. The first nozzles used in connection with universal grinding machines were small spouts held in a frame into which the water was conveyed by means of a pipe. These spouts discharged a very small stream of water on the work which assisted somewhat in preventing the work from excessive heating. With the wheels used at that time, the amount of water required was not very great, so that very little trouble was experienced in the nozzle arrangement.

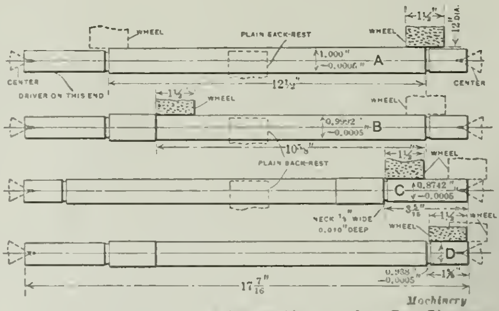


Fig. 20. Clutch Shaft for a Milling Machine ground on Four Diameters in a Total Time of 11.7 Minutes for Each Shaft

Work:—Clutch shaft for milling machine, 0.15 per cent carbon machinery steel, not hardened.

Operation:—Grinding four diameters with a Carborundum Co.'s (vitrified) aloxite wheel, grain 365, grade M; 12 inches diameter, 1¼ inch face; speed, 1910 R. P. M.—6000 feet surface speed; work speeds, 170, 190 and 200 R. P. M.—46 feet surface speed; amount removed from diameter, 0.015 inch.

Remarks:—Traverse method of grinding used; on diameter (A) work is fed past wheel twice and wheel fed in to depth, then two traverses made with wheel "fixed"; table traversed at rate of 18 linear inches per minute; 15 pieces to each truing of wheel; grinding time, 5.9 minutes; on diameter (B) wheel is fed in to depth and work traversed twice past wheel at a table traverse of 18 linear inches per minute; 25 pieces to each truing of wheel; grinding time, 2.3 minutes; on diameter (C) wheel is fed in to depth on work and work traversed past it four times by hand, the first traverse at 10 linear inches per minute, and last three traverses at 20 linear inches per minute; 20 pieces to each truing of wheel; grinding time, 2.02 minutes; on diameter (D) wheel is fed in to depth on work and work traversed four times past it by hand, the first traverse at 10 linear inches per minute, the last three traverses at 20 linear inches per minute; 30 pieces to each truing of wheel; grinding time, 1.49 minute; total grinding time for each shaft, 11.7 minutes; machine used, Norton plain grinding machine.

Following the use of increased widths of grinding wheels, the problem of keeping the work cool became more and more difficult. The diagram shown in Fig. 13 presents some of the different types of water nozzles used. At *A* in Fig. 13 is shown a plain pipe water nozzle, but the position of this nozzle has been reversed, so that it works unsatisfactorily, and has a tendency to splash the operator. The reason for this is that the capillary attraction between the water and the surface of the pipe causes it to cling to the "long side," and the consequence is that it is attracted toward or thrown away from the wheel instead of onto it. Of course, the air current set up by the revolving wheel has a tendency to draw some of the water in, but as water is heavier than air it penetrates these air currents to a certain extent.

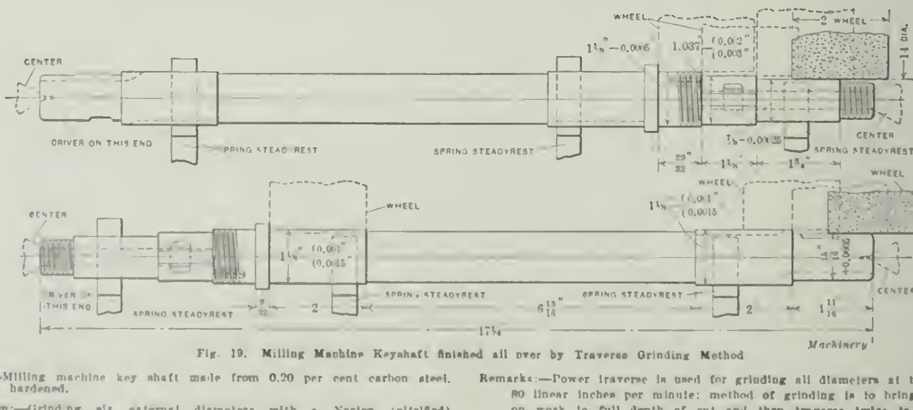


Fig. 19. Milling Machine Keyshaft finished all over by Traverse Grinding Method

Work:—Milling machine key shaft made from 0.20 per cent carbon steel, not hardened.

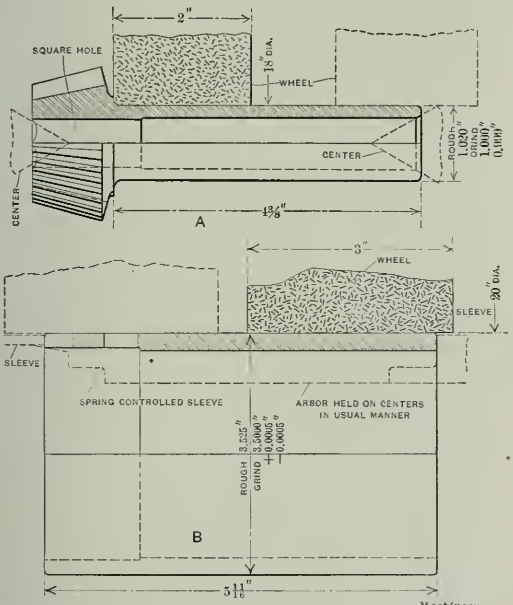
Operation:—Grinding six external diameters with a Norton (vitrified) alundum wheel, grain 36, grade L, 14 inches diameter, 2 inch face; speed, 1776 R. P. M.—6500 feet surface speed; work speed, roughing 172 R. P. M.—45 feet average surface speed; finishing, 258 R. P. M.—67 feet average surface speed; amount removed 0.010 to 0.015 inch.

Remarks:—Power traverse is used for grinding all diameters at the rate of 80 linear inches per minute; method of grinding is to bring wheel in on work to full depth of cut and then traverse twice to finish; 50 shoulders turned out to each truing of wheel; work put through in lots of 50 pieces, production, 10 to 12 shafts complete per hour; machine used, No. 11 Brown & Sharpe plain grinding machine.

The proper way of placing a nozzle of the type shown at *A* is shown at *B*. In this case it will be noticed that the angular face is not presented to the wheel but away from it. Here capillary attraction tends to direct the water in the way it should go. It will be noticed, however, that considerable splashing of the water is still present. One means of overcoming this is to use a deflector *a*, as shown at *C*, which can be adjusted so as to control the flow of the water. This prevents the water from splashing over the operator and directs it to the cutting point of the wheel on the work, where it is most needed. The lower end of the water nozzle spout and the deflector should be so shaped that the water is directed to cover the full face of the grinding wheel used. If one or both edges of the wheel are allowed to cut dry, the surface finish may be marred by feed lines, so that to secure good work it is necessary to cover the entire cutting surface of the wheel with the cooling lubricant.

The diagram at *E* shows another type of adjustable water nozzle, in which case the deflector can not only be moved up and down by adjusting it along the pipe, but it is also capable of an in-and-out movement that enables the operator to direct the stream of cooling lubricant where it is most needed. This nozzle is also so constructed and adjusted that the stream of water or cutting lubricant is directed to cover the full face of the grinding wheel.

Fig. 14 shows a satisfactory application of a water nozzle, but in this case the deflector has been set out from the wheel too far so that the water is sprayed considerably over the front of the work. By just pushing in this deflector a slight amount, the water can be directed more against the wheel, and will do more effective cooling.



Machinery

Fig. 21. Examples of Traverse and "Step-in" Methods of Grinding

A

Work:—Bevel main drive pinion, chrome-vanadium steel, oil-hardened.

Operation:—Grinding external diameter with a Norton (vitrified) alundum wheel, grain 24, grade M: 18 inches in diameter, 2 inch face; speed, 1100 R. P. M.—5200 feet surface speed; work speed, 80 R. P. M.—21 feet surface speed; amount removed from diameter, 0.020 inch.

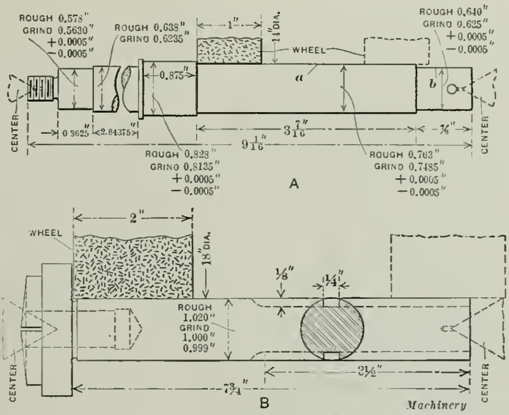
Remarks:—"Step-in" method of grinding in conjunction with traverse for finishing is used; production, 25 to 30 pieces per hour; machine used, 10 by 36 inch Norton plain grinding machine.

B

Work:—Main drive gear bearing sleeve, 0.15 carbon open-hearth Shelby seamless steel tubing, carbonized 0.030 inch deep and oil-hardened. Must strike 70 on the scleroscope.

Operation:—Grinding external diameter with a Norton (vitrified) alundum wheel, grain 24, grade M; 20 inches diameter, 3 inch face; speed, 1065 R. P. M.—5576 feet surface speed; work speed, 82 R. P. M.—74 feet surface speed; amount removed from diameter, 0.025 inch.

Remarks:—Power traverse is used and eight traverses at the rate of 56 linear inches per minute are required; wheel is fed in to a depth of approximately 0.003 inch per traverse for roughing out; production, 125 pieces in nine hours; machine used, 10 by 36 inch Norton plain grinding machine.



Machinery

Fig. 22. Examples illustrating "Step-in" Method of grinding Cylindrical Work

A

Work:—Magneto and pump drive shaft, 0.50 per cent open-hearth steel, not hardened.

Operation:—Grinding external diameters with a Norton (vitrified) alundum wheel, grain 60, grade N; 14 inches diameter, 1 inch face; speed, 2000 R. P. M.—7320 feet surface speed; work speed, 400 R. P. M.—72 feet average surface speed; amount removed from diameter, 0.015 inch.

Remarks:—"Step-in" method of grinding in conjunction with traverse is used; two minutes to grind bearing (a); production, 240 for the large diameter (a), and 300 for the small diameter (b) in nine hours; machine used, Morse Twist Drill Co. plain grinding machine.

B

Work:—Transmission main drive pinion, chrome-vanadium steel, oil-hardened.

Operation:—Grinding external diameter with a Norton (vitrified) alundum wheel, grain 24, grade M; 18 inches diameter, 2 inch face; speed, 1100 R. P. M.—5200 feet surface speed; work speed, 80 R. P. M.—21 feet surface speed; amount removed from diameter, 0.020 inch.

Remarks:—"Step-in" method of grinding in conjunction with traverse is used; four cuts to finish work; remove 0.001 to 0.002 inch by traverse; three minutes each; machine used, 10 by 36 inch Norton plain grinding machine.

Conditions Governing Amount of Cooling Lubricant to Use

There are several conditions governing the amount of water or other cooling lubricant to use for cylindrical grinding. They are:

1. The larger the work, the greater is the wheel surface in contact and the necessity for a greater supply of cutting lubricant.
2. An increased width of wheel face increases the amount of surface contact, and necessitates a greater amount of lubricant.
3. An increase of work speed necessitates an increase in the amount of cooling lubricant.
4. Some materials require more cooling lubricant than others because of their nature. For instance, hardened steel requires more cooling lubricant than soft steel if satisfactory wheels are used in both cases.

In all cases, the water supply should be sufficient to keep the work as cool as possible, and at the same time cover the entire face of the grinding wheel. Usually the pump supplied with the grinding machine is capable of being speeded up so that the amount of water supplied to the machine can be varied independently of the position of the valve opening in the supply pipe.

The pumps supplied with the plain type of grinding machine are generally of the fan type and vary in capacity from 5 to 100 quarts per minute. This type of pump is rotated at from 500 to 1200 revolutions per minute. The amount of cooling lubricant generally required for plain cylindrical grinding operations varies from 1 to 30 gallons per minute. For a wheel having, say, a 2-inch face, and grinding by the traverse method, the amount of cooling lubricant supplied would be in the neighborhood of 3 to 5 gallons per minute. Of course the amount of lubricant required is dependent entirely upon the width of wheel used, speed of work and nature of material, and as the capacity of the pump can be increased, it is a comparatively easy matter to secure the desired amount of cooling lubricant.

Examples of Plain Cylindrical Grinding

An endeavor has been made in the preceding to take up the various factors connected with the successful accomplishment of grinding operations, touching on some of the most important features. Grinding, however, is such a broad subject and the methods of accomplishing various results differ so widely that a description of any one phase must necessarily be incomplete. While it must be admitted that there are certain underlying factors that remain practically unchanged, it is nevertheless a fact that what would be considered good practice in one shop is not so considered in another; hence, the difference of opinion and methods of procedure. In order to cover every phase of the grinding subject as thoroughly as possible, it has been thought advisable, after considerable study and investigation, to show concrete examples of various classes of work, and from these draw conclusions that should be of value to grinding machine operators in general.

One of the first methods used in producing cylindrical work by grinding was by traversing a narrow face wheel past the work or the work past the wheel, depending on the type of machines used. While great advances have been made in cylindrical grinding, a large amount of work is still produced by the traverse method, but instead of using narrow face wheels much wider wheels and heavier machines are now used for this purpose.

Grinding Long, Slender Shafts

Long, slender shafts have always presented considerable difficulty in grinding. First, because of the liability of the work to spring and vibrate, and second, because of the difficulties met in securing accurate work. The sewing machine shaft shown at *A* in Fig. 15 is a good illustration of this point. This shaft is made from 0.20 per cent carbon steel, casehardened, and it must be ground for its entire length to a limit of 0.0005 inch on the diameter. The liability to chatter and vibrate is largely overcome by the use of steadyrests, three of which are used for the roughing-out operation, at which time the shaft is reduced to within 0.001 inch of the final diameter. For the finish-grinding operation, the follow type of steadyrest shown in Fig. 10 is used. This rest remains stationary directly in front of the grinding wheel, and provides the necessary support.

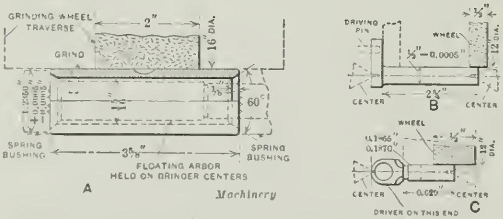


Fig. 23. Examples of grinding "Shelby" Tubing, Cast Macadamite, and a Sewing Machine Plunger—All Accurate Work—bringing up Different Points in Cylindrical Grinding

A

Work:—Piston pin made from Shelby steel tubing containing 0.15 to 0.25 per cent carbon, carbonized 0.030 inch deep and hardened in oil.

Operation:—Grinding external diameter with a Norton (vitrified) alundum wheel, grain 46, grade K; 16 inches diameter, 2 inch face; speed 1600 R. P. M.—6700 feet surface speed; work speed, 176 R. P. M.—56 feet surface speed; amount removed from diameter, 0.015 inch.

Remarks:—Wheel is fed in almost to depth, then traversed once across by hand; then power feed is thrown in and four traverses made at a traverse speed of 40 inches per minute; work held on a special arbor, two provided; production, 240 in nine hours; machine used, 10 by 36 inch Norton plain grinding machine.

B

Work:—Crank lever made from cast macadamite.

Operation:—Grinding stem with a Norton (elastic) alundum wheel, grain 120, grade 2½; 12 inches diameter, ½ inch face; speed, 2070 R. P. M.—6500 feet surface speed, work speed, 450 R. P. M.—60 feet surface speed, amount removed from diameter, 0.010 inch.

Remarks:—Traverse method of grinding used at the rate of 60 inches per minute; 0.0005 inch depth of cut per traverse of wheel, 120 pieces turned out to each truing of wheel; kerosene and spindle oil mixed half and half used as a cooling lubricant; production, 60 per hour; machine used, No. 11 Brown & Sharpe universal grinding machine.

C

Work:—Sewing machine plunger, 0.20 per cent carbon steel, casehardened.

Operation:—Grinding external diameter of stem with a Norton (elastic) alundum wheel, grain 36, grade 5; 12 inches diameter, ½ inch face; speed, 1910 R. P. M.—6000 feet surface speed; work speed, roughing, 510 R. P. M.—25 feet surface speed; finishing, 714 R. P. M.—35 feet surface speed; amount removed from diameter, 0.003 inch.

Remarks—Traverse method of grinding used, table traversed by hand; approximate number of traverses, 4, put through in lots of 5000; production, 145 per hour, machine used, No. 11 Brown & Sharpe plain grinding machine.

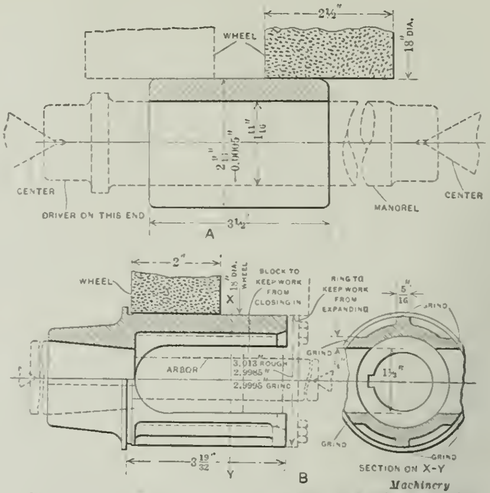


Fig. 24. Grinding a Miter Gear Sleeve for a Milling Machine and Universal Drive Shaft Yoke for an Automobile. The Latter Example illustrates a Difficult Holding Proposition

A

Work:—Miter gear sleeve for milling machine, made from cast iron.

Operation:—Grinding external diameter with a Carborundum Co.'s (vitrified) carborundum wheel, grain 40, grade P; 18 inches in diameter, 2½ inch face; speed, 1273 R. P. M.—6000 feet surface speed; work speed, 80 R. P. M.—55 feet surface speed; amount removed from diameter, 0.015 inch.

Remarks:—"Fixed-wheel" method of grinding used; wheel fed in to depth and work traversed past wheel four times; first by hand at the rate of 15 linear inches per minute and last three times by power at 25 linear inches per minute; 30 pieces turned out per each truing of wheel; production, 30 per hour; machine used, Brown & Sharpe plain grinding machine.

B

Work:—Universal drive shaft yoke, 0.20 per cent carbon, open-hearth steel carbonized and hardened.

Operation:—Grinding external diameter with a Norton (vitrified) alundum wheel, grain 24, grade M, 18 inches in diameter, 2 inch face; speed, 1200 R. P. M.—5600 feet surface speed; work speed, 80 R. P. M.—63 feet surface speed; amount removed from diameter, 0.020 to 0.025 inch.

Remarks:—"Step-in" method of grinding used, in combination with one traversing cut; production, 20 per hour; machine used, Cincinnati plain grinding machine.

Another shaft of a somewhat similar nature, but which is not hardened, is shown at *A* in Fig. 18. In this case, it will be noticed that four steadyrests are used for supporting the work. The shaft is provided with three shoulders, necessitating changing the location of one steadyrest for grinding the work at the second setting. As this shaft is not as slender as the one shown at *A* in Fig. 15, a larger amount is left on the diameter for finish-grinding, varying from 0.003 to 0.004 inch. Another reason why a greater amount is left in this case for finishing is because of the shoulders on the work which must be ground absolutely concentric with each other. Greater stiffness also allows the use of a wider face wheel and permits heavier cuts with a coarser traverse feed to be taken, which it will be noticed is almost three times as great as the traverse feed used for grinding the shaft shown at *A* in Fig. 15.

Grinding an Over-arm for a Milling Machine

The over-arm for a milling machine, shown at *B* in Fig. 16, is a somewhat easier proposition than the slender shaft just described. This is made from 0.20 per cent carbon machinery steel, not hardened, and is rough- and finish-ground in two operations. The work is of such large diameter that a hole can be drilled in the end to carry a driving pin, so that it is not necessary to reverse the work end for end on the centers to complete it. For the grinding of this over-arm, a coarse-

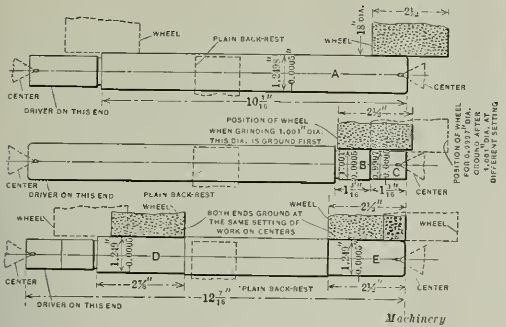


Fig. 25. Fork Shaft for Milling Machine, illustrating a Good Example of the "Fixed-wheel" Method of Grinding

Work:—Fork shaft for milling machine, 0.20 per cent carbon machinery steel, not hardened.

Operation:—Grinding five diameters with a Carborundum Co.'s (vitrified) aloxite wheel, grain 365, grade M, 18 inches diameter, 2½ inch face; speed, 1273 R. P. M.—6000 feet surface speed; work speeds, 140 and 180 R. P. M.—46 and 47 feet surface speed; amount removed from diameter, 0.015 inch.

Remarks:—"Fixed wheel" method of grinding used; for diameter (A) wheel is fed straight in to depth on work, which is traversed once past wheel by hand at 10 linear inches per minute, then power feed is thrown in and three traverses at 20 linear inches per minute are made; 7 pieces to each truing of wheel; grinding time, 4 minutes per piece; on diameter (B) wheel is fed in to depth, and work traversed four times by hand at 20 linear inches per minute; 20 pieces to each truing of wheel; grinding time, 1½ minute; on diameter (C) wheel is fed in to depth, and work traversed twice by hand at 20 linear inches per minute; 30 pieces to each truing of wheel; grinding time, 1.3 minute per piece; on diameters (D) and (E) wheel is fed in to depth, and work traversed twice by hand for each diameter at 20 linear inches per minute; 10 pieces to each truing of wheel; grinding time, 4.4 minutes for both diameters; total time to complete shaft, 9.9 minutes; machine used, Norton plain grinding machine.

grain comparatively hard bond wheel is used for both rough- and finish-grinding, so that in order to get the required finish on the work it is necessary to rotate the work faster for the finishing cut than for the roughing cut, and at the same time reduce the traverse speed of the work past the wheel. By referring to Fig. 15 it will be noticed that for roughing, a surface speed of 57 feet is used, whereas for finishing, two speeds of 57 and 79 surface feet, respectively, are employed. The last traverse is at a work speed of 79 surface feet. The traverse speeds are 66 linear inches per minute for roughing, five traverses at the same speed for finishing, and the last traverse at a speed of 25 linear inches per minute.

Grinding Shoulder Shafts

The shaft shown in Fig. 16, which is made from 0.20 per cent carbon steel, not hardened, has to be ground on six external diameters, one of which is tapered. These operations were performed with a comparatively fine grain, soft bond wheel, running at a peripheral speed of 7000 surface feet. In this case, a work speed of, on an average, 25 surface feet was used for roughing at a traverse speed of 60 linear inches per minute. While finishing, the traverse work speed past the wheel remains the same, but in order to get the desired finish on the work the work speed was increased on an average to 45 surface feet. In this case there are two alternatives for roughing. A sufficiently high work speed could have been used with a greater rate of traverse and the speed of the work and traverse feed could have been reduced for finishing. This illustrates how it is possible to produce the same piece of work by changing the work speed and power traverse and obtain practically the same results. It will also be noticed, upon referring to this illustration, that the method of grinding the various shoulders on this shaft is somewhat out of the ordinary. For the first operation, which is the grinding of the center shoulder, a single spring steadyrest is used. Then for the remaining shoulders, because of the slenderness of the work, the center shoulder is used as a point upon which the work is supported by means of a center type of steadyrest. This left about 19 inches of work unsupported and necessitated taking fine cuts; but owing to the fact that all shoulders were required to be concentric with the center one, this method of supporting was adopted.

A similar example is shown in Fig. 17, where practically all the conditions are reversed. This is due largely to a change in the grinding wheel used. In this case it will be noticed that an average work speed of 50 surface feet is used for roughing and 65 surface feet for finishing. The traverse speed is also increased over that used for the job shown in Fig. 16. In fact, it is doubled. One of the reasons for this is that the shaft is larger in diameter in proportion to its length, and can be much more rigidly supported by steadyrests, four of which are used for grinding the first two diameters and three for the last two settings. The production on this shaft, however, is limited to a certain extent by the small diameter on one end.

An interesting example of plain cylindrical grinding is the milling machine spindle shown at *B* in Fig. 18. This is made from "Union" drawn steel, and presents a difficult grinding proposition, because of the multiplicity of shoulders and the accuracy to which these must be finished. For this particular job, a No. 38 alundum, grain 46, grade K grinding wheel is used. This is a medium soft wheel of fine grain, necessitating a comparatively high work speed to get satisfactory results, which in this case is, on an average, 65 surface feet for roughing and 85 surface feet for finishing. The reason for increasing the work speed for finishing is that the traverse feed remains the same for both operations, or at the rate of 80 linear inches per minute. This brings up a point in regard to the selection of grinding wheels. If this part had been soft instead of casehardened when ground, it could have been satisfactorily ground with a slower work speed; the alternative, therefore, would be to use a slower work speed with a softer bond, coarser grain wheel.

Another example of shoulder shaft grinding is shown in Fig. 19, where the part being ground is a milling machine keyshaft made from 0.20 per cent carbon steel, not hardened. Six diameters on this shaft must be ground to limits varying from 0.0015 to 0.0005 inch. The wheel used is a comparatively fine grain alundum wheel, with a medium soft bond. The work speed is 45 feet average surface speed for roughing, and 67 feet average surface speed for finishing, with a power traverse of 80 linear inches per minute. The method of grinding is to bring the wheel in on the work to the full depth of cut and then traverse twice to finish. The first cut takes about from 0.012 to 0.014 inch from the diameter, and the last one removes from 0.001 to 0.002 inch to finish. In this

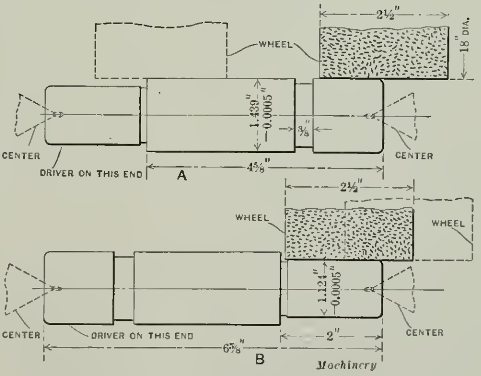


Fig. 26. Intermediate Shaft for Milling Machine ground by "Fixed-wheel" Method

Work:—Intermediate shaft for milling machine, 0.15 per cent carbon machine steel, not hardened.

Operation:—Grinding two diameters with a Carborundum Co.'s (vitrified) aloxite wheel, grain 365, grade M; 18 inches diameter, 2½ inch face; speed, 1273 R. P. M.—6000 feet surface speed; work speed, 128 R. P. M.—38 and 49 feet surface speed; amount removed from diameter, 0.015 inch.

Remarks:—"Fixed wheel" method of grinding used. On diameter (A) wheel is fed straight in to depth, and work traversed past it four times; the first time, by hand at 10 linear inches per minute and last three times by power at 22 linear inches per minute; 13 pieces to each truing of wheel; grinding time, 2.6 minutes; on diameter (B) wheel is fed straight in to depth and then work traversed past it four times at the rate of 20 linear inches per minute, by hand; 20 pieces to each truing of wheel; production, 15 shafts complete per hour; machine used, Norton plain grinding machine.

case it will be noticed also, owing to the disposition of the shoulders, that the position of the steadyrests must be changed for the two settings.

Another interesting method of shoulder shaft grinding is presented in Fig. 20, which shows a clutch shaft for a milling machine. This is made from machinery steel, not hardened. The work speeds for all the various diameters remain practically the same, about 46 feet surface speed, but the rate of traverse for grinding the various diameters is changed. For those shoulders which are comparatively long, a slow traverse speed is used, varying from 10 to 18 linear inches per minute. For the short shoulders, however, the traverse is increased to 20 linear inches per minute. This is due largely to the greater amount of wheel surface in contact with the work.

Grinding a Thin Wall Sleeve

The main drive gear bearing sleeve shown at *B* in Fig. 21 presents a difficult grinding proposition because of the thin walls of the sleeve and the liability to distort it while clamping to grind its external diameter. In order to obviate springing the work, it is held by the ends only, and floats on a special spring arbor. The external diameter is ground first, and then the bushing is located in a close-fitting sleeve chuck and the internal diameter ground. In this way, both internal and external diameters can be ground concentric with each other, and the walls will be of equal thickness all the way around. For grinding this piece, a comparatively high work speed is used, but the power traverse feed is reduced below what would be necessary if a slower work speed were adopted.

Examples of Work Produced by "Step-in" Method of Grinding

As has been previously explained, a large number of concerns are not equipped with grinding machines capable of carrying wide face wheels and have endeavored to increase production by a method which is known as "step-in" grinding. This consists in "stepping" or "butting" the wheel in at intervals along the work to within about 0.001 to 0.002 inch of the final diameter and then making several rapid traverses to finish. A good example of this class of work is shown at *A* in Fig. 21, which is a drive pinion made from a chrome-vanadium steel drop-forging, oil-hardened. A medium grade wheel with a coarse grain is used for this work and it will also be noticed that a comparatively low work speed is used—21 feet surface speed.

Another example of step-in grinding is shown at *A* in Fig. 22. This is a magneto and pump drive shaft made from high-carbon steel, not hardened. The work was done on a comparatively light machine, and in order to increase production the "step-in" method was adopted. It will be noticed in this case that a fine grain, medium bond wheel is used, and consequently a comparatively high wheel speed is necessary—in the neighborhood of 7320 feet. In order to get satisfactory results, it was necessary to increase the work speed to about 72 feet average surface speed. If a heavier machine were used for grinding this part, the wheel speed and work speeds both could have been reduced considerably, and just as good if not better results obtained.

B in Fig. 22 presents another example of "step-in" grinding in conjunction with table traverse. This operation is done on a heavier machine and consequently a medium bond coarse grain wheel is used. A slow wheel speed is also used, together with a slow work speed. This example is in direct contrast to the one shown at *A* in the same illustration, and represents the two methods that can be adopted to accomplish practically the same results on different types of machines with different wheels, wheel and work speeds.

Another interesting sleeve grinding job is shown at *A* in Fig. 23. This is a piston pin, made from "Shelby" steel tubing which is carbonized and hardened in oil. The method of supporting this piece while grinding is similar to that used for supporting the bushing shown at *B* in Fig. 21. A finer grain, softer bond wheel, however, is used, with a higher wheel speed and lower work speed. The method of grinding differs somewhat from that used on the piece shown in Fig. 21; this accounts for the change in the wheel and work speeds. In this case the wheel is fed in almost to depth and then traversed once across by hand, taking a heavy cut, then returned by power, after which four traverses are made at a speed of 40 linear inches per minute.

The sewing machine plunger shown at *C* in Fig. 23 is another interesting example of grinding. This is made from 0.20 per cent carbon steel, casehardened, and the shoulder must be ground to limits of 0.0005 inch on the diameter. Owing to the slenderness of the work and the care which must be exercised in not going below the casehardened surface, this particular piece represents a difficult grinding proposition. The grinding wheel which gave the best results was an alundum, elastic, grain 36, grade 5, rotated at 6000 surface feet, while the work speed was changed for roughing and finishing—25 feet for roughing and 35 surface feet for finishing. This method of handling the work proved satisfactory, as a production of 145 pieces per hour indicates.

Grinding Cast Macadamite

A piece of work which gave considerable trouble before it was ground successfully is the crank lever shown at *B* in Fig. 23, made from cast macadamite. This metal is similar to aluminum, except that it is a little softer. Practically every grade and grain of wheel was tried for this work without success, as well as various lubricating compounds. It was found that the work heated so much, due to the friction of the wheel in contact with it, that it was impossible to get a smooth surface. The problem was finally solved by using a mixture of kerosene and spindle oil mixed in equal proportions as a cooling lubricant. After this lubricant was tried, the wheels were again changed, using softer and harder bond as well as finer and coarser grain, but practically no change was noted on the work, showing that the lubricant solved the problem. It might also be mentioned that this cooling lubricant was also used with success while grinding cast aluminum.

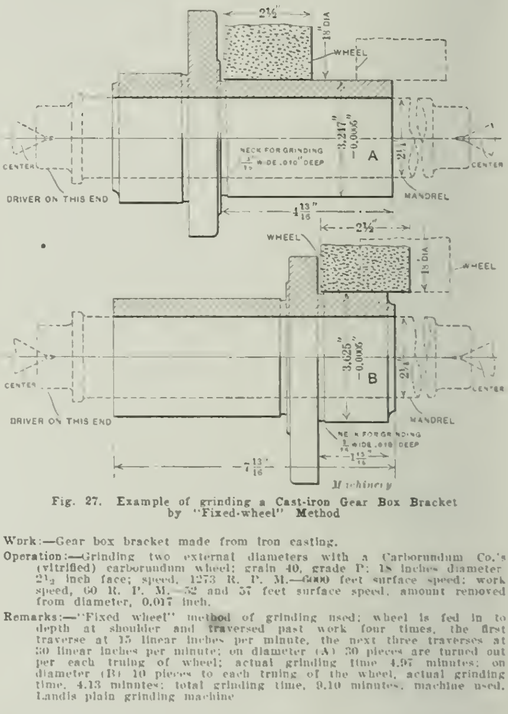


Fig. 27. Example of grinding a Cast-iron Gear Box Bracket by "Fixed-wheel" Method

Work:—Gear box bracket made from iron casting.

Operation:—Grinding two external diameters with a Carborundum Co.'s (vitrified) carborundum wheel; grain 40, grade P; 18 inches diameter 2½ inch face; speed, 1273 R. P. M.—6000 feet surface speed; work speed, 60 R. P. M.—52 and 57 feet surface speed, amount removed from diameter, 0.017 inch.

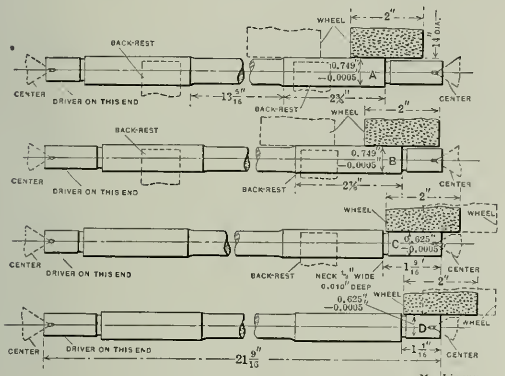
Remarks:—"Fixed wheel" method of grinding used; wheel is fed in to depth at shoulder and traversed past work four times, the first traverse at 15 linear inches per minute, the next three traverses at 30 linear inches per minute; on diameter (A) 30 pieces are turned out per each truing of wheel; actual grinding time 4.97 minutes; on diameter (B) 10 pieces to each truing of the wheel, actual grinding time, 4.13 minutes; total grinding time, 9.10 minutes, machine used, Landis plain grinding machine

Grinding Universal Drive Shaft Yoke

The universal drive shaft yoke shown at *B* in Fig. 24 was an extremely difficult proposition to handle. This piece is made from 0.20 per cent carbon, open-hearth steel, carbonized and hardened and is completely open on the front end where the grinding is done. This not only made it difficult to hold the piece rigidly to prevent vibration, but also owing to the openings on each side, the work has a tendency to act as a chisel on the face of the wheel, tearing the abrasive grains from the bond. This problem was solved by holding the work on the tapered end of the arbor, placing a block in the open end to prevent it from collapsing, and then clamping a brace across the front end. A wheel speed of 5600 feet surface speed was used and a work speed of 63 feet surface speed. The method of grinding was to step the wheel in twice along the work almost to the final diameter, and then traverse the work once across and back. By holding the work in this manner, satisfactory results were obtained and a production of twenty per hour secured.

Grinding Shoulder Shafts by the "Fixed-wheel" Method

The fork shaft for a milling machine shown in Fig. 25 was ground by what is known as the "fixed-wheel" method. In this case the wheel was fed straight in on the work to a stop, and then traversed once past the wheel by hand feed and three times by power feed. Fig. 26 shows another piece accomplished in a somewhat similar manner, but in this case it will be noticed that no steadyrests are required on the work. Fig. 28 is another milling machine part that is ground by the "fixed-wheel" method in conjunction with more than two traverses of the work past the wheel. These three examples illustrate practically similar conditions, with the exception of the application of steadyrests to the work.



Machinery

Fig. 28. Methods of grinding Reversing Shaft for a Milling Machine by "Fixed-wheel" Practice of applying Wheel to Work

Work:—Reversing shaft for milling machine, 0.15 to 0.20 per cent carbon machinery steel, not hardened.

Operation:—Grinding four diameters with a Carborundum Co.'s (vitrified) aloxite wheel, grain 365, grade M; 14 inches diameter, 2 inch face; speed, 1637 R. P. M.—6000 feet surface speed; work speed, 210 R. P. M.—35 to 42 feet surface speed; amount removed from diameter 0.015 inch.

Remarks:—"Fixed wheel" method of grinding is used; on diameters (A) and (B), wheel is fed in to stop and traversed four times past work by hand at 10 linear inches per minute for first traverse, 30 linear inches per minute for the last three traverses; 20 pieces per each truing of wheel; grinding time, 2.02 minutes for each end; on diameters (C) and (D), the wheel is fed in to depth and traversed past work four times by hand at the rate of 20 inches per minute; 20 pieces per each truing of wheel; grinding time, 1.60 minute for each end; total time, 7.42 minutes for each shaft; machine used, Landis plain grinding machine.

The gear-box bracket made from an iron casting that is shown in Fig. 27 is another example of the "fixed-wheel" method. It will be noticed in this case that a carborundum wheel, grain 40, grade P, is used. This is rotated at 6000 feet surface speed, whereas work speeds of 52 and 57 feet surface speed are used. The traverse of the wheel past the work varies from 15 to 30 linear inches per minute, the finer traverse being used for roughing and the coarser for finishing. The reason for the finer traverse for roughing is because of the heavy cut taken, whereas for finishing, lighter cuts are used and consequently higher traverse speeds can be employed.

Grinding Cast-iron and Bronze Bushings

There are two methods in use for finishing bushings. Where the wall of the bushing is not very thin, the method generally adopted is to ream the hole and then grind the external diameter, or where reaming is not satisfactory the hole is first ground and then the external diameter ground later by placing the work on a mandrel. Where the wall of the bushing, however, is thin, this method is not satisfactory, especially when the work has been hardened. The reason for this is that the work is liable to distort in hardening, and when gripped in the chuck to grind the internal diameter it is difficult to prevent springing the work. Consequently the hole cannot be ground absolutely true, and driving the work on a mandrel only increases the inaccuracy. The best method of grinding thin wall bushings, as has been previously explained, is to grind the external diameter first by holding the bushing on a floating mandrel and then grind the internal diameter by placing it in a close-fitting sleeve chuck, gripping the work from the ends only and not from the external diameter.

At *A* in Fig. 24 is shown a miter gear sleeve for a milling machine that was ground by the method first mentioned. The hole in this sleeve is reamed to finish size and then it is driven on an arbor and ground. The method of grinding is to feed the wheel in to depth, take one roughing cut, and then traverse the work past the wheel four times to get a finish, at the rate of 15 linear inches per minute for roughing, and 25 linear inches for finishing. In this case, it will also be noticed that the traverse speed is greater for finishing than for roughing because of the heavier roughing cut taken.

Three similar examples of bushing grinding are shown at *A*, *B* and *C* respectively, in Fig. 29. The bushing shown at *A* is made from cast iron and is ground by the "fixed-wheel" method. The bushing shown at *B* is made from tobin bronze and is also ground by the "fixed-wheel" method. For the grinding of the cast-iron bushing at *A* a carborundum wheel is used, whereas for the tobin bronze, an alundum wheel is used. The example shown at *C* is also ground by the "fixed-wheel" method, and for this a corundum wheel is used. In all three cases high work speeds are used, varying from 70 to 136 feet surface speed. From 70 to 80 surface feet is about the best work speed for grinding tobin bronze or phosphor-bronze, whereas the surface speed for cast iron should not exceed 60 to 70 feet when a satisfactory wheel is used.

Examples of Combined "Straight-in" and Traverse Grinding

Fig. 30 shows a pinion shaft made from 0.30 per cent carbon steel, not hardened, that is ground by two methods. The short shoulder *A* is ground by feeding the wheel straight in on the work, whereas the shoulder *B* is ground by stepping the wheel in at intervals along the work and then making several rapid traverses. Advantage here is taken of the use of a wide face wheel, and it will also be noticed that a comparatively low work speed and a coarse grain, medium bond wheel has been used. This example represents good average practice.

The rear axle shown in Fig. 31 presents an interesting method of handling this class of work. For grinding the taper bearing, the grinding wheel is fed in to depth at the end next to the tailstock, then withdrawn and moved over to the other end of the bearing and fed in to depth, after which three traverses of the wheel past the work at 16 linear inches per minute are made. The grinding of this shaft necessitates three separate settings, and for all except operation *B* the wheel is traversed. For this operation the wheel is fed straight in on the work until the final diameter is reached. Another point of interest in connection with the grinding of this part is the special driver. The requirements call for a certain length to be maintained between the taper bearing and the other end of the shaft, and to obviate the extreme care which is necessary to get all the centers of a certain depth the special driver shown is used.

An extremely difficult piece to grind is the spindle shown in Fig. 32. This is made from 0.20 per cent carbon machine steel, not hardened. The work is fairly slender, necessitating, in some cases, a special steadyrest shoe that practically covers the entire surface that is in contact with the wheel where the grinding is being done. The method of grinding this shaft varies on the different shoulders. For grinding shoulders *A* and *D* the wheel is fed straight in on the work until the final diameter is reached, whereas for grinding shoulders *B* and *C* the work is traversed past the wheel. It will be noticed here that the work speed is varied, depending on the manner in which the wheel is presented to the work. Where the wheel is fed directly in on the work, the surface speed varies from 40 to 60 feet, whereas when the work is traversed it varies from 60 to 80 feet. In other words, a slower work speed is used for "straight-in" than for traverse grinding. It will also be noticed that a combination grain corundum wheel rotated at 6000 feet surface speed is used for the job; this is the correct speed for this abrasive wheel.

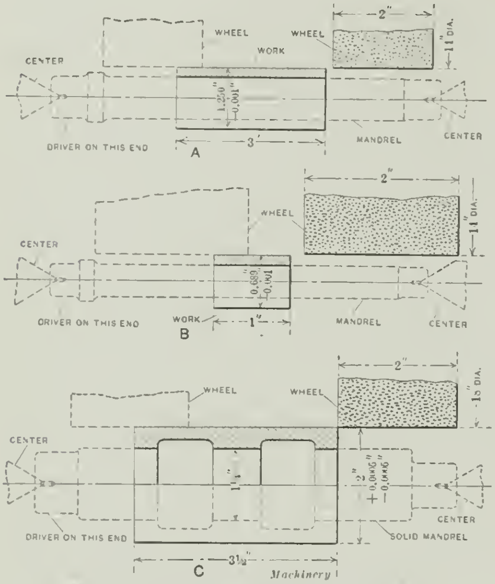


Fig. 29. Grinding Cast-iron and Bronze Bushings by Means of "Fixed-wheel" Method of Grinding

A

Work:—Bushing made from cast iron.

Operation:—Grinding external diameter with a Carborundum Co.'s (vitrified) carborundum wheel, combination grain 46, grade N; 14 inches diameter, 2 inch face; 1728 R. P. M.—6332 feet surface speed; work speed, 416 R. P. M.—136 feet surface speed; amount removed from diameter, 0.025 inch.

Remarks:—"Fixed-wheel" method of grinding is used and work is fed past wheel twice at a table speed of 16 linear inches per minute; 50 pieces turned out to each truing of wheel; production, 100 in 1½ hour; machine used, Brown & Sharpe plain grinding machine.

B

Work:—Bushing made from tobin bronze.

Operation:—Grinding external diameter with a Norton (vitrified) alundum wheel, combination grain 36, grade R; speed, 1728 R. P. M.—6332 feet surface speed; work speed, 416 R. P. M.—75 feet surface speed; amount removed from diameter, 0.020 to 0.025 inch.

Remarks:—"Fixed-wheel" method of grinding is used and two traverses of work past wheel at the rate of 10 linear inches per minute complete operation; wheel trued up once every day; production, 100 pieces in 45 minutes, or about 130 pieces per hour; machine used, Brown & Sharpe plain grinding machine.

C

Work:—Phosphor-bronze bushing.

Operation:—Grinding external diameter with an American (vitrified) corundum wheel, grain 54, grade M; 18 inches diameter, 2 inch face; speed 1241 R. P. M.—6500 feet surface speed; work speed, 134 R. P. M. 70 feet surface speed; amount removed from diameter, 0.020 inch.

Remarks:—"Fixed-wheel" method of grinding used; table traversed at a speed of 20 linear inches per minute; two traverses to complete work; 60 to 80 pieces turned out to each truing of wheel; production, 42 bushings per hour; machine used, No. 12 or 14 Brown & Sharpe plain grinding machine.

Miscellaneous Examples of Cylindrical Grinding

The automobile worm drive shaft shown in Fig. 33 is a good example of plain traverse grinding. This part is made from alloy steel, heat-treated, and the grinding is all done by traversing the work by hand.

Fig. 34 shows two special grinding operations; one is the grinding of an upper end of a valve push-rod, and the other a cone for a fan shaft. The upper end of the valve push-rod is made from screw stock and is carbonized and hardened in oil. The grinding operation consists in finishing the radius on the head of this rod with a fine grain, medium grade alundum wheel. The method of grinding this piece is to first bring the wheel in contact with the work at the shoulder, and then swing the head of the machine around until it stands at right angles to the wheel. The wheel is then fed in on the work again. This procedure is followed until the radius has been ground, bringing the push-rod head to the required diameter.

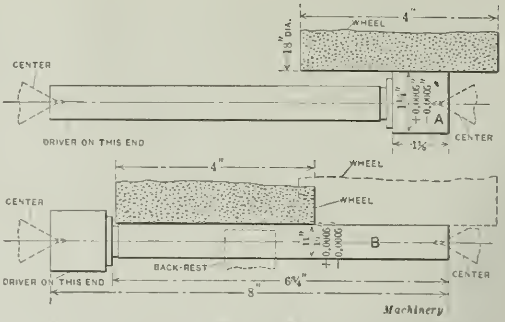


Fig. 30. Finishing a Pinion Shaft by Means of Combined "Step-in," "Straight-in" and Traverse Methods of Grinding

Work:—Pinion shaft, 0.30 per cent carbon steel, not hardened.

Operation:—Grinding two external diameters with a Norton (vitrified) alundum wheel, grain 24, grade M; 18 inches diameter, 4 inch face; speed, 1650 R. P. M.—6050 feet surface speed; work speed, 77 R. P. M.—14 to 25 feet surface speed; amount removed from diameter, 0.020 inch.

Remarks:—"Step-in" method of grinding in conjunction with traverse grinding is used; order of operations is to first feed wheel straight in on diameter (A) and grind to size. Second, reverse work on centers, step-in twice on diameter (B) to within 0.001 inch of finished size, and then traverse the work past the wheel; 50 pieces turned out to each truing of wheel; production, 20 pieces per hour; machine used, 6 by 32 inch Norton plain grinding machine.

The cone for the fan shaft shown at *B* in Fig. 34 was

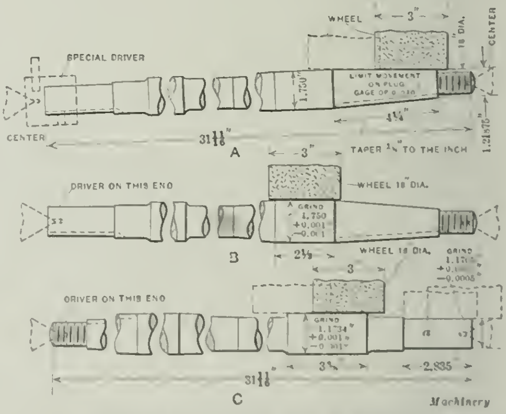


Fig. 31. Grinding a Rear Axle Shaft for an Automobile by Means of "Straight-in" and Traverse Method of Grinding

Work:—Material, Carpenter's "Samson" No. 3 nickel steel, hardened in fish oil, and tempered; allowance of 0.030 to 0.040 inch left on all diameters for grinding; method of grinding is to first feed wheel in almost to depth at the end next the tailstock, then travel over to the other end and feed to depth, and then make three traverses back and forth, using power feed, at the rate of 10 linear inches per minute; grinding limit varies on all diameters (see illustration); operations performed on a 12 by 42 inch Landis plain grinding machine; shaft must strike 60 to 70 hard on scleroscope.

Operation A:—Grinding taper with a Norton (vitrified) alundum wheel, grain 24, grade M; 18 inches diameter, 3 inch face; speed, 1580 R. P. M.—7482 feet surface speed, work speed, 92 R. P. M.—36 feet average surface speed; 16 pieces ground to each truing of wheel.

Operation B:—Grinding main bearing; wheel fed straight in on work; wheel is same grain and grade as above; production on this bearing, one piece in 35 seconds.

Operation C:—Grinding oil retainer fit with a Norton (vitrified) alundum wheel, grain 24, grade L; 18 inches diameter, 3 inch face; operating at same speed as above, but traversed; production time is 1 minute and 31 seconds each. At this same setting the differential bearing (a) is also ground by the same type of wheel, traversed at the rate of 18 inches per minute; time for this operation is 50 seconds.

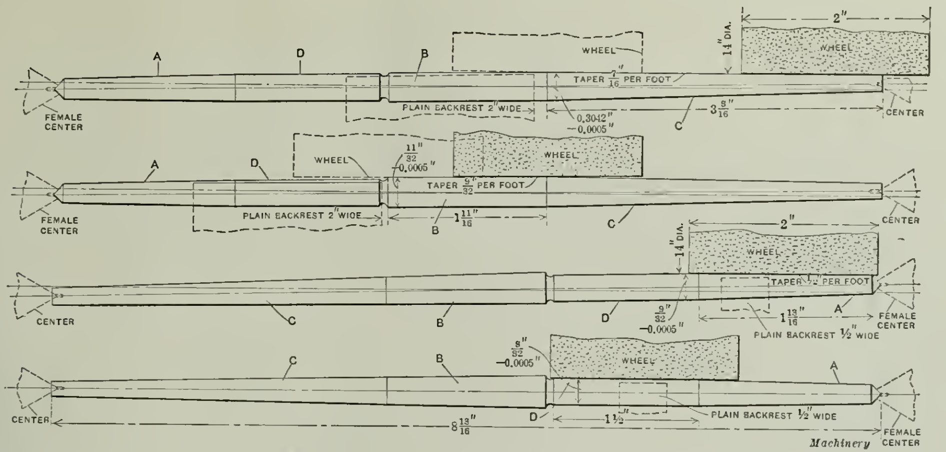


Fig. 32. An Interesting Example of Combined "Straight-in" and Traverse Grinding

Work:—Spindle, 0.20 per cent carbon steel, not hardened.

Operation:—Grinding four diameters, three of which are tapered, with an American (vitrified) corundum combination wheel, grain 58-46, grade K; 14 inches diameter, 2 inch face; speed, 1637 R. P. M.—6000 feet surface speed; work speed, roughing 489 to 733 R. P. M.—40 to 60 feet surface speed; 733 to 978 R. P. M.—60 to 80 feet surface speed for finishing on parts traversed past wheel; amount removed from diameters, 0.010 to 0.015 inch.

Remarks:—Combined straight-in and traverse method of grinding; diameters (A) and (D) are ground by feeding wheel straight in on the work, whereas diameters (B) and (C) are ground by traversing the table; in-feed for straight-in grinding 0.0005 inch per revolution of work; depth of cut for traverse grinding, 0.0005 inch deep per traverse; speed of traverse, 120 inches per minute; three plain back-rests used; shoe, 2 inches wide for parts (B) and (C), and ½ inch wide for parts (A) and (D); actual grinding time on various diameters as follows: (A), 20 seconds; (B), 45 seconds; (C), 20 seconds; (D) 22 seconds; estimated production, 25 completed shafts per hour; machine used, No. 11 Brown & Sharpe plain grinding machine.

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taken from a light grinding machine and placed on a Landis plain grinder, using an old type Landis center grinder as a fixture for holding the work. The production was increased in this way from about 500 to 1200 pieces in nine hours, because of the greater rigidity and possibility of taking heavier cuts. The method of grinding this piece is to bring the wheel directly in on the work and then make a couple of rapid traverses to finish. It will be noticed also in this case that a comparatively coarse grain, medium bond wheel is used that is rotated at a surface speed not generally recommended—8272 feet surface speed. In order to get the desired results it is also necessary to increase the work speed, which in this case is above the average, being 115 feet average surface speed.

To Increase Efficiency and Production, Records of all Grinding Jobs should be Kept

The foregoing examples of work are interesting because of the fact that they bring out the various methods adopted for handling work of practically the same character, and also for handling work that differs considerably in shape and nature of material. These examples are also a good indication of the advisability of keeping complete records of all grinding operations so that when a new piece comes along it is not necessary to waste so much time in experimenting. The chart shown in Fig. 35, while gotten up chiefly as a basis for setting piece rates, also contains a number of important points that are valuable from an efficiency standpoint. The example shown in the chart is a gear-box bracket for a milling machine, on which two diameters are to be ground. The method of procedure is carefully outlined. First, the work is put on the mandrel, then placed between the centers, then the headstock of the machine is started revolving. The wheel is then brought into position at the shoulder *A* and fed in to the work to a previously set stop. The wheel is then passed over the work four times without allowing it to run off the end of the work, using hand feed entirely. The first traverse is at 15 linear inches per minute,

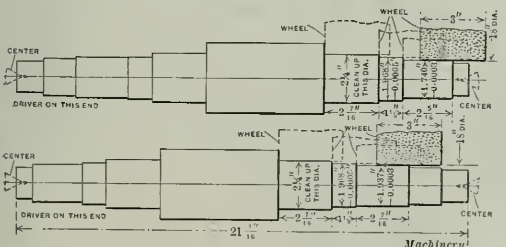


Fig. 33. An Everyday Example of Plain Traverse Grinding

Work:—Automobile worm drive shaft, alloy steel heat-treated.

Operation:—Grinding six diameters with a Norton (vitrified) alundum wheel, grain 46, grade K; 18 inches in diameter, 3 inch face; speed, 1273 R. P. M.—6000 feet surface speed; work speed, 75 R. P. M.—40 feet average surface speed; amount removed from diameter, 0.020 to 0.030 inch.

Remarks: Hand traverse is used for grinding all six diameters; the two diameters on each side of the worm are just cleaned up whereas the other two diameters indicated (see illustration) are ground to within close limits; twelve diameters ground per each truing of wheel; production, 35 shafts complete in 10 hours; machine used, Modern plain grinding machine.

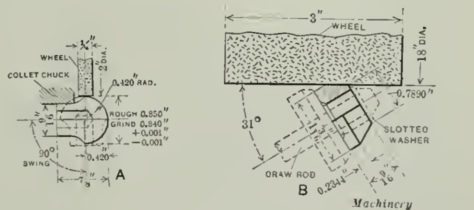


Fig. 34. Examples of Radius and Cone Grinding

A

Work:—Upper end of valve push rod, screw stock, carbonized 0.030 inch deep and hardened in oil; 70 minimum hardness.

Operation:—Grinding radius on head with a Norton (vitrified) alundum wheel, grain 67, grade M; 2 inches diameter, ¼ inch face; speed, 12,800 R. P. M.—6702 feet surface speed; work speed, 320 R. P. M.—70 feet surface speed; amount removed from diameter, 0.010 inch.

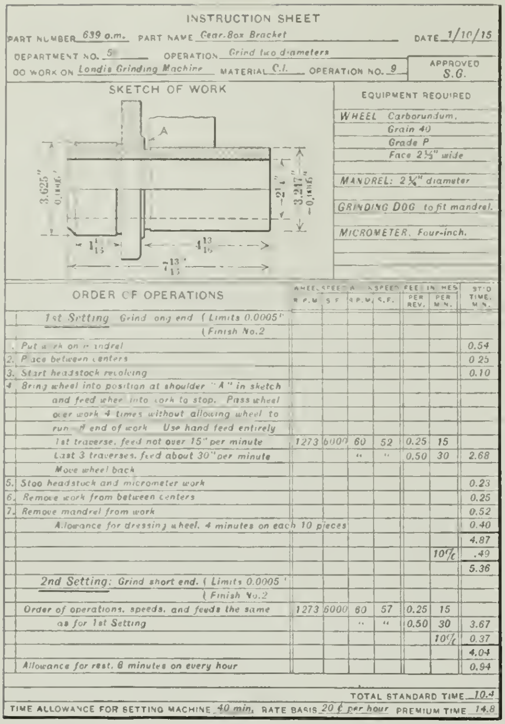
Remarks:—Wheel is first brought into contact with work on shoulder, and then head is swung around until it stands at right angles to wheel, which at the same time is fed into work; production, 250 in nine hours; machine used, Rivett universal grinding machine.

B

Work:—Cone for fan shaft, 0.15 per cent carbon open-hearth steel, carbonized 0.030 inch deep and hardened.

Operation:—Grinding cones with a Norton (vitrified) alundum wheel, grain 24, grade M; 18 inches diameter, 3 inch face; speed, 1760 R. P. M.—8272 feet surface speed; work speed, 440 R. P. M.—115 feet average surface speed; amount removed from diameter, 0.010 inch.

Remarks:—An old type Landis center grinder specially fitted up is used for holding work; wheel is fed in directly against work until cleaned up and then traversed to finish; production, 1200 in nine hours; machine used, Landis plain grinding machine.



INSTRUCTION SHEET

PART NUMBER 639 o.m. PART NAME Gear-Box Bracket DATE 1/10/15

DEPARTMENT NO. 5 OPERATION Grind two diameters

DO WORK ON Landis Grinding Machine MATERIAL C.I. OPERATION NO. 9 APPROVED S.G.

SKETCH OF WORK

A
3.625"
−0.0005"
2¼"
3.217"
−0.0005"
1¼/16
4 13/16
7 13/16

EQUIPMENT REQUIRED
WHEEL Carborundum,
Grain 40
Grade P
Face 2½" wide
MANDREL: 2¼" diameter
GRINDING DOG to fit mandrel.
MICROMETER, Four-inch.

ORDER OF OPERATIONS	WHEEL SPEED		WORK SPEED		FEED IN INCHES		ST'D TIME, MIN.
	R.P.M.	S.F.	R.P.M.	S.F.	PER REV.	PER MIN.	
1st Setting Grind long end (Limits 0.0005"							
(Finish No.2							
1. Put work on mandrel							0.54
2. Place between centers							0.25
3. Start headstock revolving							0.10
4. Bring wheel into position at shoulder "A" in sketch							
and feed wheel into work to stop. Pass wheel							
over work 4 times without allowing wheel to							
run off end of work. Use hand feed entirely							
1st traverse, feed not over 15" per minute	1273	6000	60	52	0.25	15	
Last 3 traverses, feed about 30" per minute			"	"	0.50	30	2.68
Move wheel back							
5. Stop headstock and micrometer work							0.23
6. Remove work from between centers							0.25
7. Remove mandrel from work							0.52
Allowance for dressing wheel, 4 minutes on each 10 pieces							0.40
							4.87
						10%	.49
							5.36
2nd Setting: Grind short end. (Limits 0.0005"							
(Finish No.2							
Order of operations, speeds, and feeds the same	1273	6000	60	57	0.25	15	
as for 1st Setting			"	"	0.50	30	3.67
						10%	0.37
							4.04
Allowance for rest, 6 minutes on every hour							0.94

TOTAL STANDARD TIME 10.4

TIME ALLOWANCE FOR SETTING MACHINE 40 min. RATE BASIS 20 ¢ per hour PREMIUM TIME 14.8

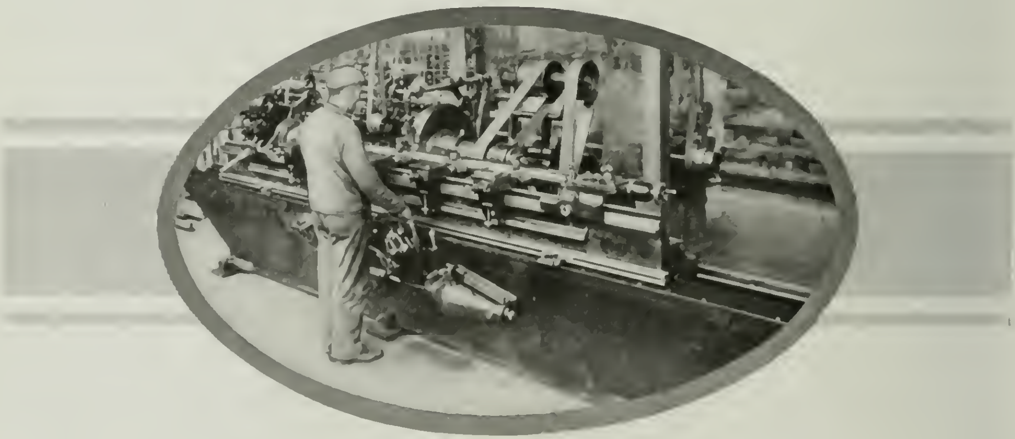
Machinery

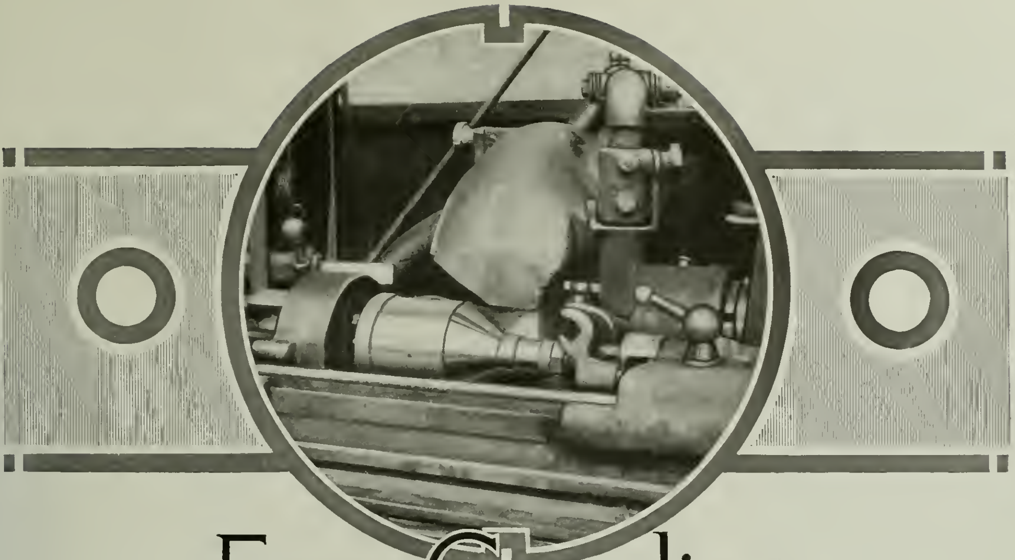
Fig. 35. Chart showing Method of keeping Complete Record of Grinding Data

and the last three traverses at double this speed, or 30 inches per minute. The wheel is then moved back from the work, the headstock is stopped, and the work measured. If ground to the size which it should be if the stop has been properly set, the work is then removed from the center and taken from the mandrel, when the operations on that particular shoulder are finished. Allowances are then made for dressing the wheel as well as making necessary adjustments of the machine, and for a resting period. Of course at the rate set forth here, it would be impossible for an operator to keep it up all day long, and a certain allowance is made for a rest every hour. In this case it is six minutes. By studying this chart, it will be seen that practically every factor has been taken into consideration, and when a piece rate price is based on a study of this character it is possible to get the cost down to about what it should be. In order to increase production, a premium rate is also given, so that there is always an incentive to turn out more work. A careful study of each job that comes up is recommended, because of the more satisfactory work that results, and the increase in production.

Summary

The examples of work shown in the foregoing have not been chosen in all cases because they represent the best practice, but have been selected to illustrate the points that it is necessary to observe in grinding cylindrical work successfully. The examples shown illustrate work that is turned out on a manufacturing basis, and are not of the tool-room variety. The reason for this is that for several years the development of the grinding machine has been along the line of increasing production, at the same time retaining the necessary accuracy. In the section on work and wheel speeds, it will be noticed that the work speeds given are considerably lower than those generally used on tool-room work. For tool-room work, as a rule, high work speeds with fine grain, hard bond wheels are used. These wheels, in order to reduce the pressure on the work, are usually trued off so that only a small portion of the wheel surface contacts with the work. This method of procedure is not recommended for regular manufacturing work, because the greatest production is only possible when the full face of the wheel is used. In this article, an endeavor has been made, in most cases, to explain the reason for points that seem to be at variance with the best practice. As has been pointed out, the method used depends upon a number of varying factors, such as, the machine used, the character of the work, and the wheels, as well as the opinion of the operator.





Form Grinding

THE term "form grinding," as applied to the manufacture of machine and automobile parts, is generally used to refer to the production of both straight and irregular-shaped surfaces. On cylindrical grinding it is used to indicate that the wheel is fed straight in on the work without any traverse of the wheel or work. In an endeavor to differentiate between form grinding of straight and irregular surfaces, other names for the grinding of plain surfaces have been suggested, such as straight-in grinding, wide-wheel grinding, etc. As a matter of fact, however, in practice the term "form grinding" is used to indicate the production of both straight and irregular shaped surfaces on cylindrical work where the work or wheel is not traversed. There are also many other applications of the formed wheel method of grinding, such as surface grinding, grinding splined shafts, crankshafts, etc. These various subjects, with the exception of grinding splined shafts, will be taken up separately in another article.

Development of Form Grinding

Comparatively little is known as to the first use of a form grinding wheel for producing irregular or straight shaped surfaces. It has been stated that the Singer Sewing Machine Co. about ten years ago used a straight-in cut method of grinding small shafts for sewing machines, and about six years ago the Norton Grinding Co. produced a special index wheel to be used in connection with truing the grinding wheel for grinding multiple diameter shafts. It is definitely known, however, that form grinding first came into prominent use in the grinding of multiple-throw crankshafts for automobile engines. The chief reason for using a wide wheel and feeding it straight in on the work in the grinding of crankshafts was that the length of the bearings and space between the crankpin cheeks was so short that a very limited traverse could be used. This made the operation of grinding crankpins and bearings both slow and expensive. Heavy, rigid grinding machines were then built to carry wide face wheels, and instead of using the grinding machine for finishing only, crankshafts were ground complete on the bearings and crankpins from the rough forgings. This advance, of course, greatly increased production, with a consequent reduction in the manufacturing costs.

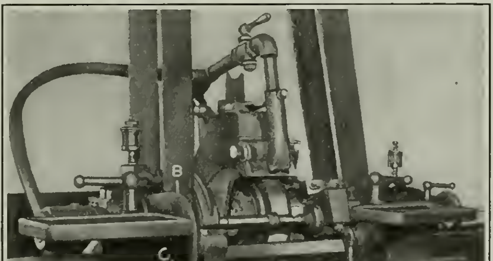


Fig. 36. Brown & Sharpe Plain Grinding Machine equipped with Special Automatic In-feeding Device for Form Grinding

Advantages and Limitations of Form Grinding

There are many advantages of form grinding, among which might be mentioned: first, greater production; second, accurately finishing hardened parts of irregular shape; third, grinding from the rough; fourth, increasing possibilities of securing interchangeable parts.

Greater production is possible because of the fact that a wide wheel carries a greater number of cutting particles that come in contact with the work than a narrower wheel, and consequently removes a greater amount of material in a given time. The wide wheel also, in covering the length of the part being ground, produces the same amount of work in a given time as several narrower wheels. To illustrate, a 1-inch face wheel only covers one-tenth the surface covered by a 10-inch face wheel, and assuming that other conditions are the same, will only produce one-tenth as much work as the wider wheel.

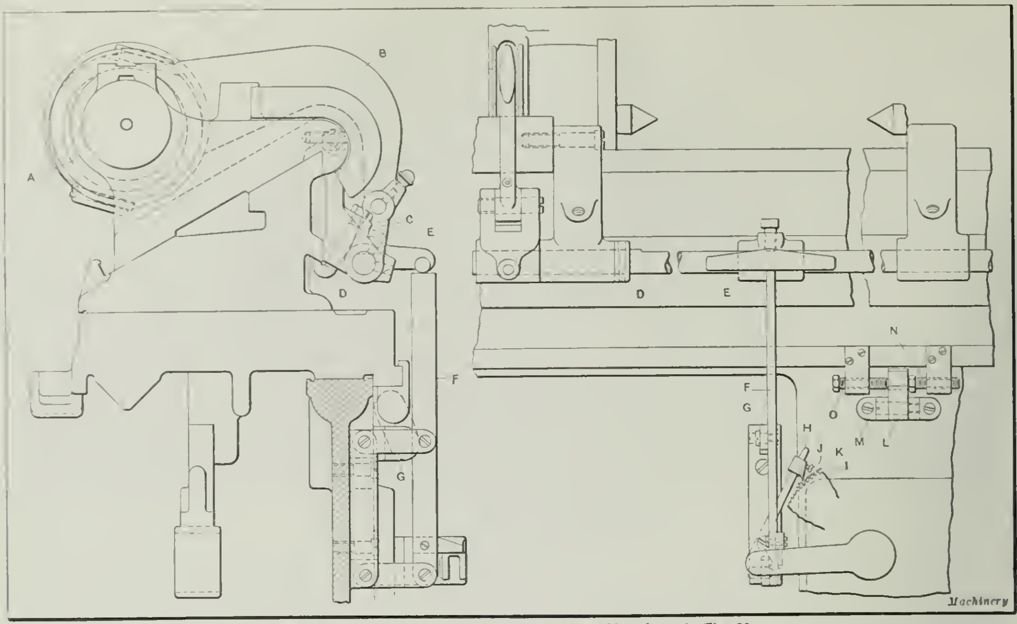


Fig. 37. Details of In-feeding Device used on Machine shown in Fig. 36

The use of the form wheels presents the only practical means of accurately finishing flat or cylindrical shaped irregular surfaces, and this advantage alone is of considerable importance. As has been previously mentioned, form grinding has made possible the grinding of crankshafts, etc., from the rough, and to a certain extent, is responsible for the great reduction in the cost of automobiles within the last few years.

An advantage of form grinding that is worthy of special note is its possibility of producing interchangeable parts. With a wide face wheel that is kept in good condition by being trued frequently with a diamond, it is a comparatively easy task to secure accurate work. The wheel is fed straight in on the work to the pre-determined point, and allowed to dwell on the work until no sparks show. In this way, parts can be ground with comparative ease to limits of 0.0005 inch.

The width of face of grinding wheels used for form grinding has gradually increased until today we find wheels up to 10 and 12 inches face being used with success. The chief limitations of form grinding are the difficulties encountered in making the grinding wheel and in producing a machine of the necessary strength and rigidity. Another limitation is in the depth of form. This can be such that the peripheral speed of the various diameters on the wheel produces a different cutting action, making the production of very deep forms impracticable. A difference of 2 inches on the diameter of the wheel, however, easily comes within the possibilities of the grain and grade that can be furnishd by the wheel manufacturers. Again, wheels for form grinding must be trued up more frequently than is necessary in traverse grinding, but this is not a serious disadvantage. In fact, grinding authorities state that on work which must be held within close limits a generous use of the diamond not only increases production, but also insures greater accuracy of product. Different degrees of finish on the work can be produced by truing the wheel so that it will be sharp or smooth. This makes it possible in some cases to use the same wheel for roughing and finishing.

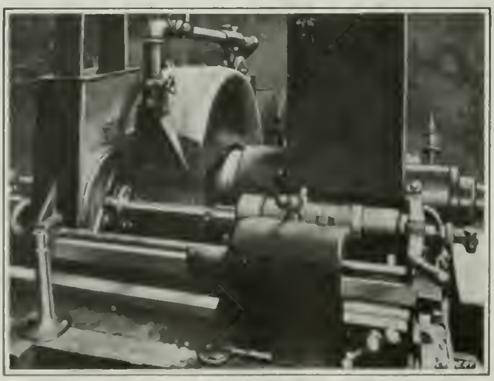


Fig. 38. Set-up on a Special-purpose Norton Plain Grinding Machine for form-grinding a Ford Transmission Shaft

A form grinding wheel, to stand up satisfactorily, should be provided with liberal fillets and sharp corners avoided. It is also impossible to do under-cutting with a grinding wheel, and where possible the work should be designed with these two points in view if form grinding is to be done. The grinding machine also calls for considerable study if satisfactory results are to be obtained. In the first place, it should be rigidly and accurately constructed so that it will stand up under the strains of the work which it is called upon to perform. The spindles should also be made of the finest kind of material, with ample bearing surfaces and large well made boxes of good material. Vibration in the machine should be reduced to a minimum.

Work Speeds for Form Grinding Mild Steel

For form grinding soft steel containing from 0.15 to 0.25 per cent carbon, the work speed should be in the neighborhood of from 30 to 55 feet surface speed, and is dependent upon the wheel used, and to a certain extent upon the finish desired. The harder the bond of the wheel as a rule, the higher the work speed, and the softer the bond, the lower the work speed. For form grinding 0.15 to 0.25 per cent carbon steel which has been casehardened, the work speeds are just about the same, but the wheels are generally of a harder bond and slightly finer grain than those used for soft steel. The examples shown in the following can be used as a general guide for the selection of the proper wheels and work speeds for different classes of work.

Work Speeds for Form Grinding Chrome-Nickel and Chrome-Vanadium Steels—Heat-treated

In the grinding of alloy steels which have been heat-treated, the work speeds seldom exceed 55 feet surface speed.

As a general rule, grinding wheels of combination grain are used for form grinding alloy steels, and it has been found that wheels of, say, No. 24 combination work best at surface speeds ranging from 25 to 40 feet. The harder the bond of the wheel, of course, the higher must be the surface speed to get the same results, but on form grinding, hard bond wheels of fine grain are not recommended because of the liability to glaze and heat up quickly. Of course the speed of the work is dependent to a certain extent upon its diameter, small-diameter work being rotated at a higher surface speed than large-diameter work. In the examples shown in Figs. 39, 40, 44, and 48, it will be noticed that the surface speeds range all the way from 39 to 55 feet, the average being about 45 to 50 feet.

Rate of In-feed of Wheel for Form Grinding

The rate at which the wheel is fed in on the work for form grinding varies all the way from 0.0005 to 0.003 inch per revolution of the work, the rate of in-feed depending on the slenderness of the work and the manner in which it is supported, also to some extent on the rigidity of the machine in which the operation is being accomplished. This in-feeding of the wheel on the work is generally done by hand, but several devices have been designed for doing this by power. Of course the hand feed method offers more latitude, as far as increasing production is concerned, than the power feed, but can only be done successfully by an experienced operator.

An interesting in-feeding device which has been adapted to the Brown & Sharpe plain grinding machine for form grind-

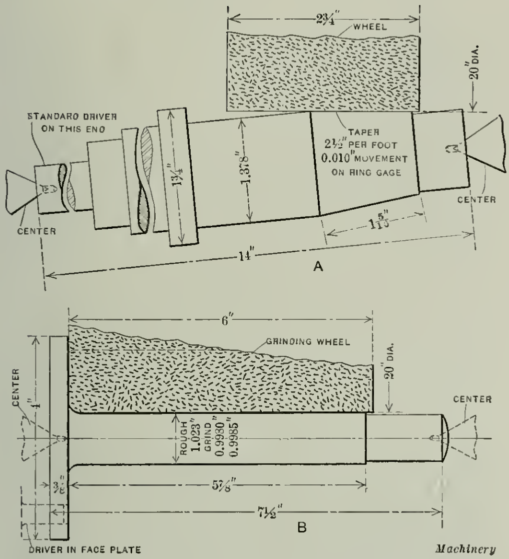


Fig. 39. Examples of form-grinding Transmission Main Drive Shafts

A

Work:—Transmission main drive shaft, 0.20 per cent carbon open-hearth steel, carbonized and hardened.

Operation:—Straight-in grinding taper with a Norton (vitrified) alundum combination wheel, grain 38-24, grade L; 20 inches diameter, 2¾ inch face; 1146 R. P. M.—6000 feet surface speed; work speed, 200 R. P. M.—70 feet average surface speed; amount removed from diameter, 0.015 to 0.025 inch.

Remarks:—Wide-face wheel is fed straight in on work, not traversed, and work-table is set off to the correct taper; production, 325 pieces in nine hours; machine used, 10 by 36 inch Norton plain grinding machine.

B

Work:—Transmission shaft, 0.20 to 0.25 per cent carbon, 0.018 per cent vanadium alloy steel drop-forging, heat-treated.

Operation:—Straight-in grinding shank with a Norton (vitrified) alundum combination wheel, grain 38-24, grade L; 20 inches diameter, 6 inch face; speed, 1146 R. P. M.—6000 feet surface speed; work speed, 150 R. P. M.—39 feet surface speed; amount removed from diameter, 0.025 inch.

Remarks:—Wide-face wheel is fed straight in on work, not traversed; 65 pieces turned out to each truing of wheel; production, 550 pieces in eight hours; machine used, 10 by 24 inch Norton special-purpose plain grinding machine.

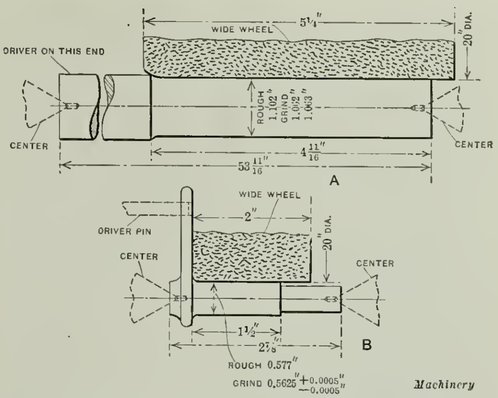


Fig. 40. Two Interesting Examples of "Straight-in" Grinding—Automobile Drive Shaft and Automobile Spring Shackle

A

Work:—Automobile drive shaft, 0.20 per cent carbon, chrome-nickel vanadium, hot-rolled steel bar, heat-treated.

Operation:—Straight-in grinding plain bearing with a Norton (vitrified) alundum combination wheel, grain 38-24, grade L; 20 inches diameter, 5¼ inch face; 1146 R. P. M.—6000 feet surface speed; work speed, 200 R. P. M.—55 feet surface speed; amount removed from diameter, 0.030 to 0.040 inch.

Remarks:—Wide-face wheel is fed straight in on work, not traversed; 60 pieces turned out to each truing of wheel; production, 375 pieces in eight hours; machine used, 10 by 50 inch, Norton special-purpose plain grinding machine.

B

Work:—Automobile spring shackle, 0.20 per cent carbon, 0.18 per cent vanadium drop-forging, heat-treated.

Operation:—Straight-in grinding shank with a Norton (vitrified) alundum wheel, grain 46, grade O; 20 inches diameter, 2 inch face; 1146 R. P. M.—6000 feet surface speed; work speed, 480 R. P. M.—71 feet surface speed; amount removed from diameter, 0.012 to 0.015 inch.

Remarks:—Wide-face wheel is fed straight in on work, not traversed; 22 pieces turned out to each truing of wheel; production, 1400 pieces in eight hours; machine used, 6 by 32 inch Norton plain grinding machine.

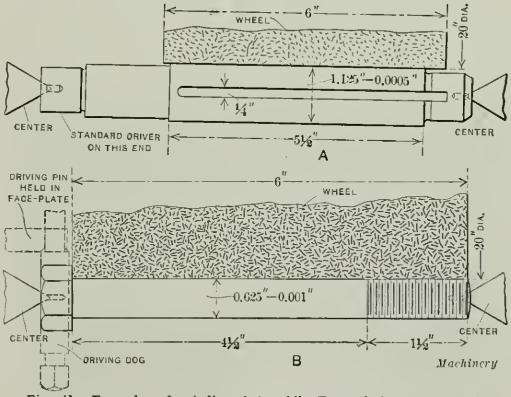


Fig. 41. Examples of grinding Automobile Transmission Countershaft and Automobile Front Axle Spindle Bolt by Form Wheel Method

A

Work:—Transmission countershaft, 0.20 per cent carbon open-hearth steel, carbonized and hardened.

Operation:—Straight-in grinding external diameter with a Norton (vitrified) alundum combination wheel, grain 38-24, grade L; 20 inches diameter, 6 inch face; speed, 1241 R. P. M.—6500 feet surface speed; work speed, 100 R. P. M.—30 feet surface speed; amount removed from diameter, 0.015 to 0.025 inch.

Remarks:—Wide-face wheel is fed straight in on work, not traversed; 50 pieces turned out to each truing of wheel; production, 330 pieces in nine hours; machine used, 10 by 36 inch Norton plain grinding machine.

B

Work:—Front axle spindle bolt, 0.20 per cent carbon open-hearth steel, carbonized and hardened.

Operation:—Straight-in grinding external plain surface and threaded section with a Norton (vitrified) alundum combination wheel, grain 38-24, grade L; 20 inches diameter, 6 inch face; speed, 1241 R. P. M.—6500 feet surface speed; work speed, 200 R. P. M.—33 feet surface speed; amount removed from diameter, 0.015 to 0.025 inch.

Remarks:—Wide-face wheel is fed straight in on work, not traversed; 50 pieces turned out to each truing of wheel; production, 480 pieces in nine hours; machine used, 10 by 36 inch Norton plain grinding machine.

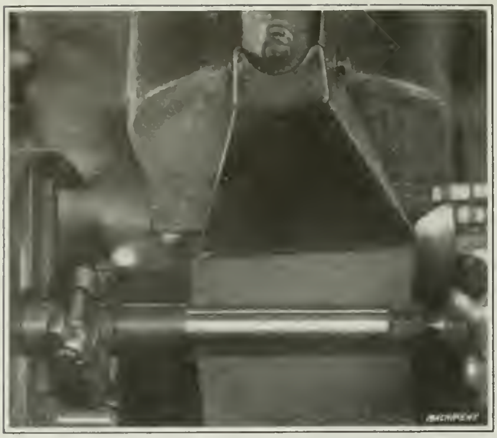


Fig. 42. Set-up for grinding Transmission Countershaft in Norton Plain Grinding Machine

ing is shown in Figs. 36 and 37. This device is operated as follows: An eccentric *A* held on the work head spindle oscillates a shaft *D* through lever *B* and connection *C*. Shaft *D* carries an adjustable shoe *E* which can be moved along it to contact with lever *F*. This lever is fulcrumed in bracket *G* and on its lower end carries a ratchet pawl lever *H*. Ratchet pawl *H*, in turn, carries a pawl *J*, which engages with a feeding dial *I* fastened to the same shaft that carries the handwheel for operating the in-feed of the grinding wheel slide.

As the work head revolves, pawl *J* moves the feeding dial *I* around two notches, or in other words brings the grinding wheel in at the rate of 0.002 inch per revolution of the work. This continues until the correct diameter has been reached, when the automatic kick-out comes into play. This consists of a segment shield *K* fastened to the feeding dial and adjustable around its circumference. This, as shown in Fig. 37, passes beneath the pawl, raising it and preventing any further action upon the ratchet dial. The grinding wheel is then allowed to dwell on the work until no sparks show, and in this way very accurate dimensions can be obtained. In fact, the limits on the particular piece on which this device was used were 0.0005 inch on the diameter. Feeding the wheel in on the work by power feed has an advantage over the hand feed, inasmuch as no feeding is done if the belt driving the work spindle slips. When an operator is feeding the wheel in by hand, care must be taken to see that the work runs smoothly, or else flats will be produced on the work. Of course, if the wheel is allowed to dwell at the end of the cut these flats will in most cases be eliminated.

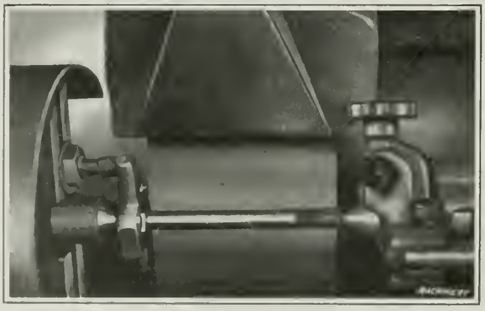


Fig. 43. Set-up for grinding Front Axle Spindle Bolt in Norton Plain Grinding Machine

Form Grinding Transmission Shafts

The finishing of transmission shafts for automobiles is a good example of the advantages to be gained by the use of wide wheels, fed straight in on the work. Fig. 38 illustrates a special-purpose Norton plain grinding machine set up for this work in the plant of the Ford Motor Co. This shaft is brought directly from the lathe turning operation, and is finished complete at the rate of 550 in eight hours, to limits of 0.0005 inch on the diameter. As is shown at *B* in Fig. 39, a No. 24, combination grain No. 38 alundum wheel is used for the job, which is 6 inches face, 20 inches diameter. *A* in Fig. 39 shows a transmission main drive shaft on which a taper bearing is being ground. In this case, the same grain and grade of wheel is used, but the work speed is much higher. While this piece has an over-all length almost twice that of *B*, the production is not anywhere nearly as great. This is largely due to the time spent in keeping the wheel face true, and probably is due to the pace set by the operator.

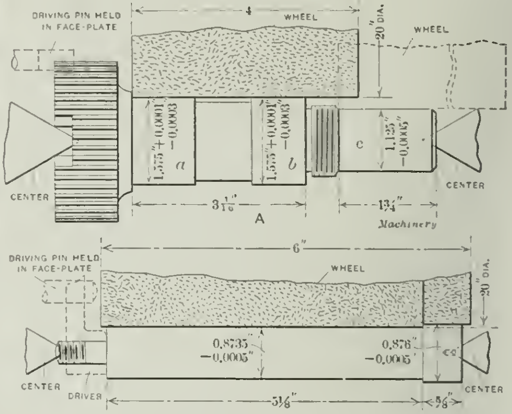


Fig. 44. Examples of grinding Idler Gear and Main Drive Gear Shaft by Form Wheel Method

A

Work:—Main drive gear, 0.20 per cent carbon alloy steel, carbonized and heat-treated.

Operation:—Straight-in grinding external diameter with a Norton (vitrified) alundum combination wheel, grain 38-24, grade L; 20 inches diameter, 4 inch face; speed, 1241 R. P. M.—6500 feet surface speed; work speed, about 100 R. P. M.—41 feet surface speed; amount removed from diameter, 0.010 inch.

Remarks:—Wide-face wheel is fed straight in on portions (a) and (b), not traversed; small end (c) is also ground in same setting by shifting wheel; production, 265 pieces in nine hours; machine used, 10 by 36 inch Norton plain grinding machine.

B

Work:—Idler gear shaft, 0.20 per cent carbon open-hearth steel, carbonized and hardened.

Operation:—Straight-in grinding two external diameters with a Norton (vitrified) alundum combination wheel, grain 38-24, grade L; 20 inches diameter, 6 inch face; speed, 1241 R. P. M.—6500 feet surface speed; work speed, 100 R. P. M.—24 feet surface speed; amount removed from diameter 0.015 to 0.025 inch.

Remarks:—Wide-face wheel is fed straight in on work, not traversed; 50 pieces turned out to each truing of wheel; production, 375 pieces in nine hours; machine used, 10 by 36 inch Norton plain grinding machine.

The automobile drive shaft shown at *A* in Fig. 40 is

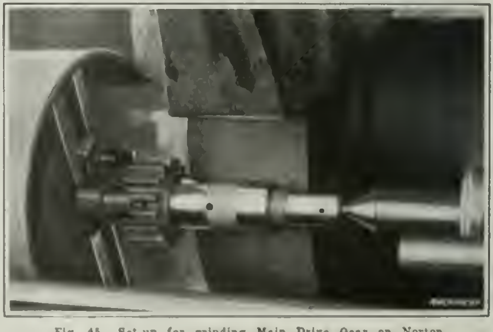


Fig. 45. Set-up for grinding Main Drive Gear on Norton Plain Grinding Machine

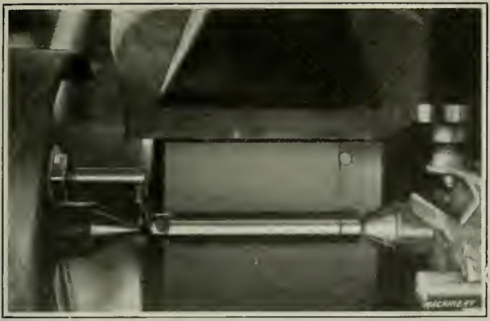


Fig. 46. Set-up for grinding Idler Gear Shaft by Form Wheel Method—Note Method of Driving

another good example of "straight-in" grinding. In this case a wheel 5¼ inches wide is used and the work is finished to a limit of 0.001 inch on the diameter. The same grade and grain of wheel is used as in Fig. 39, but the work speed has been slightly increased over that shown at *B*. This increase in speed, however, is not beyond the limits of the grain and grade of the wheel used. The automobile spring shackle shown at *B* in Fig. 40 illustrates one point previously stated regarding the work speed. In this case it will be noticed that an alundum wheel, grain 46, grade O, is used, and the surface speed is 71 feet. Here it will be noticed that the grain is much finer than for example *A* and the bond is also harder.

Form Grinding Automobile Transmission Countershaft and Spindle Bolt

Fig. 41 shows two interesting examples of form grinding. One is a transmission countershaft which is made from 0.20 per cent carbon open-hearth steel, carbonized and hardened, and the other is a front axle spindle bolt made from the same material. Figs. 42 and 43, respectively, show how these pieces are handled in the grinding machine. Referring to Fig. 42, it will be noticed that the transmission countershaft is held on the centers and driven in the ordinary manner by a dog, as is also the case with the front axle spindle bolt shown in Fig. 43.

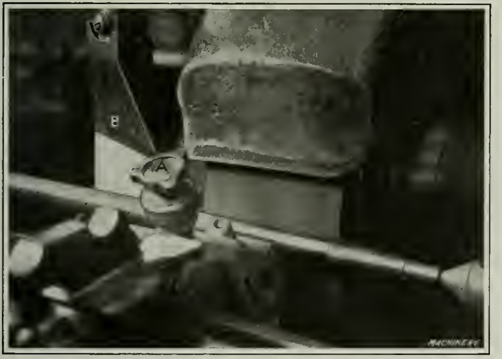


Fig. 47. Grinding a Ford Rear Axle in Norton Special-purpose Plain Grinding Machine

Grinding Automobile Gear Shafts

Two examples of form grinding on automobile parts are shown in Fig. 44. *A* is a main drive gear shaft on which three diameters are finished by means of feeding the wheel straight in on the work without any lateral traverse. Diameters *a* and *b* are finished at the same time, whereas diameter *c* is finished by moving the work over, and is done in the same setting as diameters *a* and *b*. The manner in which this gear shaft is handled is shown in Fig. 45. Here it will be seen that a driver which contacts with the teeth in the gear takes the place of the ordinary driving dog. The idler gear shaft shown at *B* is a little more difficult to grind. This is provided with two diameters and the difference between these two diameters is only 0.0025 inch, necessitating very careful truing of the grinding wheel. To accomplish this, the grinding machine is provided with stops so that the wheel truing device can be brought to the proper position each time for truing the wheel. The centers in the work are also center-reamed to the same depth, so as to bring the work in the correct relation to the wheel. Fig. 46 shows the method by which this piece is handled. A small driver screwed onto the end of this piece acts as a dog to drive the work on the centers.

Form Grinding a Rear Axle Shaft

The rear axle shaft shown in Fig. 48 is a good example of the straight-in method of grinding. Referring to this illustration, it will be seen that three diameters are ground by feeding the wheel straight in on the work. For one diameter, a wheel 6½-inch face is used, for another a 6-inch face wheel, and for the third or tapered end a wheel 3¼ inches face is used. On this work three Norton special-purpose plain grinding machines are used. Fig. 47 shows how the work is supported while operation *B* is being performed. Here, it will be seen that a Norton rigid steadyrest of the type shown in Fig. 5 is used, carrying a hardened steel work-shoe. In order to grind this bearing absolutely true, knob *A* for operating the steadyrest shoe is adjusted to spring the work against the wheel just as it is being finished to the required diameter. Another interesting point about this job is the type of water

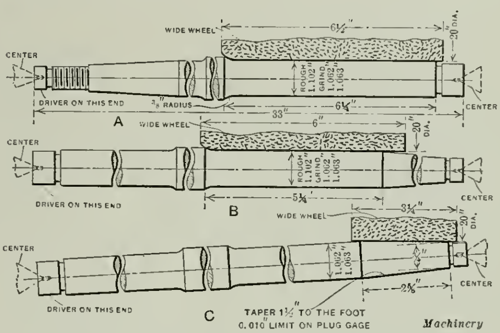


Fig. 48. Finishing a Ford Rear Axle Shaft Complete by Form Wheel Method

Work:—Rear axle shaft, 0.20 per cent carbon, 0.18 per cent vanadium alloy steel bar hot-rolled and heat-treated; allowance 0.030 to 0.040 inch left on all diameters for grinding; wheel fed straight in on work without traverse; wheel allowed to dwell at end of cut until practically no sparks show; grinding limit 0.001 inch on straight portions of shaft; three operations on a 10 by 36 inch Norton special-purpose plain grinding machine.

Operation A:—Wheel, Norton (vitrified) alundum combination, grain 38-24, grade L; 20 inches diameter, 6½ inch face; speed, 1146 R. P. M.—6000 feet surface speed; work speed, 200 R. P. M.—55 feet surface speed; 60 pieces turned out to each truing of wheel; production, 350 pieces in eight hours.

Operation B:—Wheel, same as above; same data also applies to wheel speed, work speed, production, etc.

Operation C:—Wheel, Norton (vitrified) alundum combination, grain 38-24, grade L; 20 inches diameter, 3¼ inch face; speed, 1146 R. P. M.—6000 feet surface speed; work speed, 200 R. P. M.—51 feet average surface speed; 60 pieces turned out per each truing of wheel; production, 450 pieces in eight hours.

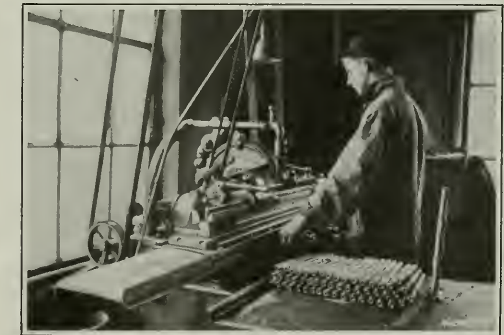


Fig. 49. Grinding Motor Armature Shafts by Form Wheel Method

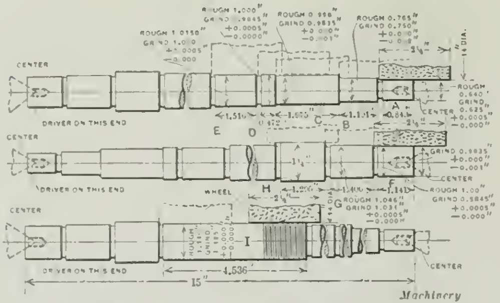


Fig. 50. Motor Armature Shaft, finished Complete at the Rate of 105 in Ten Hours

Work:—Armature shaft, 0.15 to 0.25 per cent carbon machine steel; ground after rough-turning operations when soft; allowance of 0.015 inch on all diameters for grinding except one; wheel fed straight in on work without traverse at the rate of about 0.002 inch per revolution of work; wheel allowed to dwell at end of cut until no sparks show; grinding limit varies on all diameters from 0.0005 to 0.002 inch; eight form grinding operations, one traverse operation; performed on a 6 by 32 inch Norton plain grinding machine; shafts carried through in lots of 500; one shoulder finished on each shaft at one time; production, about 105 finished shafts in ten hours.

Operations A to E inclusive:—Wheel, Norton (vitrified) alundum, 2¼ inches wide, 14 inches diameter; grain 24, grade N; speed, 1500 R. P. M.—5500 feet surface speed; trued with diamond every 75 shoulders ground; work speed, 350 R. P. M.—58 to 92 feet surface speed.

Operations F to H inclusive:—Wheel, same as above; same data also applies to wheel speed; work speed, 350 R. P. M.—90 to 115 feet surface speed; for operation (F) wheel is trued 0.001 inch taper.

Operation I:—Wheel, same as that used for operations (A) to (H) inclusive; same data also applies to wheel speed; work speed, 350 R. P. M.—104 feet surface speed; 0.032 inch removed from diameter; time, one minute for each shaft; wheel traversed.

spout used. In this case it will be noticed that a special water spout made from sheet metal has been slipped over the regular spout. This spout *B* is made fan-shaped and throws a stream of cutting lubricant across the entire width of face of the grinding wheel. The stream of cutting lubricant directed by this spout is also "thin," thus reducing splashing.

Grinding Motor Armature Shafts

The motor armature shaft shown in Fig. 50 is another good example of straight-in grinding. In this case the wheel used is not wide as compared with the other examples that have been shown. This 2¼-inch face wheel, however, covers all the shoulders on the shaft except shoulder *I* which is 4.536 inches long. The method by which this particular example is ground is shown in Fig. 49. The operator takes a batch of about 100 shafts, and grinds one shoulder at a time on all the shafts; then he shifts the position of the work table in relation to the wheel and grinds the second shoulder, and so on until all the shoulders except *I* have been finished; for this shoulder the work is traversed past the wheel. It will also be noticed that shoulder *F* is ground with a slight taper, and for grinding this, it is necessary to true the wheel to a corresponding taper.

Grinding Electric Starter Shafts

The electric starter shaft shown in Fig. 52 is another example which illustrates the advantages of form grinding on shafts of the multi-shoulder variety. This particular electric starter shaft is made from cold-rolled steel, and has five diameters that are ground by feeding the wheel straight in on the work. Three of the diameters require separate settings for each operation, whereas two diameters are ground by forming the wheel to cover both dimensions at the same time. In this way five operations are performed on four machines, and the product from each machine is 100 shafts per hour. As shown in Fig. 37, for performing operation *D*, Fig. 52, a stop is provided on the machine for locating the wheel in the correct relation to the work. This comprises a block *L* fulcrumed in bracket *M* which can be swung down out of the way when truing the grinding wheel by means of the device shown on the machine in Fig. 51. The work is then relocated by moving block *L* into place between the two set-screws *N* and *O*. As shown in Fig. 51, the diamond truing device consists of two rods *A* and *B* which are held in the holder in an angular position, so as to bring their two forward ends about 1½ inch apart. The plungers holding the diamonds are operated by micrometer screws so that each diamond point is independently adjustable.

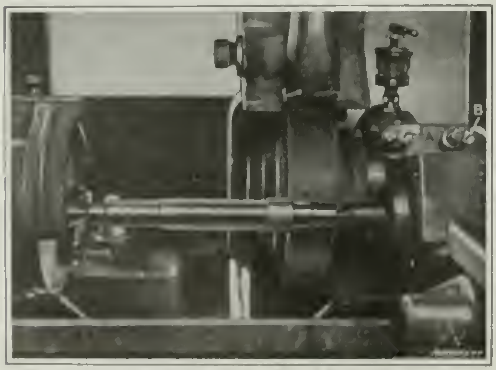


Fig. 51. Set-up for grinding Electric Starter Shafts by "Straight-in" Method on Brown & Sharpe Plain Grinding Machine

Advantages of Form Method of Grinding on Miscellaneous Machine Parts

The example of straight-in grinding shown in Fig. 53 is an excellent illustration of the advantage of straight-in over traverse grinding. When this particular part was ground by the traverse method, the time for 100 pieces was seven hours, thirty minutes. By bringing the wheel straight in on the work, the time was cut down on 100 pieces to two hours,

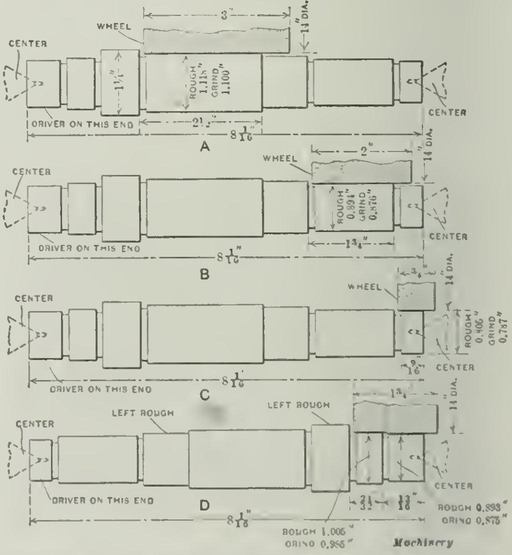


Fig. 52. Electric Starter Shaft, finished Complete at the Rate of 100 Shafts per Hour on Four Brown & Sharpe Plain Grinding Machines

Work:—Electric starter shaft, cold-rolled steel; ground after rough-turning operation when soft; allowance of 0.018 inch left on all diameters for grinding; wheel fed straight in on work without traverse; in-feed, 0.002 inch per revolution of work; wheel allowed to dwell at end of cut until practically no sparks show, grinding limit, 0.00025 inch on all diameters; five operations performed on four B. & S. plain grinding machines; output, 100 shafts per hour from each machine.

Operation A:—Wheel, Norton (vitrified) alundum, 3 inches by 14 inches, combination grain 38-30, grade L; speed, 1450 R. P. M.—5314 feet surface speed; trued with diamond for every 80 shafts ground; work speed, 188 R. P. M.—54 feet surface speed.

Operation B:—Wheel, Norton (vitrified) alundum, 2 inches by 14 inches, combination grain 38-30, grade L, speed, 1450 R. P. M.—5314 feet surface speed; trued with diamond after every 80 shafts ground; work speed, 188 R. P. M.—44 feet surface speed.

Operation C:—Wheel, Norton (vitrified) alundum, ¾ by 14 inches, combination grain 38-30, grade L; speed 1450 R. P. M.—5314 feet surface speed; work speed, 188 R. P. M.—40 feet surface speed.

Operation D:—Wheel, Norton (vitrified) alundum, 1¾ inch by 14 inches, combination grain 38-46, grade K; speed, 1450 R. P. M.—5314 feet surface speed, trued after every 80 shafts with special diamond truing device carrying two diamonds, work speed, 188 R. P. M.—43 feet average surface speed.

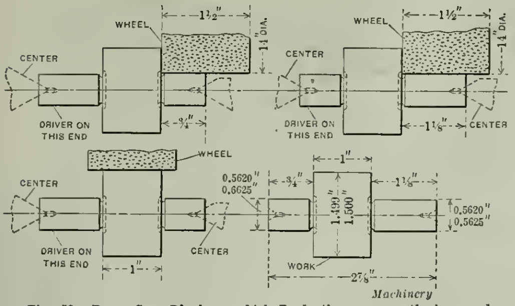


Fig. 53. Pump Gear Blank on which Production was greatly increased by using "Straight-in" Grinding in preference to the Traverse Method

Work:—Pump gear blank, 0.30 per cent carbon steel, not hardened.

Operation:—Straight-in grinding three diameters with an American (vitrified) corundum wheel, combination grain 58-46, grade L; 14 inches diameter, 1½ inch face; speed, 1773 R. P. M.—6500 feet surface speed; work speed, small diameters, 441 R. P. M.—65 feet surface speed; amount removed from diameter, 0.015 inch.

Remarks:—Wide face wheel is fed straight in on work without lateral traverse at the rate of 0.0005 inch per revolution of the work; 100 pieces turned out to each truing of wheel; work put through in lots of 100 pieces; production, 100 pieces in two hours, eighteen minutes; machine used, No. 11 Brown & Sharpe plain grinding machine.

eighteen minutes without sacrificing accuracy or finish of work. The cast-iron drive pinion shown at *B* in Fig. 54 is another example which illustrates the advantage of straight-in grinding over traversing the wheel. On a lot of 100 pieces, the previous time by the traversing method was seven hours, forty-eight minutes. This time was practically cut in two by bringing the wheel straight in on the work, the grinding then being accomplished in four hours, thirty minutes. The example *A* in Fig. 54 shows a little closer time between the traversing and straight-in methods of grinding. On forty pieces the time required for traversing the wheel was twenty-six minutes, twenty-six seconds, and by bringing the wheel straight in on the work the time for forty pieces was twenty-one minutes, twelve seconds—a gain of about five minutes. The reason that the straight-in method shows such a slight advantage in this case is because of the slenderness of the work and the care with which it has to be handled. The gain, however, is sufficient to warrant the use of the straight-in method of grinding in preference to traversing the work.

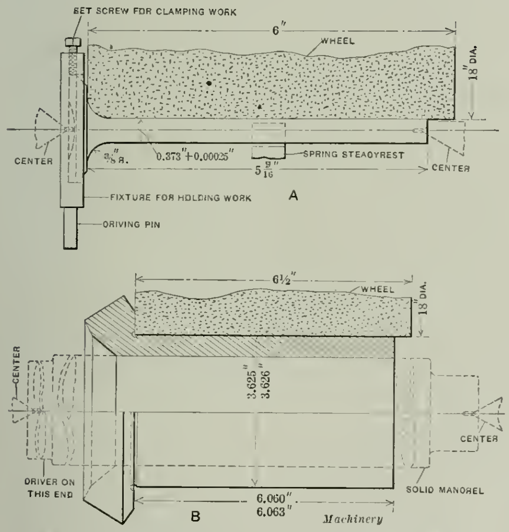


Fig. 54. Two Interesting Examples of the "Straight-in" Method of Grinding—one showing up the Limitations and the other the Advantages of this Method

A

Work:—Gas engine valve stem, 0.30 per cent carbon steel, not hardened.

Operation:—"Straight-in" grinding diameter of stem with a Norton (alundum) wheel, grain 38-46, grade J; 18 inches diameter, 6 inch face; speed, 1379 R. P. M.—6500 feet surface speed; work speed, 255 R. P. M.—25 feet surface speed; amount removed from diameter, 0.010 to 0.012 inch.

Remarks:—Wide face wheel is fed straight in on work without any lateral traverse, at the rate of 0.0005 inch per revolution of the work; 50 pieces turned out to each truing of wheel; production, 40 pieces in twenty-one minutes, twelve seconds; machine used, No. 12 Brown & Sharpe plain grinding machine.

B

Work:—Drive pinion made of cast iron.

Operation:—"Straight-in" grinding stem of pinion with a Norton (vitrified) crystolon wheel; grain 50, grade L; 18 inches diameter, 6½ inch face; speed 1379 R. P. M.—6500 feet surface speed; work speed, 79 R. P. M. —75 feet surface speed; amount removed from diameter 0.015 inch.

Remarks:—Wide face wheel is fed straight in on work without any lateral traverse at the rate of 0.0005 inch per revolution of the work; 10 pieces turned out to each truing of wheel; production, 100 pieces in four and one-half hours; parts put through in lots of 100 pieces; machine used, No. 16 Brown & Sharpe plain grinding machine.

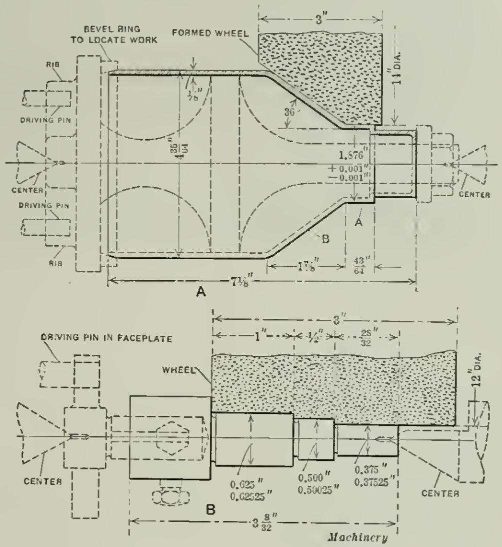


Fig. 55. "Straight-in" Grinding Cream Separator Bowl Shell and Igniter Shaft by Form Wheel Method

A

Work:—Cream separator bowl shell, 0.18 to 0.25 per cent carbon hot-rolled strip steel, annealed, pickled and "limed," but not hardened.

Operation:—Grinding straight and tapered portions of bowl with a Norton (vitrified) alundum wheel, grain 24, grade M; 14 inches in diameter, 3 inch face; speed, 1364 R. P. M.—5000 feet surface speed; work speed, 48 R. P. M.—50 feet average surface speed; amount removed from diameter, 0.012 to 0.015 inch.

Remarks:—Wide face wheel is fed straight in to grind bevel and straight portions in the following manner: first, wheel is fed straight in to rough (A) to within 0.003 inch of finished size; second, wheel is traversed sideways to finish (B); third, wheel is moved back 0.004 inch from bevel surface to finish (A); 25 to 200 pieces turned out to each truing of wheel; varies with grade of steel and annealing; averages 50; production, 192 in nine hours; machine used, 6 by 32 inch Norton plain grinding machine.

B

Work:—Igniter shaft, 0.20 per cent carbon steel, not hardened.

Operation:—"Straight in" grinding three external diameters with a Norton (alundum) wheel, grain 38-46, grade K; 12 inches diameter, 3 inch face; speed, 2069 R. P. M.—6500 feet surface speed; work speed, 306 R. P. M.—40 feet average surface speed; amount removed from diameter, 0.010 inch.

Remarks:—Wide face wheel is fed straight in on work without lateral traverse; actual grinding time—one man mounting work, one man operating machine—43 minutes for 100 shafts; work put through in lots of 100 pieces; machine used, No. 11 Brown & Sharpe plain grinding machine.

The example of straight-in grinding shown at *B* in Fig. 55 brings up a point in regard to operating the machine that has not previously been mentioned. On account of the shape of this particular part, it is necessary to use a special driver which must be held in place by set-screws, as shown. This takes some time to put in place, and two methods were adopted for operating the machine. One was to have one man mounting the work and operating the machine, and by this method the time for 100 pieces was fifty-three minutes. By having two men, one helper and one machine operator, the time on 100 pieces was cut down to forty-three minutes. For truing up the grinding wheel, a special truing device

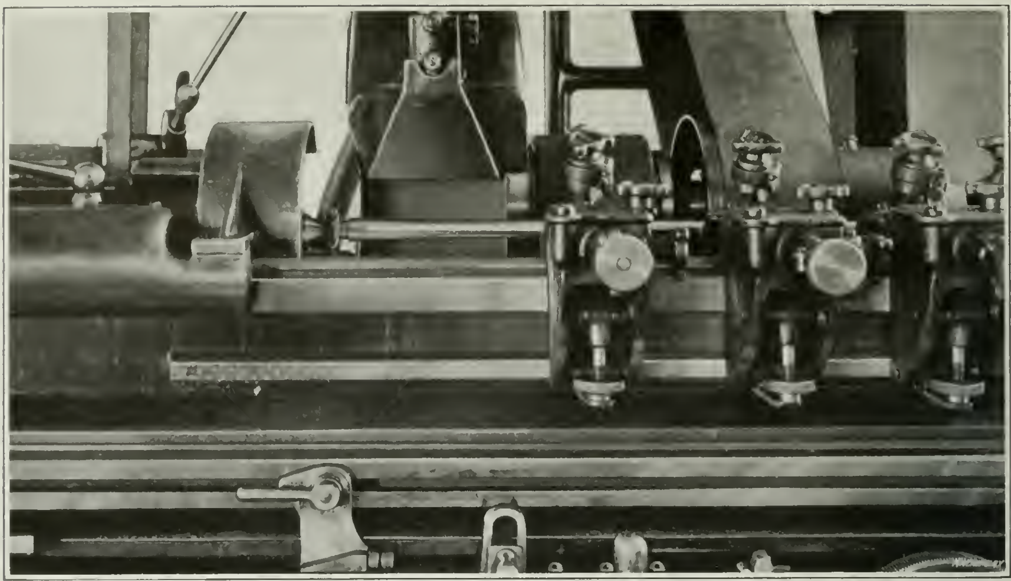


Fig. 56. Set-up on a 10 by 36 Inch Norton Plain Grinding Machine for grinding Rifle Barrels in One Operation

holding three diamond holders was used, so that all three diameters on the wheel could be trued up at the same setting.

Grinding a Cream Separator Bowl Shell

The cream separator bowl shell shown at *A* in Fig. 55 illustrates an example of work for which the form wheel method of grinding is particularly adapted. In this case, a tapered and straight shoulder has to be finished and the method of accomplishing this is to first feed the wheel straight in to rough diameter *A* to within about 0.003 inch of the finished size. Then the work is moved sidewise so as to finish bevel surface *B*. The work is again moved back from the wheel about 0.004 inch, whereupon the wheel is fed straight in to finish surface *A* and at the same time take a light finishing cut from surface *B*. In this way, both surfaces are finished accurately at the rate of 192 pieces in nine hours.

Grinding Rifle Barrels

The grinding of rifle barrels in large quantities has necessitated devising special equipment and means for handling the work expeditiously. It is no exception, therefore, to find that the wide face grinding wheel has been adapted with success to this work. Fig. 56 shows a Norton 10 by 36 inch plain grinding machine set up and in operation on rifle barrel grinding. This particular rifle barrel, shown in Fig. 57, is over 26 inches long, and is practically ground for its entire length. The barrel is ground taper from the muzzle up to within a short distance of the breech end and terminates in a 10-inch radius. The wheel used for this purpose is 5 inches face, 20 inches in diameter, and is trued with a 10-inch radius for about one-half its face width, the remaining part of the face being trued straight. The swivel table of the machine is set off to the required taper.

This particular rifle barrel is made from an unannealed forging of from 0.45 to 0.50 per cent carbon. Usually it is ground after the bore of the barrel has been reamed, and in some cases slugs are inserted in the ends instead of having the centers fit directly in the bore. On this particular barrel the external diameter is finished by the power and hand traverse methods. The taper portion of the barrel is ground by traversing the work past the wheel by power, whereas the radius portion is finished by hand. The operator, as soon as he finishes the taper, brings the work slowly up against the radius on the wheel and finishes this portion of the barrel to shape and size. On an average, thirty-five to forty barrels can be turned out between each truing of the wheel, but the straight portion of the wheel requires to be trued up about twice for every truing up of the radius section. The truing, however, is done by taking a very light cut with the diamond from the face of the wheel, and does not alter the diameters on the wheel perceptibly. The rate at which the work is traversed past the wheel varies to a considerable extent, but the usual practice is to take light cuts with coarse traverse feeds, practically the full width of the wheel being used per revolution of the work for roughing. Three standard Norton rigid steadyrests located from 8 to 10 inches apart are used for supporting the work. These steadyrests carry hardened and ground steel shoes which are finished to the same taper as that on the barrel.

Another interesting example of rifle barrel grinding is shown in Fig. 58. As will be seen by referring to this illustration, this rifle barrel is handled in an entirely different manner. Instead of traversing the wheel along the work straight from the radius section to the muzzle, the wheel is stepped in at intervals along the diameter of the work, the reason for this being that the taper on the barrel is not continuous but changes at five points. To complete the barrel requires five operations and five Norton 10 by 36 inch plain grinding machines, which are fitted up with special attachments for this work. For performing

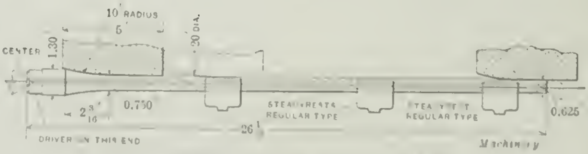


Fig. 57. Example illustrating One-operation Method of grinding Rifle Barrels

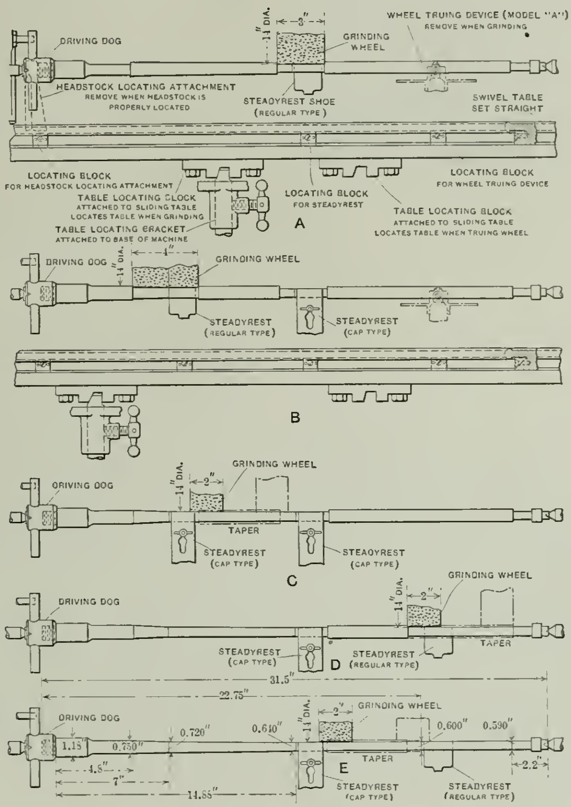
Work:—Rifle barrel, 0.45 to 0.50 per cent carbon unannealed steel forgings.

Operation:—Grinding taper and radius with a Norton (vitrified) combination wheel, grain 28-36, grade K; 20 inches diameter, 5 inch face, speed, 1184 R. P. M., 6200 feet surface speed, work speed, 150 R. P. M., 35 feet average surface speed, amount removed from diameter, 0.015 to 0.020 inch.

Remarks:—Power traverse is used for grinding taper and upon completion of this section, work is fed slowly by hand against wheel to finish radius; 35 to 40 barrels to each truing of wheel; three rigid steadyrests used 8 to 10 inches apart; production, 20 completed rifle barrels per hour; machine used, 10 by 36 inch Norton plain grinding machine.

operation *A*, the machine is provided with a headstock locating attachment which fits over the locating block on the left-hand end of the table, so that the headstock can be brought up until the center engages with the center hole in the locating attachment. The locating block for the headstock is common to all of the five machines used for this work. This device is provided for relocating the headstock after the center has been ground, which is necessary because of the wear that takes place. As is shown in Fig. 58, operation *A* consists in spotting the barrel in the center, and the locating block on the swivel table is placed properly for locating the steadyrest to support the work at this point. The table is located by a pin at the front of the base which engages with a slot in a block attached to the sliding table. In this way the rifle barrel is always in the correct position relative to the grinding wheel for spotting the center of the barrel.

The second locating block on the sliding table shown to the right of the one just mentioned, is used for locating the table when the wheel truing device is being used. For operation *A*, the swivel table is set in the correct position for grinding straight work, and the former on the truing device is provided with the necessary double taper so as to produce the correct shape on the face of the 3-inch wheel. After the first barrel has been ground, the micrometer stops on the steadyrests and the positive stops on the cross-feed mechanism are properly set to obtain the correct diameter on the barrel. These are left in this position until it is necessary to adjust them as the wheel wears down. The shoes used in the steadyrests are made from hardened steel and are ground to fit the shape of the barrel at the points where they contact with it.


DRIVING DOG
14" DIA.
3"
GRINDING WHEEL
WHEEL TRUING DEVICE (MODEL "A")
REMOVE WHEN GRINDING
HEADSTOCK LOCATING ATTACHMENT
REMOVE WHEN HEADSTOCK IS PROPERLY LOCATED
STEADYREST SHOE (REGULAR TYPE)
SWIVEL TABLE SET STRAIGHT
LOCATING BLOCK FOR HEADSTOCK LOCATING ATTACHMENT
TABLE LOCATING BLOCK ATTACHED TO SLIDING TABLE LOCATES TABLE WHEN GRINDING
TABLE LOCATING BRACKET ATTACHED TO BASE OF MACHINE
LOCATING BLOCK FOR STEADYREST
LOCATING BLOCK FOR WHEEL TRUING DEVICE
TABLE LOCATING BLOCK ATTACHED TO SLIDING TABLE LOCATES TABLE WHEN TRUING WHEEL
A
DRIVING DOG
14" DIA.
4"
GRINDING WHEEL
STEADYREST (REGULAR TYPE)
STEADYREST (CAP TYPE)
B
DRIVING DOG
14" DIA.
2"
GRINDING WHEEL
TAPER
STEADYREST (CAP TYPE)
STEADYREST (CAP TYPE)
C
DRIVING DOG
14" DIA.
2"
GRINDING WHEEL
TAPER
STEADYREST (CAP TYPE)
STEADYREST (REGULAR TYPE)
D
31.5"
22.75"
DRIVING DOG
1.15"
0.750"
0.720"
0.610"
14" DIA.
2"
GRINDING WHEEL
0.600"
0.590"
TAPER
2.2"
4.8"
7"
14.85"
E
STEADYREST (CAP TYPE)
STEADYREST (REGULAR TYPE)

Machinery

Fig. 58. Example illustrating Five-operation Method of grinding Rifle Barrels

Work:—Rifle barrel, 0.45 to 0.50 per cent carbon unannealed steel forgings.

Operation A:—Spotting center of barrel for steadyrest shoe and finishing terminal points of two tapers with a Norton (vitrified) alundum wheel, grain 38-36, grade J or K; 14 inches diameter, 3 inch face; speed, 1637 R. P. M.—6000 feet surface speed; work speed, 150 R. P. M.—25 feet average surface speed; amount removed from diameter, 0.012 to 0.015 inch.

Operation B:—Spotting for steadyrest shoe and finishing barrel to size at terminus of two tapers near breech end of barrel with a Norton (vitrified) alundum wheel, grain 38-36, grade J or K; 14 inches diameter, 4 inch face; operating at same speed as for operation (A); work speed also the same.

Operation C:—Traverse grinding portion of barrel located between points spotted in operations (A) and (B) with a Norton (vitrified) alundum combination wheel, grain 24, grade J or K; 14 inches diameter, 12 inch face; wheel and work speeds the same as for operation (B).

Operation D:—Traverse grinding taper near muzzle of barrel with a Norton (vitrified) alundum combination wheel; grain 24, grade J or K; wheel and work speed same as for operation (B).

Operation E:—Traverse grinding taper portion located midway between muzzle and center of barrel with the same shape and brand of wheel as used for operation (D); wheel and work speeds same as for operation (B).

Remarks:—Five Norton 10 by 36 inch plain grinding machines are required with one operator for each machine; each of the five operations requires practically the same time; production is at the rate of 35 per hour from each machine.

Operation *B* consists in spotting the barrel by the use of a 4-inch face wheel close to the breech end. For supporting the barrel for this operation, a cap-type steadyrest is placed on the table in the correct position by means of a locating block, and the shoe of this rest engages that portion of the barrel that has already been ground. A regular type solid steadyrest is placed on the table directly in front of the point where operation *B* is being accomplished, to give additional support to the work. A locating pin engaging with the table locating block is attached to the sliding table, and correctly locates the work with reference to the grinding wheel for this operation, as was the case in operation *A*. The wheel truing device in this case also has two tapers so as to produce the correct shape on the face of the grinding wheel. When performing this operation, the swivel table is set, as before, for grinding straight work, the wheel being trued to the correct taper.

Operation *C*, as shown in Fig. 58, consists in traversing the work past a 2-inch face wheel. For this operation, the table is set off to the required taper, and two cap-type steadyrests are located as indicated, for supporting the work. In this operation, the two tapers produced by the form wheels in operations *A* and *B* are matched up. The wheel is trued by using the table traverse, the diamond being held in a holder attached to the footstock of the machine.

Operation *D* is also a traverse grinding operation, and the headstock is located in the same manner as for operation *A*. A cap-type steadyrest is used at the center of the barrel and is located by the block on the swivel table. A regular type steadyrest is placed to the right of the cap-type steadyrest, and is also located in the correct position by means of a locating block. The swivel table is set off to the correct taper, and a 2-inch face grinding wheel is used. . The power traverse is used for this traverse grinding operation. The grinding wheel is trued by means of a diamond carried in the holder on the footstock of the machine.

Operation *E* is performed in a somewhat similar manner to operation *D*, and is the final operation on the barrel. By referring to Fig. 58, it will be noted that every provision has been made for the rapid operation of the grinding machine so that the operator can more fully apply his attention to the turning out of the work. The production from each machine is figured on a basis of thirty-five rifle barrels per hour, giving a total of about 350 completed rifle barrels in ten hours from five machines. For grinding this barrel it will also be noted that full advan-

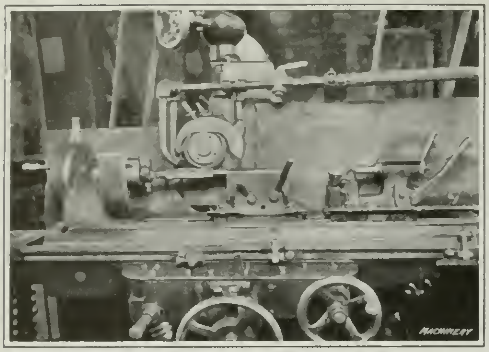


Fig. 59. Set-up on a No. 20 Bath Multiple-key Shaft Grinding Machine for grinding a Splined Transmission Shaft

tage is taken of the wide face wheel, trued to different tapers, and bringing it straight in on the work. This, combined with traversing the work, enables the greatest production to be obtained on this peculiar shape of rifle barrel.

For information on the grinding of shrapnel shells by the form wheel method, reference should be made to the article "Shrapnel and Shrapnel Manufacture," in the April, 1915, number of MACHINERY.

Form Grinding Splined Shafts

Splined shafts for automobile transmissions present another application of the form wheel to straight and circular surfaces. For this class of work, as a rule, a No. 20 Bath multiple-key shaft grinding machine is used, as shown in Fig. 59. This machine carries a form wheel which simultaneously works on both sides of the spline, and also on the radius between the splines. The wheel is kept trued up to the proper shape by means of the special wheel truing device, shown to the right of the illustration, which will be described in a subsequent article. The work, as shown, is held on centers and is driven by a dog in the usual manner. The head carrying the headstock center is rotated to index the work around for grinding the various splines, and several different methods are used for accomplishing this work. On the main drive shaft, shown at *A* in Fig. 60, the method of grinding is to first rough-grind all around the shaft to within 0.002 inch of the finished size, then true up the wheel with a special wheel-truing device, and take a finishing cut all around, four to five traverses per each spline being made for roughing and two traverses for finishing. On the example shown at *B* in Fig. 60, which is practically the same type of shaft, the method of handling is the same, but a different wheel is used. For example *A*, a Detroit combination wheel, grain 10-14, grade F, is used. This wheel is a combination of two different size grains and two different bonds; the sides of the wheel which operate on the splines are of fine grain, hard bond, whereas the center is of coarse grain and soft bond. For the example shown at *B*, the wheel used is a Norton alundum, grain 46, grade M, of practically a straight grain throughout, and is not of harder bond on the sides than in the center. With the wheel used on example *A*, it is necessary to true it up before taking the finishing cuts on every piece, whereas the wheel used on example *B* turns out from twelve to fifteen pieces to each truing of the wheel. The production on example *A* is sixty pieces in ten hours, whereas the production at *B* is 100 pieces in nine hours. From a study of these two examples of work, it would appear that a hard side, soft center wheel is not as satisfactory from a production standpoint as a wheel of an even bond and grain throughout.

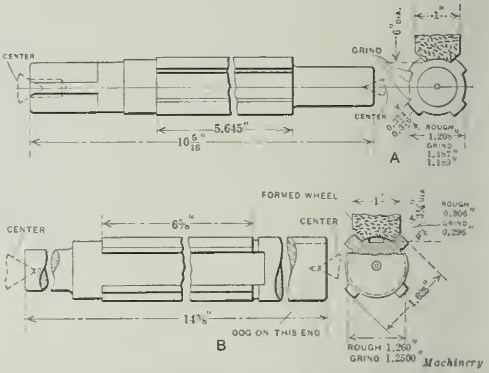


Fig. 60. Two Examples of Splined Transmission Shaft Work that call for the Use of Formed Grinding Wheels

A

Work:—Main transmission drive shaft, 0.20 per cent carbon, open-hearth steel, carbonized and hardened.

Operation:—Form grinding splines and radius with a Detroit (vitrified) combination wheel, grain 10-14, grade F; 6 inches diameter, 1 inch face; speed, 3185 R. P. M.—5000 feet surface speed; traverse work speed, 4.3 linear feet per minute; amount removed, 0.010 inch from each side of splines; 0.020 inch from diameter.

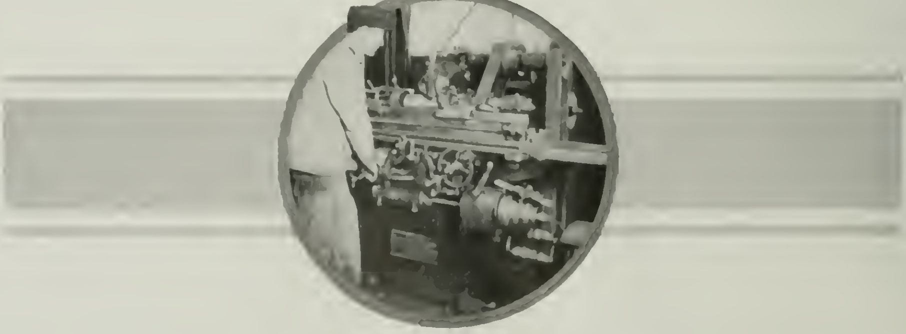
Remarks:—Sides of splines and radius are first rough-ground all around to within 0.002 inch of finished size, then wheel is trued with a special wheel truing device and shaft is finish-ground all around; number of traverses, four to five for each spline for roughing, two traverses for finishing. A combination wheel with hard bonded fine grain sides, and soft bonded coarse grain center is used; production, 60 pieces in ten hours; machine used, No. 20 Bath multiple-key shaft grinding machine.

B

Work:—Main transmission drive shaft, 0.50 per cent carbon steel drop-forging, hardened.

Operation:—Form grinding splines and radius with a Norton (vitrified) alundum wheel, grain 46, grade M; 3¼ inches diameter, 1 inch face; 2500 R. P. M.—2125 feet surface speed; traverse work speed, 8¼ linear feet per minute; amount removed 0.007 to 0.010 inch from each side of the splines; 0.014 to 0.020 inch from diameter.

Remarks:—Sides of splines and radius are first rough-ground by indexing the work after each traverse of the wheel, and two or three complete indexings made for roughing and finishing; wheel trued with special truing device; 12 to 15 pieces turned out per truing of wheel; production, 100 pieces in nine hours; 300 pieces ground by one wheel; machine used, No. 20 Bath multiple-key shaft grinding machine.



GRINDING CROWNED PULLEYS[*]

FORMING THE CROWN WITH WIDE FACE WHEELS

BY HOWARD W. DUNBAR[†]

Howard W. Dunbar[‡]

ONE of the very simple and effective discoveries in the application of belting to the transmission of power has been the crowning of the face of the pulley, *i. e.*, making the center larger in diameter than the edges, for the purpose of guiding the belt in a straight line and thereby keeping it in position without using such mechanical means as belt guides or flanges for this purpose. This has been an important discovery, but like many other simple mechanical laws applied in machines, the publication of information regarding the proportioning of the crown on a pulley has been so sadly neglected that almost every individual has his own views and ideas as to just how much or how little a pulley should be crowned to accomplish the desired results. We find in the numerous handbooks represented to be authorities on all subjects they treat almost as many different formulas and rules for determining the crown for pulleys as there are authors or handbooks. Some even go so far as to say that "the figures must be modified to meet the individual conditions." Of course, theoretically, low speeds require a higher crown than high speeds; leather belting higher crowns than cotton belting; wide pulleys and belts higher crowns than narrow ones, etc.

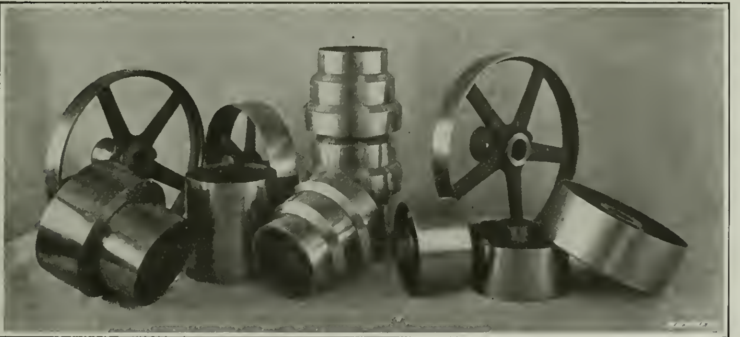


Fig. 1. Examples of Pulleys on which Crowning Operation was performed on Norton Grinding Machine. Note Special Cone Pulleys in Center of Illustration, on which Angular Faces between Steps were finished by Grinding

Some authorities recommend that the height of the crown should be 1/20 of the width of the face of the pulley, some 1/24, some 1/8 to 1/4 inch in height per foot of width, and so on indefinitely. The crowning or increasing of the diameter of the pulley at the center makes it possible to dispense with flanges or mechanical means for guiding the belt, due to the tendency on the part of the belt always to climb to the high point on the pulley. Consequently, the crown has but one object, and that is to guide the belt. The ideal condition for the transmission of power, insuring the greatest efficiency of the belt, is when the face of the pulley is absolutely straight and true. Therefore the nearer we can approach this condition, the more efficient will be the belt.

There are two principal factors which determine the position that a belt takes upon a crowned pulley, and these are modified by each other. First: The exact location of the highest point of the crown on the face of the pulley. Second: The diameter of the two extreme edges of the pulley. To insure the belt driving in its proper place on the pulley, the highest point of the crown should be exactly in the center, and the two edges of the pulley of exactly the same diameter, so that the nearer these conditions can be approached, the more ideal will be the drive.

The common method of crowning pulleys in general use is by two tapers, as illustrated in the left-hand view of Fig. 4. This method is selected principally because of its easy application in manufacturing (excluding the grinding process as a means of producing crowns) and has always been looked upon as being inefficient. The curved face crown, when the curve can be held uniform throughout, is a better means of crowning and more effective. The illustration of the position of the belt in Fig. 4 has been exaggerated to show the effect of crowning the pulley by the two-taper process. It will be noticed that the greatest tension on the belt is at point *C*, and naturally a strain is imposed at this point. The really effective driving is done somewhere between the center and outside edges, and may be represented by the space between *A* and *B*. Because of the stiffness of the belt (which is increased as the speed increases) the belt has a tendency to assume the position shown by the illustration. Although in actual practice the belt has the appearance of touching the pulley face all over, the pressure between the two extreme edges varies at different points, being the least near the edges and the greatest at the center. The real effective driving portion of the belt is between the points *A* and *B*.

The crown shown in Fig. 4 is accurate in height and in accordance with an approved formula taken from one of our prominent reference books. On the right of the same illustration is shown a pulley crowned by the grinding process, employing a straight-in cut. It will be seen that this crown has a symmetrical curve throughout the entire face of the

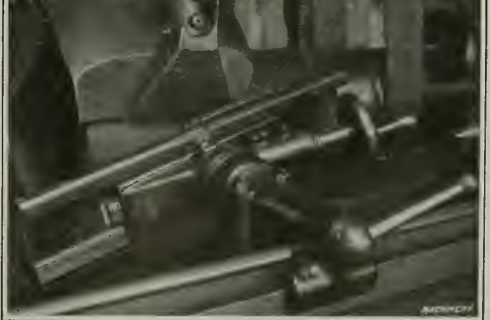


Fig. 2. Truing Device for producing Required Concavity in Wheel for grinding a Specified Height of Crown on Pulley

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[*] For additional information on the crowning of pulleys published in MACHINERY see also "Crown Faced Pulleys," by George N. Vanderhoef, April, 1913, and "Pulley Crowning," by George A. Gauthier, September, 1905.

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pulley. By this practice it is possible to produce pulleys with a crown of the minimum height, and because of the accuracy of the crown it will still guide the belt. The two extreme diameters on the edges of the pulley are held to a given dimension within a limit of 0.001 inch, the curve being symmetrical from edge to edge, which insures the highest point of the crown coming at the center and gradually decreasing toward the edges, with no abrupt differences in diameter from point to point. The fact that the belt lies uniformly over the face of the crown and approaches the ideal condition of a flat surface on the pulley, insures driving qualities and a power transmitting ability in the belt which are materially greater than when a crown is employed using the two-taper method produced by the old practice.

Extensive investigations on the shape and height of the crown for pulleys lead to the statement that for ordinary conditions employed in the operation of machine tools, and with the ordinary materials generally used for such purposes, the speeds, belts (whether leather or cotton), etc., have little bearing on the required height of crown to insure a satisfactory guiding of the belt, if such a crown is produced by grinding. The width of the face of the pulley is really the only important factor. This follows because of the possibility of producing the pulley face with a curve which is symmetrical throughout from edge to edge, and with diameters at the extreme edges of the pulley so nearly alike that the effect of their difference is negligible. A formula used by the Norton Grinding Co. which in actual practice is producing satisfactory work is: 1/200 of pulley face plus 0.02 inch = height of crown.

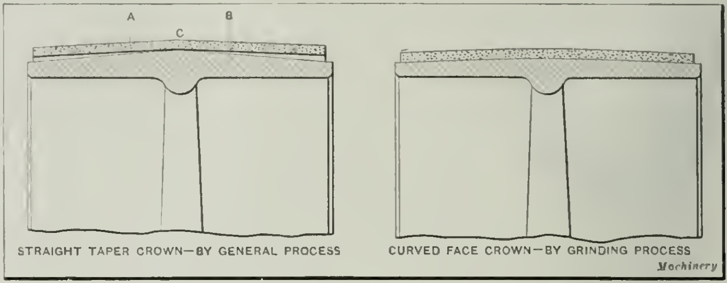
A
B
C
STRAIGHT TAPER CROWN—BY GENERAL PROCESS
CURVED FACE CROWN—BY GRINDING PROCESS
Machinery

Fig. 4. Relative Conditions of a Belt running on a Pulley where the Crown is formed by a Double Taper and One where the Crown is formed by a Uniform Curve

Pulleys crowned to this formula are illustrated by Fig. 1. By the wide face grinding process it is also possible to produce, in addition to the crowning of the face, other shapes in connection with the pulley diameter. This feature is illustrated by the special pulleys shown in the center of Fig. 1. Here the angular face which reaches from one cone step to the other was formed at the same time that the crown was put on the various steps of the cone. This is convenient in crowning the faces of tight and loose pulleys where the loose pulley is of a lesser diameter than the tight. A special fixture is necessary in doing such work, but is not treated in this article. The fixture for truing the wheel to grind crowns is shown in Fig. 2. This attachment is tilted on an angle with relation to the axis of the wheel to be trued. The degree to which the body of the fixture is tilted determines the amount of concavity in the wheel, which, in turn, determines the height of the crown on the pulley. The slide carrying the diamond is moved back and forth across the wheel in a straight line by the handwheel connected with a rack and pinion for this purpose. At the swiveling point, graduations are supplied which provide an easy means for setting the fixture, and a central graduation on the slide indicates the position of the diamond when in the center of the wheel.

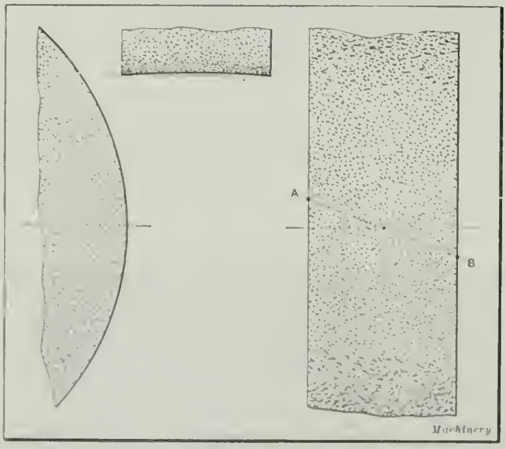

Fig. 3. Diagram illustrating Principle on which Concave Wheel Truing Device operates

Reference to the diagram Fig. 3 will show how the diamond causes the face of the wheel to be properly trued to produce a crown on the pulley. The fact that the diamond carriage is tilted at an angle, and that the diamond travels across the face of the wheel on a diagonal, causes the diamond to cut deepest as it passes across the center of the wheel and is midway between its two edges. The left-hand projection in the diagram illustrates this feature. Because the wheel is receding above and below the center line, as the diamond rises or falls on either side of the center line, it is cutting away less of the wheel, so that at points *A* and *B* it runs out into nothing, while it is removing the most material in the center. Different degrees of depth of cut can be accomplished by changing the angle of the path that the diamond travels on, so that it will be seen that if it travels on a path parallel with the axis of the wheel, the depth of cut will be the same at all points. The capacity of this attachment provides for truing on a straight line, and from this up to a concavity in the wheel having a depth of ¼ inch. In width, the attachment will true wheels up to 12 inches, which at the present time is the widest wheel used on a Norton grinding machine.

It must be borne in mind in crowning pulley faces in this manner, that the wheel is traveling straight into the work and does not travel laterally, so that the form in the wheel is what actually produces the crown on the pulley. This is only one other phase of the application of the wide face wheel and straight-in cuts for form grinding work. The production of work by this process is in proportion to the degree of accuracy required for the finished product, and varies with each individual case, depending upon the amount of material to be removed, the kind of material being ground, the width of the face of the pulley, the diameter of the pulley, and the many other variables that must be taken into consideration in all grinding problems.

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The contributor of an article on wire-forming machinery recently published in Machinery has received many letters from all parts of the country, representing widely diversified industries. The writers of the letters had need of machinery of the sort described, although in some cases they were connected with establishments which to the casual observer would seem to have no use for metal-working machinery whatsoever. A large meat packing house, for instance, needed automatic wire-forming machinery to make can-openers, skewers and other wire products used in the preparation of food. So it is with many other large concerns. The more efficiently they are operated, the more likely they are to be buyers of machinery and of machine tools for its repair.

THE ADJUSTABLE WEDGE STOP IN JIG AND FIXTURE DESIGN*

A REVIEW OF THE DEVELOPMENT OF A SATISFACTORY FIXTURE DETAIL

BY R. E. McCOY†

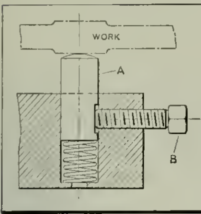

Fig. 1. Simple Type of Adjustable Stop

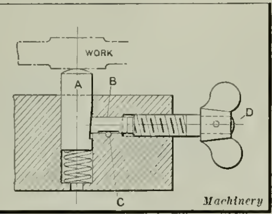

Fig. 2. Improvement on Stop shown in Fig. 1

IN the design of jigs and fixtures for light castings, it is always necessary to support the work directly under the cut when accuracy is desired. If the work is not supported directly under the cut, it will spring away from the cutter at that point. If it springs only a thousandth of an inch or two, it will cause trouble where the limits are close, especially if the work is to be interchangeable.

In machining castings the best results are obtained by locating from the web of the casting, allowing the casting to rest on three points; if more than three points are used, the casting will rock, owing to its uneveness. It is also necessary that the bosses to be machined be supported by individual supports. These supports must be made adjustable; they must also be very sensitive, so that no strain will be put on the casting when locating it in the fixture. Profiling and milling fixtures are the best examples of cases where adjustable stops must be used. There are many designs, but a great majority of these are failures, because they do not accomplish the purpose for which they were designed—that of preventing the work from springing under the pressure of the cutter.

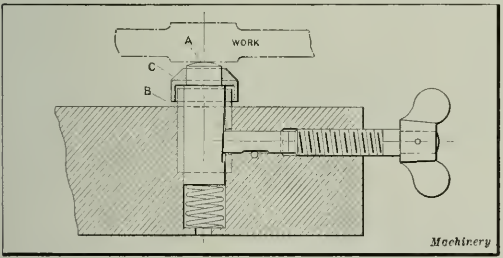

Fig. 3. A Further Improvement upon the Adjustable Stops shown in Figs. 1 and 2

In this article a series of experimental designs of various kinds of adjustable stops is described; all these were designed before one was obtained that would actually perform its work well. These experiments were carried on over a great number of years, until the adjustable wedge stop was finally developed. The illustrations show the various stages of its development.

Fig. 1 shows the simplest kind of adjustable stop. This stop is unsatisfactory, because the plunger *A* slips back under the pressure of the cutter, and the stop clogs up with dirt so that it will not work. Considerable time is lost in sending the fixtures to the tool-room to be overhauled, made necessary by their clogging up and sticking. The method of clamping the plunger is very slow, as it is necessary for the operator to use a wrench in tightening and loosening the set-screw *B*.

Fig. 2 is an improvement over Fig. 1. The plunger *A* has a slight angle milled on the side instead of the straight cut in Fig. 1, to keep it from slipping back. A piece of hardened drill rod *B*, kept from turning by a small pin *C*, is added for the screw *D* to clamp against. A wing nut is fastened to the screw to do away with the necessity of using a wrench. This stop is not satisfactory, however, because it shifts in tightening; the angle milled on the side of the plunger keeps it from slipping back under the pressure of the cutter, but it does not keep it from slipping back while it is being tightened. The stop also clogs up with dirt the same as the stop shown in Fig. 1.

Fig. 3 is an improvement over Fig. 2. A bronze bushing *B* is driven into the base of the fixture and allowed to project above the base as shown. The plunger *A* has a sliding fit in the bushing. A dirt shield *C* is driven onto the end of the plunger and extends down over the outside of the bushing as shown, making the stop fairly dirt-proof; but this stop is not satisfactory because it shifts in tightening, the same as the stop shown in Fig. 2.

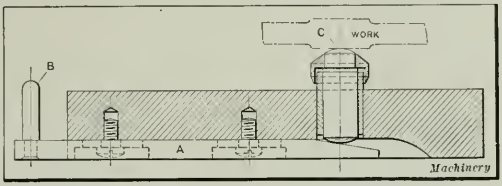

Fig. 4. Simple Form of Adjustable Wedge Stop

Fig. 4 shows the next step taken to overcome the troubles already described. The thumb-screw and spring plunger shown in Figs. 1, 2 and 3 has been abandoned and a sliding wedge *A* added in its place. The wedge is provided with a handle *B*, attached so that it can be operated easily, and is held in place by two shoulder screws that are inserted through two elongated slots milled in the wedge. It was thought that at last a stop had been designed that would perform the work for which it was intended, but when put into actual use on a fixture it proved to be a failure, because the wedge would slip back owing to the vibration of the machine while in operation; this permitted the plunger *C* to drop down.

The next improvement in the stop is shown by the addition of an "anti-slipper" to prevent the wedge from slipping back, as shown in Fig. 5. The handle *B* in Fig. 4 has been abandoned and a stud has been riveted into the wedge *A* instead, the stud extending up through an elongated slot cut in the base of the fixture and threaded for the knurled nut *B*. When nut *B*, which also acts as a handle for shifting the wedge, is tightened, it clamps wedge *A* and anti-slipper *C*

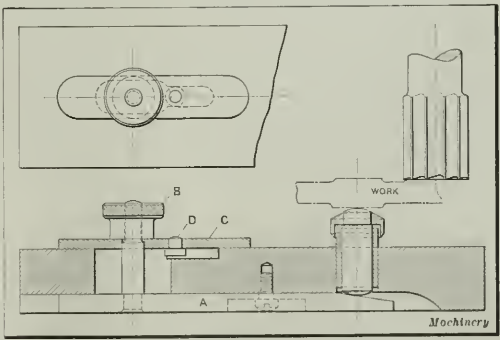

Fig. 5. Improvement upon the Adjustable Wedge Stop shown in Fig. 4

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* For previous articles on clamping and locating devices used in jigs and fixtures see "Jig and Fixture Design," March, 1915; "Clamping Work in Jigs," December, 1913; and "Jigs and Fixtures," April, May, June and July, 1908. See also MACHINERY'S Reference Book No. 41, "Jigs and Fixtures."

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against the base; this prevents the wedge from slipping back as a result of the vibration of the machines on which the fixtures are used. The anti-slipper also acts as a covering for the slot cut in the base, thus acting as a dirt shield, and is kept from turning when tightening and loosening the nut by a stud *D* driven into it and sliding in a slot cut in the base as shown. This wedge, however, failed when in actual use, because it would spring down under the pressure of the cutter, due to slight unevenness of the platens of the machines where the fixtures were used.

Hence it was improved upon by the design shown in Fig. 6; the flat style of wedge shown in Figs. 4 and 5 was abandoned for a wedge *A* made of drill rod, sliding in a hole drilled in the base of the fixture; the stud *B* was screwed into the back end of the wedge instead of being riveted, as shown in Fig. 5, so that it could be easily assembled. The bushing *C* was provided with a shoulder, and a headless set-screw *D* was added to prevent the plunger *E* from dropping out and getting lost, as it did sometimes when the fixtures were not in use. This design, however, was not sensitive, due to too much friction on the wedge *A*, and to dirt that would work under the anti-slipper *F*; therefore it was impossible for the operator to feel when the stop had a bearing against the work.

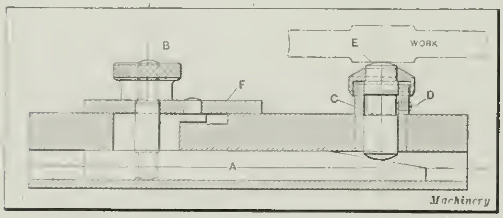


Fig. 6. A Further Improvement upon the Adjustable Wedge Stops shown in Figs. 4 and 5

Fig. 7 is practically the same design as Fig. 6; the only change made is in the bushing *A*, which has been lengthened so that it will act as a support for the end of wedge *B*. Bushing *A* is made of cold-rolled steel, carbonized and hardened, instead of bronze as before, in order to obtain more strength and better wearing qualities. The base is also cut away as shown; this method of construction removes about one-half the friction that caused the failure of the stop shown in Fig. 6; but this stop was still not as sensitive as it should be to get ideal working conditions.

Fig. 8 illustrates the next step taken to improve the stop; this design practically overcame all the objectionable features already mentioned. The bushing *A* has been lengthened and given a much larger shoulder to insure still better lining conditions. A small pin *B* replaces the headless set-screw in Figs. 6 and 7, which keeps the plunger from falling out and getting lost. The arrangement for clamping the wedge has been changed considerably. The bronze casting *C* is the added feature. A hole has been cut in the base into which the casting has been inserted, permitting it to have clearance all around. This allows it to be easily lined up with the plunger. The casting is held in place by two fillister-head screws and dowels. Two holes have been drilled in the casting; these holes act as a support for the back end of the wedge, as shown, the front end being supported in such a manner that it has the minimum amount of friction, making it very sensitive. The casting *C* also supports and at the same time raises the anti-slipper *D* from the base of the fixture, making it dirt-proof also. In Figs. 5, 6 and 7 a stud driven into the anti-slipper and sliding in a slot cut in the base of the fixture, prevents it from turning when the knurled nut is tightened or loosened, but in Fig. 8 a tongue cut on the anti-slipper and having a sliding fit in a slot cut in the casting *C* answers the same purpose.

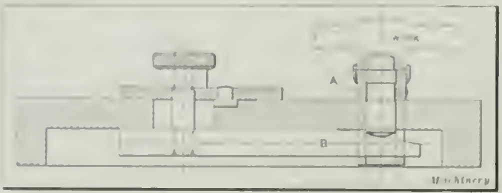


Fig. 7. A more Satisfactory Form of Adjustable Wedge Stop than that shown in Fig. 6

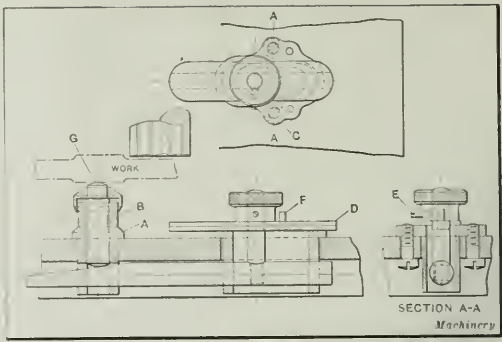


Fig. 8. Principle of the Final Improvement in the Adjustable Wedge Stop

A stud *E* is screwed into the side of the knurled nut and a small pin *F* is driven into the anti-slipper; this pin acts as a stop for the stud, and prevents the operator from turning the nut more than is necessary in tightening and loosening.

We now have a stop that will not slip back under the pressure of the cutter and that does not shift in tightening; it is dirt-proof, thus saving time and the expense formerly caused by the presence of dirt; and the plunger is prevented from getting lost. It does not slip back due to vibration of the machines or spring down under the pressure of the cutter, due to the unevenness of the platens of the machines on which the fixtures are used. The device is simple and can be quickly operated, and it is so sensitive that the operator can feel the instant that the plunger *G* comes in contact with the work. It was found, however, that owing to so many large holes being drilled in the base of the fixture, and so much being cut away from underneath when locating the adjustable stops on the base, that the base became weakened and that it would spring out of shape. This was overcome by drilling a clearance hole for the wedge. The end of the hole was provided with a wooden plug to keep out the dirt as shown in Fig. 9; the toolmakers also complained of the great difficulty encountered in lining up the holes in bushing *A* with the holes in casting *B*. This was remedied by making the bushing an easy fit; the small pin *D* and round-head screw *C* were added to keep the bushing from turning or working loose.

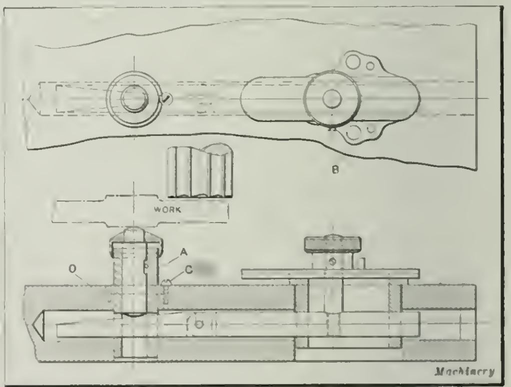


Fig. 9. The Adopted Form of Adjustable Wedge Stop

The wedge itself was jointed and made in two parts to take care of the variations vertically that might occur in drilling the holes in the bushing and casting in which the wedge slides. This practically made the wedge self-aligning, and reduced the friction on the wedge caused by the holes not lining up properly with each other.

We have here an adjustable stop that is desirable in every way. It performs its work exceedingly well. It is easily assembled on the fixtures under all conditions, and because of the stops being made in large quantities and carried in stock in the tool-room, it is inexpensive to make.

Application to the Design of a Fixture

Fig. 10 shows the construction drawing of a simple profiling fixture. It will give a good idea of just how the adjustable wedge stops are used. The casting *A* to be machined is shown by the dot-and-dash lines, located in the fixture and resting on three studs *B*. The bosses to be finished are marked *f*. As this is the first machining operation, the necessity of having adjustable stops under the bosses to be finished, in order to get an accurate product from the fixture, is obvious.

The Pneumatic Adjustable Wedge Stop

We will now proceed to the pneumatic adjustable wedge stop. This type represents the highest development of adjustable stop, but owing to the fact that an equalizing valve and an operating valve have to be used in conjunction with the pneumatic stops, no matter if there is only one or if there are a dozen stops needed on the fixture, and owing to the high class of workmanship necessary to make the stops as well as the valves work successfully, it is not advisable to use the pneumatic adjustable type on fixtures needing only a few stops. It is not economical, for instance, in the fixture shown in Fig. 10, because the time saved in operating the pneumatic adjustable stop is too small in this case; but when a large number of stops are needed, the time saved in placing the work in the fixture and its removal from the fixture after machining by the use of the pneumatic adjustable stops offsets by far the extra expense in making the stops. The cost of the finished product for one hundred pieces was in some cases reduced one-half and even two-thirds after this style stop was used, as it is only necessary for the operator to touch a valve, and all the stops are operated instantly.

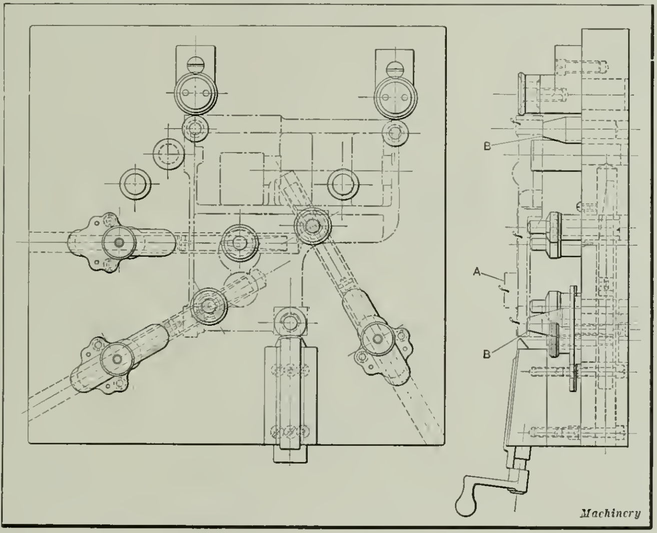


Fig. 10. Fixture in which Adjustable Wedge Stops are used

Fig. 11 shows a pneumatic profiling fixture on which the pneumatic adjustable wedge stops are used. The air from the main line enters the operating valve *A* located in the lower right-hand corner of the fixture, by passing through a hole drilled in the base and then up through a small brass tube which enters the side of the valve, as shown; from there it is distributed through small tubing around to the various stops throughout the fixture, the arrows shown indicating the flow of the air.

Sections *A-A* and *B-B* show the position of the ports cut in the valve stem *B* after the work is located in the fixture ready to be machined. As the conditions under which the operating valves are used vary, the position of the ports and air holes in the stem *B* and the air holes and the slots through which the brass tubing passes that distributes the air to the various stops, must suit these conditions, but the general design of the valve always remains the same. Rubber packing is placed around the tubes where they pass through the base of the valve to prevent any leakage of air at that point.

The body of the operating valve *A* is made of a bronze casting and is held in position on the base of the fixture by two screws. The valve stem *B* is made of hardened tool steel and ground to insure a perfect air-tight working fit. The handle *C* is held on the stem by the flat-head screw *D*. The small pins *E* act as stops and insure that the valve stem *B* is always located properly when the valve is operated. By means of the oiler shown on the side of the valve, oil can always be distributed around to the various stops. This keeps them properly oiled and in good working condition at all times. The equalizing valve *F* can be placed in the most convenient position, and its position on the line of tubing is generally governed by the design of the fixture. It exercises the same control over the pneumatic stops wherever it is placed on the line of tubing. It is very important that the equalizing valve be always kept in good working order and properly adjusted to suit the existing conditions, as it must have absolute control of the distribution, to maintain and equalize the amount of air pressure on each stop at all times, and lock all the stops in position after the functions just described have been performed.

The detailed construction of the equalizing valve is as follows: Body *G* is a brass casting having two slots cut in the base through which the brass tubes that distribute the air pass, and around which rubber packing is placed to prevent leakage at the point where the air enters the valve. The mechanism of the valve is of very simple construction, as will be seen from the illustration, and is composed of a medium hard rubber ball *H*, a spring *I* made of brass wire, a cap *J* made of sheet brass, which prevents the spring *I* from injuring the rubber ball *H*, an adjusting screw *K* made of cold-rolled steel and casehardened, and an adjusting nut *L* made of brass and kept from turning on the screw *K* by small grooves cut in the body *G*, whereby the proper tension can be obtained on the spring *I*. Plug *M* screwed into the body *G* and the collar *N* that is held in position on the adjusting screw *K* by the headless set-screw *O* are also made of brass. As much brass is used in the construction of the valve as possible, because the moisture in the air used to operate the stops does not corrode the working parts when made of brass. This, of course, is an important point in a fixture of this kind.

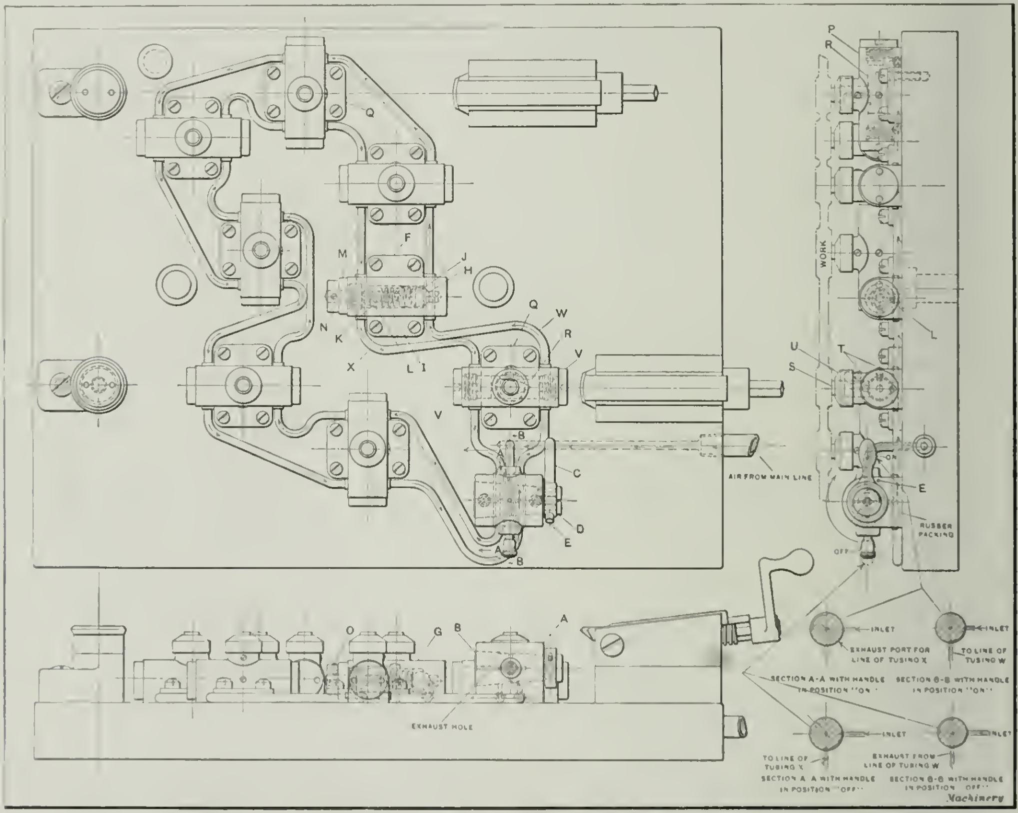
The body *P* of the adjustable stop *Q* is also made of brass. The tubing passes through two slots cut in the base of the body and around which rubber packing is placed to prevent the leakage of air at the point where it enters the stop. The piston *R* and the plunger *S* are made of tool steel, hardened and ground. The object of using the two headless set-screws *T* is to insure that the piston *R* is always kept in proper alignment and to prevent the plunger from dropping out. Cap *U* placed on the end of the plunger *S* makes the stop dirt-proof. The plugs *V* screwed into the body *P* are made of brass. The small ends turned on the plugs act as bumpers to control the maximum travel of the piston *R*.

After the piece to be machined has been located in the fixture and clamped in position, the handle *C* of the operating valve is turned from the position shown by the dotted line in the end view, as indicated by the arrow, until it comes in contact with the stop pin *E*. The port cut in the valve stem *B*, also shown in detail by the cross-section *B-B*, is then open for the free passage of the air through the valve. The air then enters the line of tubing which leads to the adjustable stops *Q* through a small hole drilled in the body of the valve and indicated by the arrows which show the direction of the flow of the air through the tubes. From the line of tubing *W* the air enters the stops through a small hole, forcing the piston *R* forward. As the plunger *S* rests on the taper that is cut on the piston, the plunger is forced upward until it comes in contact with the work.

The equalizing valve *F*, by the aid of the adjusting screw *K* and the adjusting nut *L* has been adjusted so that the instant the plunger *S* of the adjustable stops comes in contact with the work—not sufficiently to put any strain on the casting, but barely touching it—the air pressure causes the rubber ball *H* in the valve *F* to move back from its seat and let air through the valve into the other line of tubing *X*, as indicated by the arrows. The air passes through the tube and through a small hole into the stop whose plunger *S* has come in contact with the work, the air entering the space in the adjustable stop at the other end of the piston *R*. The air pressure thus becomes the same on both ends of the piston, after the plunger has obtained a bearing against the work.

When the work is ready to be removed from the fixture the handle *C* of the operating valve *A* is moved back to the position indicated by the dotted lines. The port on section *B-B* of the valve stem is now closed, shutting off the supply of air from the main line, and at the same time the exhaust port is opened as shown in the lower section of *B-B*, permitting the air in the line of tubing *W* that moved the plunger *R* of the adjustable stops forward to exhaust through a hole in the end of the valve stem *B*. As the air pressure on the rubber ball *H* of the equalizing valve is reduced, the spring forces the ball to move back to its seat in the valve; this closes the valve and prevents the air in the line of tubing *X* from leaking out through the exhaust hole by way of the line of tubing *W*. The port on section *A-A* of the valve stem is now open, permitting the air from the main line to pass into the line of tubing *X*, from which it enters the adjustable stops *Q* and forces the piston *R* back, thus permitting the plungers *S* to drop back to their original position.

The air pressure on pistons *R* is maintained until the handle of the operating valve is moved in the direction and over to the position indicated by the arrow. As the handle is turned, and an instant before the port in the valve stem that will permit the air from the main line to rush into the line of tubing *W* opens, all the air is permitted to be exhausted from the stops by way of the tube *X* through the exhaust hole in the end of the valve stem. This exhaust port is closed again before the port opens that lets air into the line of tubing *W*; this prevents the air that passes through the equalizing valve to the line of tubing *X* from leaking out through the exhaust hole in the operating valve *A*.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EXHAUST HOLE
INLET
EXHAUST PORT FOR LINE OF TUBING X
INLET
TO LINE OF TUBING W
SECTION A-A WITH HANDLE IN POSITION "ON"
SECTION B-B WITH HANDLE IN POSITION "ON"
INLET
INLET
TO LINE OF TUBING X
EXHAUST FROM LINE OF TUBING W
SECTION A-A WITH HANDLE IN POSITION "OFF"
SECTION B-B WITH HANDLE IN POSITION "OFF"
Machinery

Fig. 11. Fixture provided with Pneumatic Adjustable Wedge Stops

Clamping Features

A feature of the fixture shown in Fig. 10 is the simple and rapid method by which the work is clamped in the fixture. This design of clamp has great holding power and does not loosen owing to vibration; the clamp can be easily and quickly operated, and there is no danger of the cutter running into the clamps, as they do not project above the surfaces that are to be machined. It is only necessary to use one clamp on the fixture shown in Fig. 10, although in some cases, as in Fig. 11, two or more are necessary. This single clamp not only keeps the work from tearing loose while machining, but it aids in locating the work in the fixture as well. This design of clamp is known as a knife-edge clamp, and is generally used in conjunction with stops known as knife-edge stops. These clamps and stops are made in large quantities and carried in stock, and are easily located on the fixtures as needed. Sometimes it is found necessary to elevate the clamps from the base of the fixture by means of spacing blocks. This has been done on both the fixtures shown in Figs. 10 and 11.

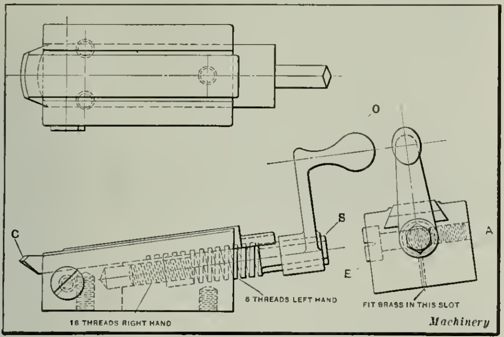

Fig. 12. Clamping Device used in Fixtures shown in Figs. 10 and 11

Fig. 12 illustrates the detailed construction of the clamp. The body *A* is made of cast iron, screw *B* is made of cold-rolled steel, carbonized and hardened, knife-edge *C* is made of tool steel, hardened, and handle *D* is a malleable-iron casting. To assemble the clamp, screw *B* is screwed into the tapped hole in body *A* as far as the threads will permit; then knife-edge *C* is slid up in the slot cut in the body until the square threads cut on the knife edge come in contact with the square threads on the screw. Now, by turning the screw with the aid of the handle, the knife edge is easily drawn up onto the screw to the working position. The front end of the body *A* has a slot cut in it into which a piece of sheet brass has been fitted as shown. This slot with the aid of the clamping screw *E* takes up the wear and keeps the knife-edge always working snugly.

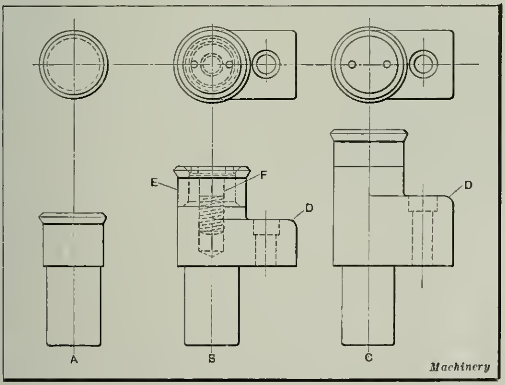

Fig. 13. Locking Points or Stops used in Fixtures shown in Figs. 10 and 11

Fig. 13 shows the detailed construction of the three sizes of the knife-edge stop carried in stock. Stop *A* is made of tool steel, hardened and ground. As it is necessary to use stops of considerable height, for instance like those used on the fixtures shown in Figs. 10 and 11, a stop that will insure greater stability is necessary, so stops *B* and *C* were designed. The bodies *D* of these stops are of cast iron and can easily be adjusted to suit the height of the work by simply facing off the bottom of the body. The hardened and ground tool steel button *E* is held in place on the body by the screw *F* made of cold-rolled steel, carbonized and hardened. A specially designed spanner wrench is used in tightening the screw.

* * *

FIFTIETH ANNIVERSARY OF WORCESTER POLYTECHNIC INSTITUTE

The fiftieth anniversary of the founding of the Worcester Polytechnic Institute was celebrated at Worcester, June 6 to 10. The most important part of the celebration took place Wednesday, June 9. On that date representatives from over ninety universities and colleges, engineering institutions and societies all over the United States assembled in Worcester for the celebration exercises which were held in Mechanics Hall. At these exercises, the president of the Polytechnic Institute, Ira Nelson Hollis, presided, and among the speakers were the Hon. David I. Walsh, governor of Massachusetts, John A. Brashear, president of the American Society of Mechanical Engineers, and A. Lawrence Lowell, president of Harvard University. These exercises having taken place in the forenoon, a meeting was held in the afternoon in the lecture room of the Electrical Engineering Building, when George I. Alden, president of the Norton Co., a member of the Board of Trustees of the Polytechnic Institute, and formerly professor of mechanical engineering there, spoke on the ideals of the Washburn shops, which are connected with the institute for the training of mechanical engineers in shop practice. Prof. W. W. Bird, of the mechanical engineering department and director of the Washburn shops, also read an abstract of a paper to be presented at the Buffalo meeting of the American Society of Mechanical Engineers on "The Effects of Humidity on Leather Belting." At night a banquet was held at the Bancroft Hotel at which speeches were made by the Hon. John W. Weeks, senator from Massachusetts, Major General Leonard Wood, of the U. S. Army, Howard Elliott, president of the New York, New Haven & Hartford Railroad, and others.

The celebration, which was favored with excellent weather, marked a half-century milestone of an institution that has proved itself exceptionally practical in its ideals in engineering education, and from which have come a great number of leading engineers in all the fields of industrial endeavor. The institute was founded in 1865 as an institution of higher education by a gift of $100,000 from John Boynton, but it derived its peculiar character from the endowment of a commercial shop for the teaching of machine construction by Ichabod Washburn. This shop is operated in connection with the academic part of the institution as part of the instruction of students. At the time, the union of a commercial shop with an educational institution was considered an experiment in education, the idea being to associate an engineering college with what would correspond to a clinic or hospital connected with a medical school. The shop has consistently adapted itself to the times, and has always preserved a permanent organization of its own, entirely apart from the students. Workmen are employed the year round, and the students simply use the shops as a laboratory of work-shop management, and while they are engaged in the making of the tools and apparatus sold by the shops, the latter in no sense depend upon the students for their productive capacity. The students pass through a course of patternmaking with 124 hours, and then complete 376 working hours in the foundry, machine shop, and forge shop. In addition, they work during the summer a total of 432 hours in the various shops. The final work in shop training then takes the student into the office where he is placed in closer contact with actual business experience than he could be anywhere outside of a large commercial shop. A young man who has completed this work has a training which will advance him rapidly to usefulness in connection with management, it being strictly understood that the shops are not intended to train the young men to become expert mechanics, but merely to make it possible for them to gain an all-around knowledge of the problems met with in machine shop practice and industrial work generally, so that as engineers they will have a fair knowledge of all the branches of the machine-building industries.

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We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

JULY 1915

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GUARDING OUR NATIONAL REPUTATION

It is well known that a manufacturer may palm off an inferior product or disregard his business engagements in his own country, and only his individual reputation is affected; but when he commits these offenses in a foreign country the reputation of his nation suffers. This is particularly true of American manufacturers at present, and every American industry should guard with jealous care the reputation of its members; for every violation of commercial ethics by an American will be used with telling effect by our foreign competitors. For a trifling gain, one careless or unscrupulous manufacturer can inflict injury on the reputation of an entire industry that it will take years to repair. No business friendships nor questions of expediency should be considered in such circumstances, because it is a question of the common good. Every manufacturer should do his utmost to root out such offenses, be the offenders big or little.

* * *

GRINDING AND GRINDING MACHINES

Although grinding is one of the oldest processes used for shaping, polishing and sharpening tools, the history of machine grinding practically began in the sixties with the invention of the universal grinding machine by Joseph R. Brown of the Brown & Sharpe Mfg. Co. The original cylindrical grinder was a fourteen-inch Putnam lathe converted into a grinding machine by mounting a grinding wheel on the carriage. The grinding machine was regarded then and for many years after as purely a tool-room appliance to be used for the accurate finishing of hardened steel parts only. Since then the art of machine grinding has developed greatly, and now it is regarded by many as one of the most effective and rapid methods of machining cylindrical parts.

The limitation of grinding today is the grinding wheel, which although greatly improved as compared with the product of wheel makers forty or fifty years ago, is still imperfect. It consists of an aggregation of abrasive grains, either natural or artificial, united by various bonds, which present irregular cutting edges at all angles, many of them ineffective. The ideal grinding wheel is that in which all the cutting edges of the abrasive grains are properly shaped and presented to the work in the most effective position, like the teeth of a milling cutter. This ideal, of course, can hardly be attained by present methods.

The articles on grinding in this and following numbers are intended to bring together available material that will be useful to those concerned with the economical production of machine parts. Grinding is a difficult operation to analyze because of the many factors intimately associated in that work. It is more difficult than lathe work, as there are more points to be considered. The analysis made by Mr. Alden of the relation between work speed and depth of cut known as "grain depth of cut" is an important step toward the establishment of grinding on a rational basis. In these articles no attempt at analysis of this kind is made, but many examples of work are given describing the results obtained, and indicating what can be done mainly by showing what has been done.

* * *

INTEGRAL SHAFT SPLINES

The defects of inserted keys or splines in circular shafts of sliding-gear speed-changing transmissions had not been seriously studied by designers until the advent of the automobile. Early in the development of automobile change-gear construction these keys were found to be unsuitable. A shaft having a key laid in one side is considerably weakened by the keyway and the key soon loosens under the repeated shocks of use. When shifting a gear under load, twice the effort is required to move it along the shaft than when the gear is supported by two keys diametrically opposite; but two keys located opposite do not materially mitigate the trouble of loosening.

The weakness of the inserted key brought the square shaft into use for change-gear construction. Though this seemed like a reversion to an undesirable old-style form used years ago in mill work, because it was a commercial shape and required no turning the change, nevertheless, was a step in advance. A square shaft presents four solid angular "keys" to overcome torsional resistance, and the part sliding thereon can be moved more freely than when only one key is provided. The square shaft, however, is heavier than it need be for a given torsional strength, and as the requirements of automobile service became more severe, more key bearing surface than could be obtained with the square shaft of limited size was required. Designers then developed the integral spline shaft, that is a round shaft in which the keys or splines are produced by milling out the metal between, thus producing four, six or eight keys integral with the shaft. While it was an expensive process to mill the shafts and fit them to their gears it was well worth the cost.

When the advantages of the hobbing machine for gear cutting were recognized, some enterprising minds turned to the possibilities of hobbing splined shafts, with surprising results. Not only was it found possible to hob integral splined shafts, but it was found that it could be done at a rate so rapid that the cost of producing them was actually less than that of the square shaft.

The advantages of the sliding-gear shaft of the multiple spline type are so evident wherever construction demands sliding-gear changes, that machine tool builders are introducing it into the construction of milling machines and other machine tools. It has large area of spline surface, greater torsional strength than the inserted key shaft, and the cost is low. The broaching machine makes the problem of machining the hub for the reception of the multiple spline shaft a simple and rapid operation. It might be said that the broaching machine was the forerunner of the multiple spline shaft, inasmuch as it made the use of this improved form practicable. Without the broaching machine the cost of cutting multiple keyways as accurately as is demanded in modern practice would have been prohibitive. Thus the development of a machine tool opened possibilities of improvement in machine design practice generally. Not only has it effected improvement in machine practice, but the cost of production has been materially reduced. The cost of hobbing a multiple spline shaft and broaching a gear to fit it is lower than the cost of boring a gear, cutting a keyway, turning the shaft, cutting a keyway in it, and fitting a key—the usual practice before the development of integral splined shaft construction.

INDEXING TECHNICAL LITERATURE[*]

A SYSTEM THAT EDUCATES WHILE IT INDEXES

BY WALTER G. LOHMEYER[†]

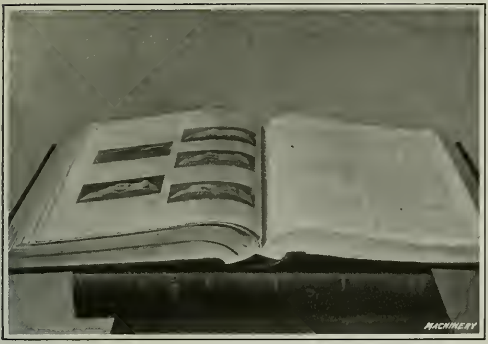

Fig. 1. Bound Volume of **MACHINERY** for 1912, used in connection with Card Index

THE subject of indexing has been given a great deal of space in technical papers, as each writer seems to lay stress on a particular feature applying to some specific use to which his index is put. No attempt will be made here to do more than roughly outline a system, but knowing the tendency of most men to go to extremes in this direction, the present article has been prepared with the hope that it may prove of value to those who have put off starting an index because they have found most systems too expensive and laborious. The main object of a good index is to enable one to find any desired information without the necessity of going over an innumerable number of books. The expense of the index in time and money must, of course, be commensurate with its practical value.

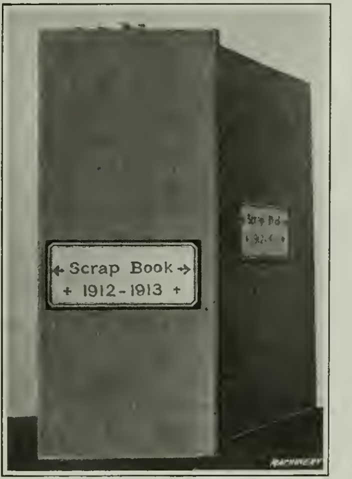

Fig. 2. Scrap Book in which Clipped Articles are preserved

Binding of the Books

The publications most closely allied to the needs or interests of the indexer are bound in volumes about one and one-half inch thick, which means one volume annually in a monthly, and four volumes annually in a weekly paper. The annual volumes are lettered on the back with the name of the publication and the year, as shown in Fig. 1 for MACHINERY, 1912. Quarterly volumes are marked with the name and year, but have an affix of the quarter in which they start, as *Iron Age*, 1912-2, meaning the volume of *Iron Age* beginning with April, 1912. The including of advertising matter is optional, but it has very little value to the individual aside from its historical interest. An extra blank sheet is inserted at the beginning of each month on which the printed index of that issue and small scraps from various sources are pasted. Binding and lettering in gold, complete with a three-quarter leather back costs about $2 per volume; and this also includes the re-numbering required when a paper starts its year with some other month than January. Each volume starts with page one, and the pages are numbered consecutively through both the editorial and advertising pages. Other publications which are not considered of sufficient value to warrant binding are clipped by cutting out entire pages with a sharp knife as near as possible to the inner edge; and they are then trimmed, perforated and bound in a 4-inch Tengwall binder. The pages are consecutively numbered and on the back of each volume is stuck a label marked "Scrap Book" and dated for the year, as shown in Fig. 2.

Starting an Index

It has been said that the beginning of all things is hard, but the beginning of a card index is surprisingly simple. After choosing some general subjects for the main titles as Shop Practice, Gearing, Metals, Press Work, Machinery, Automobiles, etc., a number of letter size envelopes are marked with these titles. Then small slips of paper ½ by 5 inches in size, are cut and each article of interest is listed on one side of an individual slip. The main title, as Gearing, is written on one side, and the other side is marked with the title of the article, the page number, volume symbol and date as 48-M-13, "Practical Form of Skew Bevel Gear Tooth." These slips are then placed in their various main title envelopes, and divided into such sub-titles as may be found desirable. No attempt should be made at this time to lay out definite lines of classification, as the subsequent necessity of adding subjects will simplify the final arrangement. An entire volume may be indexed in this way before entering the articles on the cards; and then by spreading out all the slips of a main title, a comprehensive view is obtained for guidance in making out an intelligent arrangement of titles and sub-divisions.

Another way that has been found to take less time, but which requires more experience, is to use cards for the main titles and add the page number, volume symbol, date and subject directly. However, as the marking of the cards must be done with a pen (a typewriter does not do good enough work to pay for the time occupied in inserting the cards) and as most of us do not write well enough, it will be found that the expense of reprinting an entire card or sub-dividing for changes more than makes up for the time spent in writing out the slips. For a small private index, standard 3 by 5 inch cards will be satisfactory, while for office use, 5 by 8 inch vertical cards may be used.

Sub-divisions by Color

Sub-divisions by color can be used for a strictly technical index, but for general purposes a white card is best. Where the color system is used, the following suggestion may be of value: Blue for all theoretical information, "How to

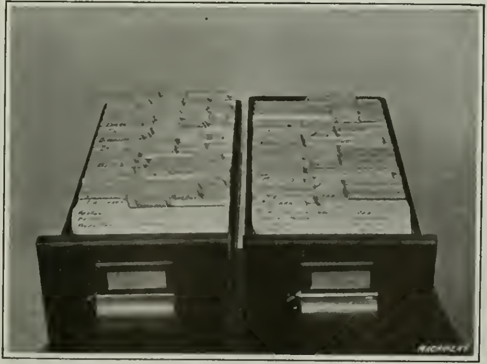

Fig. 3. Complete Card Index ready for Use

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[*] For additional information on this subject, see also "Filing Articles and Data," published in MACHINERY for August, 1913, and other articles there referred to.

[†] Address: 45 Maplewood Ave., Bridgeport, Conn.

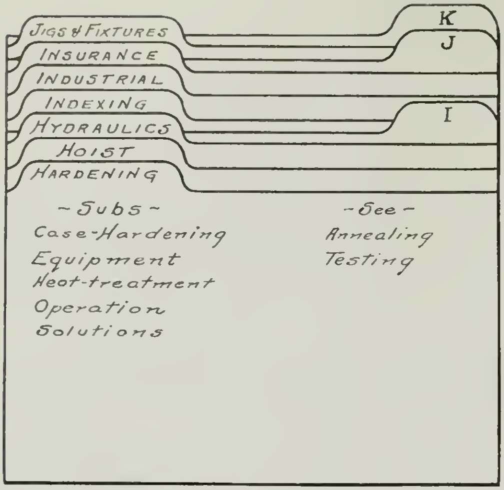


Fig. 4. Arrangement of Main Title Cards in Index

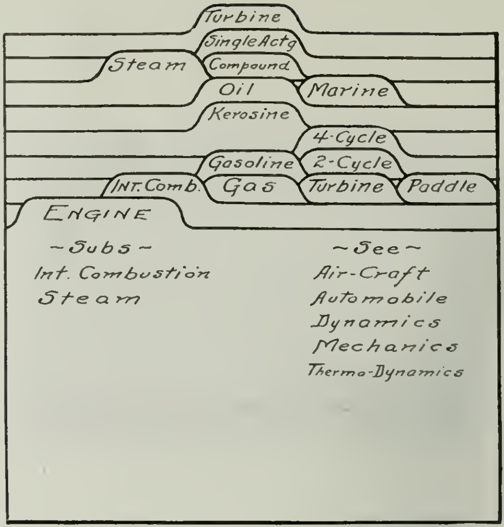


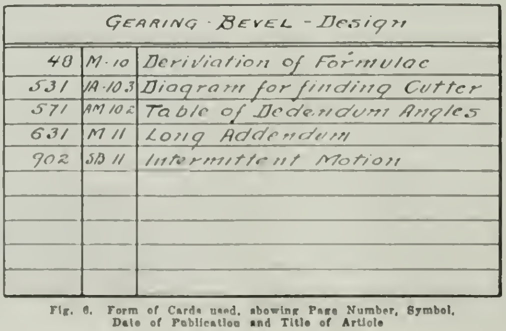
Fig. 5. Arrangement of Sub-title Cards for Card Index

figure it out," formulas, charts, designs, data, etc.; salmon for all practical information, "How it is done," production operations, recipes, methods in use, construction details, etc.; white for all general information on industrial matters, law, patents, tariff, etc.; buff may be used as a fourth color for denoting articles pertaining to a subject of especial interest. For instance, a man interested in production systems could index every article having any bearing on this subject on buff cards, even though both the main and subtitle did not show it. In a recent article describing the heat-treatment of blanks before machining, a very simple and effective routing system was explained, and by having the article indexed on a buff-colored card, this fact would have been recorded. The colored cards are filed under the same system as the white, but make the subject more readily accessible.

Main title cards are arranged alphabetically behind each other, and only the left "third" of a set divided into three tabs is used for this purpose, allowing for expansion of the index without alteration. These cards, as their name implies, are of prime importance; and they are used for subjects which are not directly related to one another, the arrangement of the cards in the file being shown in Fig. 4. The remaining space on the cards to the right of the tabs on the main title cards is used for the tabs of the sub-title cards, as shown in Fig. 5. The sub-divisions follow in the order of their position from the main title card; all subjects relating to a main title are alphabetically arranged behind each other, and the sub-title cards of each division show on the right, behind the main title card for that division. An alphabetical index is used as a general guide for subjects which do not warrant individual title cards, and such an index is made on the right-hand tab of the sub-title cards, the letters appearing behind each other as shown in Fig. 4.

Symbol System

The cards are ruled with columns for the page and symbol, but no printed heading for the column is required as it quickly becomes habitual to look in the proper column. Any convenient symbol system will do, providing it is not confusing or complicated. The advantage of these particular symbols is the graphic correlation which exists between the article, the publication in which it appeared and the year of publication. M = MACHINERY; IA = *Iron Age;* AM = *American Machinist;* EN = *Engineering News;* SB = *Scrap Book.* These symbols are entered for each article, in the second column on the card. as shown in Fig. 6.



GEARING · BEVEL - Design		
48	M·10	Deriviation of Formulae
531	IA·103	Diagram for finding Cutter
571	AM 102	Table of Dedendum Angles
631	M 11	Long Addendum
902	SB 11	Intermittent Motion

Fig. 6. Form of Cards used, showing Page Number, Symbol, Date of Publication and Title of Article

Cross Reference

When an article pertains to more than one subject, it is indexed under the title to which it is primarily allied and cross reference is made to the other titles. For example, an article on stop-screws which appeared in a recent publication was indexed under Machine Design Details, but Lathe, Planer, Milling Machine and Shaper, to all of which machines it could be applied, are cross references to Machine Design. This avoids bulkiness and superfluous work, making duplication of cards almost unnecessary. The idea will be readily understood by referring to Figs. 4 and 5.

Educational Value

Few of us seem to have time to do more than glance through the current literature relating to our own particular work, with perhaps the occasional reading of an entire article. We look over the titles and subconsciously remember, when the information is required, that some particular paper contained it—sometimes we even find it without difficulty. But while this is apparently economical as regards time, there are many instances when memory fails us, and then too, it crowds our mind with a vast amount of unprofitable material, leaving little space for the more important matters in hand. With a good index system it is necessary to read enough of every article to make possible its intelligent listing under the proper title, after which the entire subject may be dropped until it is needed, although the systematic reading serves to stimulate brain activity and broaden the reader's viewpoint.

Summary

In these days of modern methods and special machines, no man in the manufacturing business can keep up-to-date without the help of at least one technical publication; but the simple receiving of the paper with a casual glance through its pages is almost as useless as not having it at all. It follows that if we are to benefit by the experience of others in the field, it becomes almost impossible to get along without some definite means of finding the desired information. The foregoing system is an adaptation of the one used in the United States Patent Office, and in its present simplified form it is easy to handle, develops rapid and convenient classifications and gives a sense of pride in accomplishment to the indexer. After the system is started it takes only a few hours every month to read and classify the articles, the pages of which are temporarily numbered in pencil for this purpose.

* * *

A NEW COMPETITOR OF ACETYLENE

BY J. F. SPRINGER*

The gases commonly employed in autogenous welding and cutting are oxygen, acetylene and hydrogen, all of which are expensive products. The average cost of oxygen throughout the United States is probably not less than $0.025 per cubic foot measured at atmospheric pressure; the average cost of acetylene probably ranges from $0.0075 to $0.01 per cubic foot; and the cost of hydrogen may safely be placed at about the same figure. Apparently no one has yet devised a system of oxygen manufacture that will enable this gas to be inexpensively produced. However, there appears to be a likelihood of heavy reduction in the cost of the fuel gas used in autogenous welding—not through a reduction in the cost of acetylene or hydrogen, but through the discovery of an adequate substitute for these gases. This substitute is a semi-natural gas obtained from the waste gas from oil wells, and is known as "gasol." It can be produced at about $0.001 per cubic foot, and its heating capacity is even greater than that of acetylene. Other things being equal, this gas selling for $0.0008 to $0.001 per cubic foot should have a considerable advantage over acetylene or hydrogen selling at $0.008 to $0.01—ten times as much.

RELATIVE VALUES OF GASES USED FOR WELDING AND CUTTING

Name of Gas	Cubic Feet of Oxygen required to burn one Cubic Foot	Heat Value in B. T. U. per Cubic Foot	Cost of 1000 B. T. U.
"Gasol".......	2	2300	$0.00162
Blau Gas. ...	2	1800	$0.00213
Acetylene	1½	1500	$0.00217
Hydrogen.....	2	500	$0.008

Machinery

Note: The above figures are based on the following prices: oxygen, 1½ cent per cubic foot; "gasol," 10 cents per pound; blau gas, 10 cents per pound; carbide, $70 per ton; and hydrogen, 1 cent per cubic foot.

In addition to the advantage in price, there is an economy in handling this new fuel gas. It is collected at the point of origin and compressed into liquid form, the liquid gas being shipped to the user in a suitable steel container. As the weight of the liquid gas in a container is equal to the weight of the container, an economy is effected in transportation costs. The gas issuing from the oil well, which is collected and compressed into the liquid form, is of variable composition, containing various percentages of hydro-carbon gases. The constituents of a typical sample of the crude gas as collected at the oil well include gases known as methane, hexane, butane, propane, and ethane mixed with more or less water and vapor. These constituents of the crude gas may be liquefied by the application of various amounts of pressure, the temperature remaining the same; or they may be brought to the liquid form by reductions in temperature, when the pressure remains constant.

All the gases with the exception of methane may be liquefied by the application of a moderate pressure under ordinary temperature conditions. But at 10 degrees F. it requires a pressure of 2700 pounds per square inch to liquefy methane, and this is obviously beyond commercial possibilities. At the maximum temperature which the gas will encounter during transportation, the pressure necessary to bring about the liquefaction of methane is impractical. The expense of the container would either be prohibitive or there would be a constant danger of the container exploding. These considerations make it necessary to eliminate the methane from the crude gas before it is liquefied, and as the heating value of methane is considerably below that of hexane, butane, propane or ethane, the elimination of the methane results in the production of a residual gas of higher heating value. However, the heating value of methane is not to be despised, and this gas is used in the locality where the residual gas is liquefied.

By applying a pressure of from 850 to 900 pounds per square inch to the residual gas at ordinary temperature, the gas will be brought to the liquid condition. This pressure can be readily obtained in practice and the cost of containers which will safely withstand the pressure of the gas is not excessive. The liquid gas has a specific gravity of about 0.5, or one-half that of water. One quart of the liquid weighs about 1 pound and produces approximately 10 cubic feet of gas. The containers in which the gas is shipped weigh approximately 100 pounds and have a capacity for 100 pounds of the liquid; accordingly, they hold approximately 1000 cubic feet of gas, which has a total heating value of about 2,000,000 B. T. U.

Natural gas requires an unusually large amount of oxygen for its combustion, but the gas evolved from the "gasol" liquid contained in the cylinders requires still more oxygen for its complete combustion. As a result, it will be evident that the burner of the welding torch must be designed to deliver a higher amount of oxygen relative to the fuel gas than is the case where acetylene is used. At first thought, it may appear that the relatively higher consumption of oxygen will largely offset the advantage of the lower cost of the fuel gas. This is not the case, however, as less of the liquid gas is used to do a given amount of work because its heat value is relatively higher than that of acetylene. A further economy would also be effected through saving the first cost and maintenance expense of an acetylene generating plant. In the event of this substitute for acetylene finding wide application, the manufacturers of cutting and welding equipments would not be seriously affected, as essentially the same type of apparatus could be used. No doubt it would be necessary to make certain modifications in design, a case in point being in respect to the relative cross-sectional areas of the oxygen and gas ducts in the torch, but aside from changes of this nature, the welding and cutting of metals with "gasol" would be the same as when acetylene is used.

* * *

MATERIALS OF ENGINEERING CONSTRUCTION

The materials of engineering construction will receive special attention in the proceedings and discussions of the International Engineering Congress to be held in San Francisco, September 20-25. The field will be treated under eighteen or more topics, covering: timber resources; preservative methods; brick and clay products in general; life of concrete structures; aggregates for concrete; water-proofing; volume changes in concrete; world's supply of iron; life of iron and steel structures; special steels; status of copper and world's supply; alloys; aluminum; testing of metals in full size members and in structures. About twenty-five papers are expected for the volume to be prepared by authors representing five different countries. The list of authors includes many of the most eminent names in this field of engineering work throughout the world. For further information, address W. A. Cattell, secretary, 417 Foxcroft Bldg., San Francisco, Cal.

* * *

Some tradenames eventually become regarded as legitimate words and are recognized as parts of the language. A well-known example is "kodak," a term that has become generally used to designate a small, light camera. A type of trade name that has become quite popular in the past few years is that ending with "co," an example of which is "Mesco," being the initials of the name with the ending "co" of the Manhattan Electrical Supply Co. The obvious advantages of this form of trade name are the ease with which it can be coined and the degree of identification afforded.

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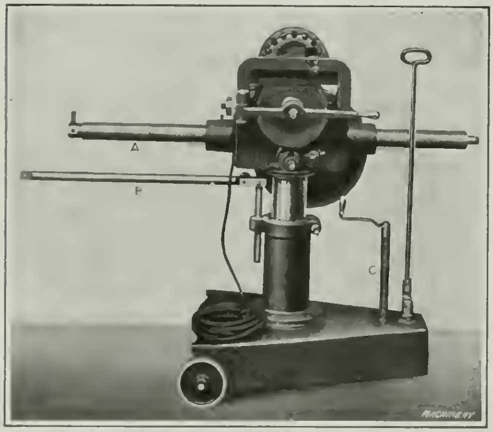
* Address: 618 West 136th St., New York City.

A "MECHANICAL GUINEA"

The "guinea" in the industrial world is a willing laborer to whom are assigned the rough, hard jobs that trained men despise. The aim of efficient shop management should be to eliminate as many of the "guinea" jobs as possible by providing power-driven machines for doing them. It is not wise to pay machinists forty cents an hour to do by main strength what an electric motor may be made to accomplish at a hundredth of the cost.

In the building of machine tools, the fitting of heavy slides is a task requiring both skill and muscle—skill for the actual fitting and muscle to move the slides back and forth. On many fitting jobs it is necessary to employ two men, as the strength of one is insufficient. One-fourth their time and three-fourths of their energy is expended in moving the slides back and forth to show by red-lead markings where the high spots are. A power-driven machine for reciprocating these slides releases one man for other work and increases the production of scraped surfaces by the other.

The Lucas Machine Tool Co., Cleveland, Ohio, has provided two electrically driven machines for reciprocating tool-slides when being scraped in, known as "mechanical guineas," one of which is shown in the illustration. It comprises a heavy triangular base mounted on three wheels and supporting a column on top of which are mounted an electric motor and the horizontal ram *A*. The machine is set up in front of the rail on which a slide is to be fitted, the brace *B* being placed between the rail and the column and the ram connected to the slide. When adjusted, the screw *C* is turned down to lift the weight off the front wheel and hold the machine in position. The ram may be traversed by hand, using a crank, or by power. When the desired stroke has been adjusted by hand, the reversing stops are set and the motor is started.



Lucas "Mechanical Guinea" for reciprocating Machine Tool-slides in Process of Fitting

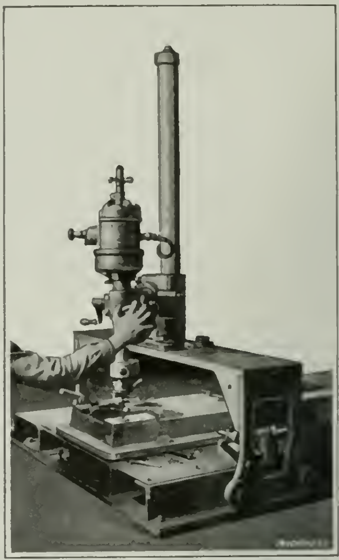
One man can, with the aid of the machine, scrape and fit the heaviest boring machine slides, such as table and saddle, saddle and bed, etc. While the machine is not intended to be a jacking or wearing-down device, it nevertheless may be used effectively to reduce the amount of scraping by wearing down the inequalities. Another advantage due to the use of power is that the gibs can be set up much closer than would be possible if moved by hand, and a more intimate bearing of the opposing surfaces is secured.

* * *

In order to gain more daylight time, the industries of Detroit, Mich., have been placed on eastern standard time, all clocks having been pushed ahead one hour May 15. Cleveland adopted the eastern standard time about one year ago. It seems unfortunate that the cities of the Middle West cannot hold to central standard time. The confusion resulting from a difference of one hour between local timepieces and railroad time causes many travelers to miss train connections

UNUSUAL APPLICATION OF PORTABLE ELECTRIC DRILL

When the boring of holes in the bases of pumping machinery does not warrant the use of a large radial drilling machine, Charles S. Lewis & Co., St. Louis, Mo., use a portable electric drill of the type manufactured by the United States Electrical Tool Co., Sixth Ave. and Mount Hope St., Cincinnati, Ohio. A platform is provided upon which the various sized pump bases may be set up, and a carriage high enough to clear the largest base casting runs on this platform. The carriage supports a United States type GF radial drill, and clamps hold the carriage rigidly in place during the drilling operation. After all the holes have been drilled, an Errington tapper is substituted and the holes are tapped. The portable radial drill is provided with two speeds; the column is made heavy and the radial arm is of special length to cover the requirements of this work.



Use of United States Portable Electric Drill on Pump Base Castings

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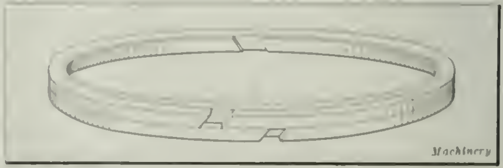
TRIPLE ECCENTRIC PISTON RING

A triple eccentric piston ring for automobile, marine, motorcycle and steam engines, air compressors, pumps, refrigerating machine, etc., has been put on the market by the Peerless Piston Ring Co., 91-107 Lafayette St., Newark, N. J., which has some features of interest to those who know the difficulties of making "leak-proof" piston rings.

The new ring is of the composite type which, when assembled, has a broad inner ring and two narrower rings outside, in contact with the walls of the cylinder. The inner ring serves the double purpose of expanding the outer rings and forming a seal to the joints. Both the inner and outer rings are of the eccentric type, the thick part of the inner ring being placed next to the thin part of the outer ring so that the assembled ring is concentric throughout. The joints in all are cut in the thin parts. The outer rings are held in a fixed position relative to the inner ring by a pin set in the latter, which can be seen between the two joints in the outer rings.

A study of this construction shows that it is theoretically "leak-proof." This ring prevents the gas or steam which gets beneath the ring in the piston ring groove from escaping through openings in the ring on the exhaust side. The double construction effectually seals all joints in the rings.



Peerless Triple Eccentric "Leak-proof" Piston Ring

ORGANIZING A NIGHT FORCE

The paper on organizing a night force read by Harold C. White at the recent meeting of the National Machine Tool Builders' Association in Atlantic City touched a vital subject to concerns whose normal capacity is exceeded by the demand for its product. The average plant is built and organized to turn out a maximum production with a full force working eight, nine, or ten hours a day. To exceed this production, it is necessary to run overtime or organize a night shift. Either is undesirable, and is avoided by good managers whenever possible. When men are required to work two or three hours overtime four or five nights a week, the production will increase for a few days and then it will begin to drop until in some cases it falls to the normal production when the men are working full time only. The cause is simply that the men become tired out and no longer have the energy and initiative to work with accustomed celerity. Overtime work then is profitable only for short periods, as an emergency measure. If the demand for product is such that overtime would have to be worked for many weeks or months, it is far better to organize a night force. How can this be done most efficiently?

Mr. White pointed out that labor employed at night is usually employed at a disadvantage. In the first place, it is difficult to obtain first-class workmen for a night shift. The normal skilled workman capable of holding a job prefers, of course, to work days, and usually has no difficulty in holding a day job. The men available for night work therefore are the comparatively unskilled or inefficient mechanics who are generally dropped when industrial conditions require contraction of the working force. A second difficulty is that of properly feeding men working at night. Night hours upset the domestic routine, and workmen are likely to be poorly nourished when working nights. For this reason, it seems advisable to furnish hot coffee and other refreshments in the middle of the night shift. It is not only desirable to do this, but necessary for their welfare; it is also necessary to pay a night shift somewhat higher wages. The amount of extra wages appears to range from ten to twenty per cent.

A third disadvantage of working nights is the difficulty of obtaining sufficient sleep. Those who work at night must sleep through the day, but street noises and the light make it almost impossible for nervous men to obtain an adequate amount of sleep, and they soon break down because of the lack.

It was pointed out in the discussion that a shop requiring to organize a night force can employ a number of its best workmen in the night shift. These men, having steady employment, will not seriously object to the night shift for a few weeks, provided they are paid higher wages and are accorded other favors customary in such cases. These men may be used as a training force for the night shift, and may be placed in those positions where the best work and most careful inspection are necessary. It is possible also to arrange the hours of the day and night forces so that the night force will be relieved at a time when it is possible to obtain a few hours sleep in the very early morning, before the noises of the streets become too loud. Thus, in a plant working nine-hour shifts, the day shift begins at 7 and quits at 5; the night force goes on immediately and quits at 2 in the morning. Men leaving work at this time can get a normal amount of sleep before noon.

Mr. White pointed out that one reason why a night force was likely to turn out bad work is that the machinery, being used twice as much as usual, deteriorates twice as fast and, of course, requires twice as much repair work. The tendency in times like these is to neglect repair work and the consequence is that the equipment goes way below par long before it would if used only by a day shift.

The conclusions are that to operate a night shift efficiently it is necessary to employ some highly skilled men, to pay wages above the day rate, to supply refreshments, to carefully inspect machinery and tools, and to make all needed repairs promptly. Efficient lighting is also an important factor. It has been shown that highly efficient lighting does wonders in raising the standard and quantity of the product.

FINDING CHANGE GEARS FOR HOBBING SPIRAL GEARS[*]

BY GEORGE W. FELTON[†]

The degree of uncertainty resulting from the use of the usual methods employed for finding suitable change gears for hobbing spiral gears, and the loss of time arising from this cause, led the writer to set himself the task of developing a more satisfactory method. It is not within the scope of this article to describe the several formulas for finding change gears which are supplied by the different makers of hobbing machines, except to say that the best and latest of these leaves something to be desired. After making a careful study of the subject, the method of procedure described in the following was devised, and this method has been found satisfactory in every way. It is not only a considerable time-saver, but the opportunity offered for selecting the best of several combinations of gears is worth a great deal when extreme accuracy is desired. Furthermore, the calculation is of such a simple character and so little time is required to reach a satisfactory solution that the method should appeal to all hobbing machine operators.

Formulas for Change Gears

The required change gear ratio is dependent upon whether the hob is of the same hand as the gear which is to be cut or of the opposite hand. Herewith are given the fundamental formulas for the two conditions:

For a hob of the same hand as the gear, the following formula is used:

$$\frac{\text{Lead} \div \text{feed}}{\text{Lead} \div \text{feed} - 1} \times \frac{60 \times \text{number of threads in hob}}{\text{number of teeth in gear}} = \frac{\text{product of drivers}}{\text{product of driven gears}} \qquad (1)$$

For a hob of the opposite hand to that of the gear, the following formula is used:

$$\frac{\text{Lead} \div \text{feed}}{\text{Lead} \div \text{feed} + 1} \times \frac{60 \times \text{number of threads in hob}}{\text{number of teeth in gear}} = \frac{\text{product of drivers}}{\text{product of driven gears}} \qquad (2)$$

The preceding formulas give a true statement of the conditions which exist when we have to hob a spiral gear of any kind. If, however, these formulas are strictly followed out in the way in which they are given, *i.e.*, by selecting a definite feed and dividing it into the lead, it is very likely that prime numbers will be encountered, in which case all of the labor and time that has been spent in making the calculation is lost, and it is necessary to select another value for the feed and begin the calculation over again. The following method of solving the problem enables one to obtain suitable change gears in a few minutes, and with only a slight mental effort. The following notation is used:

L = lead of gear spiral in inches;
N = number of teeth in gear to be cut;
T = number of threads in hob;
F = feed per revolution of gear being cut;
R = number of times F is contained in L = $\frac{\text{lead}}{\text{feed per revolution}}$.

Using the preceding notation Formula (1), for a hob of the same hand as the gear to be cut, may be expressed as follows:

$$\frac{R}{R-1} \times \frac{60\,T}{N} = \frac{\text{product of drivers}}{\text{product of driven gears}} \qquad (3)$$

Similarly, Formula (2) for a hob of opposite hand to that of the gear which is to be cut may be expressed in the following form:

$$\frac{R}{R+1} \times \frac{60\,T}{N} = \frac{\text{product of drivers}}{\text{product of driven gears}} \qquad (4)$$

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[*] For additional information published in MACHINERY relative to the gearing of hobbing machines for generating spiral gears, see "Differential Mechanism on Gear Hobbing Machines" by W. Natisch, May, 1912; and "Calculating Gears for Generating Spirals on Hobbing Machines" by Glenn Muffly, December, 1911.

[†] Chief Designer, New Process Gear Corporation, Syracuse, N. Y.

Method of Procedure

The method of procedure is as follows: First, look up the logarithm of the lead of the gear which is to be cut. Second, decide upon an approximate feed per revolution of the gear blank, which is suitable for the work; and then select a value of the feed F in Table I, which is of approximately the same value. The logarithm of $\frac{1}{F}$ will be found opposite this value of the feed in the right-hand column of the table. Third, add the logarithm of $\frac{1}{F}$ to the logarithm of the lead, the result being the logarithm of R. Fourth, take the resulting logarithm and find a value of the logarithm of R in Table II which is of approximately the same value. If such a value of the logarithm of R is found, the corresponding value of R will be obtained in the column to the left of the logarithm in Table II. If a sufficiently close value cannot be found, it will be necessary to select another value of the feed F in Table I, which is close to the original value, and then go through the same method a second time. As the process is simply one of addition, a dozen or more trials may be made very quickly. It should be borne in mind that the sum of the logarithm of the lead and the logarithm of $\frac{1}{F}$ should correspond with the value of the logarithm of R found in Table II to the fourth decimal place, or the values should at least be very nearly equal. Table II is merely a table of numbers up to 1197, in which all numbers that are useless for this work have been omitted. The table provides for cutting spiral gears of all leads up to 39 inches, using a feed of about 1/32 inch per revolution of the gear blank. This table could, of course, be continued indefinitely.

Proof

$F \times R =$ lead cut;

$\frac{\text{Lead cut}}{\text{Correct lead}} = 1$ when perfect results are obtained.

Maximum tolerance should be between 1.001 and 0.999 for gears on shafts at right angles; or between 1.0001 and 0.9999 for gears on parallel shafts.

Example

Suppose it is required to cut a steel spiral gear with 41 teeth of 10 pitch, 45 degree spiral angle, and 5.7982 inch lead, for shafts at right angles, using a single-threaded hob of the same hand as the gear. Following the method of procedure which has been outlined: First, look up the logarithm of the lead and write it down several times in a horizontal row as shown in the following calculation. Second, decide upon a suitable rate of feed, which for steel will be about 0.025 inch per revolution of the gear blank. Next refer to Table I for a feed of approximately this value, and take several successive values of the logarithm of $\frac{1}{F}$. Third, add the values of the logarithm of the lead and the logarithm of $\frac{1}{F}$. Fourth, refer to Table II and find a value of the logarithm of R which is approximately equal to the sum of the logarithms already determined. The calculation is as follows:

$$\begin{array}{lccc}
\text{Logarithm of lead} = & 0.76329 & 0.76329 & 0.76329 \\
\text{Logarithm of } \frac{1}{F} = & 1.58947 & 1.57209 & 1.55499 \\
\hline
\text{Logarithm of } R = & 2.35276 & 2.33538 & 2.31828
\end{array}$$

The sum of the logarithm of the lead and the third value of the logarithm of $\frac{1}{F}$, comes sufficiently close to the logarithm of R, for $R = 208$.

$$\text{Then } \frac{R}{R-1} \times \frac{60\,T}{N} = \frac{208}{207} \times \frac{60 \times 1}{41} = \frac{24 \times 52 \times 60}{27 \times 46 \times 41} = \frac{\text{product of drivers}}{\text{product of driven gears}}.$$

The feed gears found in Table I to the left of the value of the logarithm of $\frac{1}{F} = 1.55499$ which was used, are $\frac{37}{83}$, and

TABLE I. FEED TABLES FOR GOULD & EBERHARDT TWENTY-FOUR INCH HOBBING MACHINE

For Machine with Simple Feed Gearing (Fixed Centers)					For Machine with Compound Feed Gearing				
Feed Gears		Feed per Revolution of Blank = F		Log. $\frac{1}{F}$	Feed Gear Ratio		Feed per Revolution of Blank = F		Log. $\frac{1}{F}$
Driver	Driven	Fraction	Decimal		Driver	Driven	Fraction	Decimal	
24	96	$\frac{1}{64}$	0.0156250	1.8061800	16	64	$\frac{1}{64}$	0.0156250	1.8061800
25	95	$\frac{5}{304}$	0.0164474	1.7839036	16	63	$\frac{1}{63}$	0.0158730	1.7993405
26	94	$\frac{13}{752}$	0.0172872	1.7622748	16	62	$\frac{1}{62}$	0.0161290	1.7923917
27	93	$\frac{9}{496}$	0.0181452	1.7412391	16	61	$\frac{1}{61}$	0.0163934	1.7853298
28	92	$\frac{7}{368}$	0.0190218	1.7207495	16	60	$\frac{1}{60}$	0.0166667	1.7781513
29	91	$\frac{29}{1456}$	0.0199176	1.7007634	16	59	$\frac{1}{59}$	0.0169492	1.7708520
30	90	$\frac{1}{48}$	0.0208333	1.6812412	16	58	$\frac{1}{58}$	0.0172414	1.7634280
31	89	$\frac{31}{1424}$	0.0217697	1.6621485	16	57	$\frac{1}{57}$	0.0175439	1.7558749
32	88	$\frac{1}{44}$	0.0227273	1.6434527	16	56	$\frac{1}{56}$	0.0178571	1.7481880
33	87	$\frac{11}{464}$	0.0237069	1.6251251	16	55	$\frac{1}{55}$	0.0181818	1.7403627
34	86	$\frac{17}{688}$	0.0247093	1.6071397	16	54	$\frac{1}{54}$	0.0185185	1.7323938
35	85	$\frac{7}{272}$	0.0257353	1.5894704	16	53	$\frac{1}{53}$	0.0188679	1.7242759
36	84	$\frac{3}{112}$	0.0267857	1.5720964	16	52	$\frac{1}{52}$	0.0192308	1.7160033
37	83	$\frac{37}{1328}$	0.0278614	1.5549965	16	51	$\frac{1}{51}$	0.0196078	1.7075702
38	82	$\frac{19}{656}$	0.0289636	1.5381501	16	50	$\frac{1}{50}$	0.0200000	1.6989700
39	81	$\frac{13}{432}$	0.0300926	1.5215408	16	49	$\frac{1}{49}$	0.0204082	1.6901961
40	80	$\frac{1}{32}$	0.0312500	1.5051500	16	48	$\frac{1}{48}$	0.0208333	1.6812412
41	79	$\frac{41}{1264}$	0.0324367	1.4889636	16	47	$\frac{1}{47}$	0.0212766	1.6720979
42	78	$\frac{7}{208}$	0.0336538	1.4729655	16	46	$\frac{1}{46}$	0.0217391	1.6627578
43	77	$\frac{43}{1232}$	0.0349026	1.4571428	16	45	$\frac{1}{45}$	0.0222222	1.6532125
44	76	$\frac{11}{304}$	0.0361842	1.4414815	16	44	$\frac{1}{44}$	0.0227273	1.6434527
45	75	$\frac{3}{80}$	0.0375000	1.4259693	16	43	$\frac{1}{43}$	0.0232558	1.6334685
46	74	$\frac{23}{592}$	0.0388514	1.4105951	16	42	$\frac{1}{42}$	0.0238095	1.6232493
47	73	$\frac{47}{1168}$	0.0402397	1.3953456	16	41	$\frac{1}{41}$	0.0243902	1.6127839
48	72	$\frac{1}{24}$	0.0416667	1.3802112	16	40	$\frac{1}{40}$	0.0250000	1.6020600
49	71	$\frac{49}{1136}$	0.0431338	1.3651828	16	39	$\frac{1}{39}$	0.0256410	1.5910646
50	70	$\frac{5}{112}$	0.0446429	1.3502480	16	38	$\frac{1}{38}$	0.0263158	1.5797836
51	69	$\frac{17}{368}$	0.0461957	1.3353997	16	37	$\frac{1}{37}$	0.0270270	1.5682017
52	68	$\frac{13}{272}$	0.0477941	1.3174198	16	36	$\frac{1}{36}$	0.0277778	1.5563025
53	67	$\frac{53}{1072}$	0.0494403	1.3059186	16	35	$\frac{1}{35}$	0.0285714	1.5440680
54	66	$\frac{9}{176}$	0.0511364	1.2912711	16	34	$\frac{1}{34}$	0.0294118	1.5314789
55	65	$\frac{11}{208}$	0.0528846	1.2766709	16	33	$\frac{1}{33}$	0.0303030	1.5185139
56	64	$\frac{7}{128}$	0.0546875	1.2621117	16	32	$\frac{1}{32}$	0.0312500	1.5051500
57	63	$\frac{19}{336}$	0.0565476	1.2475854	16	31	$\frac{1}{31}$	0.0322581	1.4913617
58	62	$\frac{29}{496}$	0.0584677	1.2330850	16	30	$\frac{1}{30}$	0.0333333	1.4771213
59	61	$\frac{59}{976}$	0.0604508	1.2185985	16	29	$\frac{1}{29}$	0.0344828	1.4623980
60	60	$\frac{1}{16}$	0.0625000	1.2041200	16	28	$\frac{1}{28}$	0.0357143	1.4471580
61	59	$\frac{61}{944}$	0.0646186	1.1896419	16	27	$\frac{1}{27}$	0.0370370	1.4313638
62	58	$\frac{31}{464}$	0.0668103	1.1751551	16	26	$\frac{1}{26}$	0.0384615	1.4149733
63	57	$\frac{21}{304}$	0.0690789	1.1606546	16	25	$\frac{1}{25}$	0.0400000	1.3979400
64	56	$\frac{1}{14}$	0.0714286	1.1461280	16	24	$\frac{1}{24}$	0.0416667	1.3802112
65	55	$\frac{13}{176}$	0.0738636	1.1315705	16	23	$\frac{1}{23}$	0.0434783	1.3617278
66	54	$\frac{11}{144}$	0.0763888	1.1169695	16	22	$\frac{1}{22}$	0.0454545	1.3424227
67	53	$\frac{67}{848}$	0.0790094	1.1023205	16	21	$\frac{1}{21}$	0.0476190	1.3222193
68	52	$\frac{17}{208}$	0.0817308	1.0876147	16	20	$\frac{1}{20}$	0.0500000	1.3010300
69	51	$\frac{23}{272}$	0.0845588	1.0728416	16	19	$\frac{1}{19}$	0.0526316	1.2787536
70	50	$\frac{7}{80}$	0.0875000	1.0579920	16	18	$\frac{1}{18}$	0.0555556	1.2552725
71	49	$\frac{71}{784}$	0.0905612	1.0430505	16	17	$\frac{1}{17}$	0.0588235	1.2304489
72	48	$\frac{3}{32}$	0.0937500	1.0280300	16	16	$\frac{1}{16}$	0.0625000	1.2041200
73	47	$\frac{73}{752}$	0.0970745	1.0128902	16	15	$\frac{1}{15}$	0.0666667	1.1760913
74	46	$\frac{37}{368}$	0.1005431	0.9976463	16	14	$\frac{1}{14}$	0.0714286	1.1461280
75	45	$\frac{5}{48}$	0.1041667	0.9822712	16	13	$\frac{1}{13}$	0.0769231	1.1139434
76	44	$\frac{19}{176}$	0.1079545	0.9667502	16	12	$\frac{1}{12}$	0.0833333	1.0791812
77	43	$\frac{77}{688}$	0.1119186	0.9510975	16	11	$\frac{1}{11}$	0.0909091	1.0413927
78	42	$\frac{13}{112}$	0.1160714	0.9352744	16	10	$\frac{1}{10}$	0.1000000	1.0000000
79	41	$\frac{79}{656}$	0.1204268	0.9192769	16	9	$\frac{1}{9}$	0.1111111	0.9542425
80	40	$\frac{1}{8}$	0.1250000	0.9030900	16	8	$\frac{1}{8}$	0.1250000	0.9030900

Machinery

feed per revolution is 0.0278614 inch.

The accuracy of the result is proved as follows:

$$\frac{\text{Lead cut}}{\text{Correct lead}} = \frac{208 \times 0.0278614}{5.7982} = 0.9993.$$

While this method was worked out especially for use in connection with the 24-inch Gould & Eberhardt hobbing machine, the principle involved could be readily adapted to any other make of gear hobber. The formula may be regarded as having two separate parts. The first part, *i.e.*, $\frac{R}{R-1}$ or $\frac{R}{R+1}$ which is the "accelerating" or "retarding" part, according to the hand of the hob, is not affected by the type of machine, but depends entirely upon the feed, the lead being fixed. The second part of the formula, *i.e.*, $\frac{60\,T}{N}$, which equals the $\frac{\text{product of drivers}}{\text{product of driven gears}}$ for hobbing spur gears, varies for different machines. The real problem amounts to finding a factor R which will avoid encountering prime numbers and still give a feed which is suitable for the material of which the gear is composed, and at the same time produce accurate work. The need for a close approximation will be evident to anyone who studies the matter.

TABLE II. VALUES OF THE FACTOR R AND LOGARITHM OF R

R	Log. R	R	Log. R	R	Log. R	R	Log. R	R	Log. R	R	Log. R	R	Log. R	R	Log. R
99	1.99563	189	2.27646	291	2.46389	+402	2.60422	530	2.72427	+670	2.82607	+832	2.92012	−1001	3.00043
−100	2.00000	−190	2.27875	−292	2.46538	−403	2.60530	531	2.72509	671	2.82672	−833	2.92064	+1007	3.00302
+104	2.01703	+194	2.28780	+294	2.46834	+405	2.60745	532	2.72591	−672	2.82736	+836	2.92220	−1008	3.00346
105	2.02118	195	2.29003	295	2.46982	406	2.60852	533	2.72672	+675	2.82930	−837	2.92272	+1014	3.00603
−106	2.02530	−196	2.29225	296	2.47129	407	2.60959	−534	2.72754	−676	2.82994	+840	2.92427	−1015	3.00646
+110	2.04139	+200	2.30103	−297	2.47275	−408	2.61066	+539	2.73158	+679	2.83186	−841	2.92479	+1022	3.00945
111	2.04532	−201	2.30319	+299	2.47567	+413	2.61595	−540	2.73239	−680	2.83250	+845	2.92685	1023	3.00987
−112	2.04921	+203	2.30749	300	2.47712	414	2.61700	+549	2.73957	+688	2.83758	846	2.92737	1024	3.01030
+114	2.05690	204	2.30963	−301	2.47856	415	2.61804	550	2.74036	689	2.83821	847	2.92788	1025	3.01072
115	2.06069	−205	2.31175	+304	2.48287	−416	2.61909	551	2.74115	−690	2.83884	−848	2.92839	1026	3.01114
116	2.06445	+207	2.31597	305	2.48429	+423	2.62634	552	2.74193	+696	2.84260	+850	2.92941	−1027	3.01157
117	2.06818	208	2.31806	−306	2.48572	424	2.62736	−553	2.74272	−697	2.84323	851	2.92992	−1032	3.01367
118	2.07188	209	2.32014	+315	2.49831	425	2.62838	+558	2.74663	702	2.84633	−852	2.93043	+1034	3.01452
119	2.07554	−210	2.32221	−316	2.49968	426	2.62940	559	2.74741	703	2.84695	+854	2.93145	1035	3.01494
120	2.07918	+212	2.32633	+318	2.50242	427	2.63042	560	2.74818	704	2.84757	−855	2.93196	1036	3.01535
121	2.08278	−213	2.32837	319	2.50379	+429	2.63245	−561	2.74896	−705	2.84818	+860	2.93449	−1037	3.01577
122	2.08635	+215	2.33243	−320	2.50515	−430	2.63346	−567	2.75358	+710	2.85125	−861	2.93500	+1044	3.01870
123	2.08990	216	2.33445	+322	2.50785	+434	2.63748	−568	2.75434	711	2.85186	+867	2.93801	−1045	3.01911
124	2.09342	−217	2.33645	323	2.50920	−435	2.63848	+574	2.75891	712	2.85248	868	2.93851	+1053	3.02242
125	2.09691	+219	2.34044	324	2.51054	+437	2.64048	575	2.75966	713	2.85308	869	2.93901	−1054	3.02284
−126	2.10037	220	2.34242	−325	2.51188	−438	2.64147	−576	2.76042	714	2.85369	870	2.93951	+1064	3.02694
+128	2.10721	221	2.34439	+328	2.51587	+440	2.64345	+580	2.76342	−715	2.85430	−871	2.94001	1065	3.02734
129	2.11058	−222	2.34635	329	2.51719	441	2.64443	581	2.76417	+725	2.86033	+873	2.94101	1066	3.02775
−130	2.11394	+224	2.35024	−330	2.51851	−442	2.64542	582	2.76492	−726	2.86093	874	2.94151	1067	3.02816
+132	2.12057	−225	2.35218	+332	2.52113	+444	2.64738	583	2.76566	+728	2.86213	875	2.94200	−1068	3.02857
133	2.12385	+230	2.36172	−333	2.52244	−445	2.64836	584	2.76641	729	2.86272	−876	2.94250	+1071	3.02978
134	2.12710	231	2.36361	+335	2.52504	+450	2.65321	−586	2.76789	730	2.86332	+884	2.94645	1072	3.03019
135	2.13033	−232	2.36548	−336	2.52633	−451	2.65417	+588	2.76937	731	2.86391	−885	2.94694	−1073	3.03059
−136	2.13353	+234	2.36921	+340	2.53147	+455	2.65801	589	2.77011	−732	2.86451	+890	2.94939	+1078	3.03261
+140	2.14612	235	2.37106	341	2.53275	−456	2.65896	−590	2.77085	+735	2.86628	−891	2.94987	1079	3.03302
141	2.14921	236	2.37291	342	2.53402	+459	2.66181	+594	2.77378	736	2.86687	+896	2.95230	1080	3.03342
142	2.15228	237	2.37474	343	2.53529	−460	2.66275	−595	2.77451	737	2.86746	−897	2.95279	−1081	3.03382
143	2.15533	−238	2.37657	344	2.53655	+464	2.66651	+602	2.77959	−738	2.86805	+899	2.95375	+1088	3.03662
144	2.15836	+242	2.38381	−345	2.53781	−465	2.66745	−603	2.78031	+740	2.86923	900	2.95424	−1089	3.03702
145	2.16136	243	2.38560	+350	2.54406	+468	2.67024	+608	2.78390	741	2.86981	901	2.95472	+1104	3.04296
146	2.16435	244	2.38738	351	2.54530	469	2.67117	609	2.78461	−742	2.87040	902	2.95520	1105	3.04336
147	2.16731	245	2.38916	−352	2.54654	−470	2.67209	610	2.78532	+747	2.87332	−903	2.95568	1106	3.04375
−148	2.17026	246	2.39093	+354	2.54900	+472	2.67394	611	2.78604	−748	2.87390	+912	2.95999	1107	3.04414
+152	2.18184	247	2.39269	355	2.55022	473	2.67486	−612	2.78675	+759	2.88024	−913	2.96047	−1108	3.04453
153	2.18469	248	2.39445	356	2.55145	474	2.67577	+615	2.78887	−760	2.88081	+923	2.96520	+1113	3.04649
154	2.18752	249	2.39619	−357	2.55266	475	2.67669	−616	2.78958	+767	2.88479	924	2.96567	−1114	3.04688
155	2.19033	−250	2.39794	+360	2.55630	476	2.67760	+620	2.79239	−768	2.88536	−925	2.96614	+1120	3.04921
−156	2.19312	+252	2.40140	−361	2.55750	−477	2.67851	−621	2.79309	+774	2.88874	+930	2.96848	1121	3.04960
+158	2.19865	−253	2.40312	+363	2.55990	+480	2.68124	+623	2.79448	775	2.88930	−931	2.96894	+1127	3.05192
159	2.20139	+255	2.40654	364	2.56110	−481	2.68214	624	2.79518	776	2.88986	+935	2.97081	−1128	3.05230
160	2.20412	−256	2.40824	365	2.56229	+483	2.68394	−625	2.79588	−777	2.89042	−936	2.97127	+1131	3.05346
161	2.20682	+258	2.41161	−366	2.56348	484	2.68484	+629	2.79865	+779	2.89153	+943	2.97451	−1132	3.05384
−162	2.20951	259	2.41329	+368	2.56584	485	2.68574	−630	2.79934	780	2.89209	944	2.97497	+1139	3.05652
+164	2.21484	260	2.41497	369	2.56702	−486	2.68663	+636	2.80345	781	2.89265	945	2.97543	−1140	3.05690
165	2.21748	−261	2.41664	370	2.56820	+492	2.69196	637	2.80413	782	2.89320	−946	2.97589	+1147	3.05956
−166	2.22010	+264	2.42160	371	2.56937	493	2.69284	638	2.80482	783	2.89376	+948	2.97680	−1148	3.05994
+168	2.22530	265	2.42324	−372	2.57054	494	2.69372	639	2.80550	−784	2.89431	949	2.97726	+1156	3.06295
169	2.22788	266	2.42488	+374	2.57287	495	2.69460	−640	2.80618	+792	2.89872	−950	2.97772	−1157	3.06333
170	2.23044	267	2.42651	375	2.57403	496	2.69548	+644	2.80888	−793	2.89927	+960	2.98227	+1159	3.06408
171	2.23299	−268	2.42813	376	2.57518	497	2.69635	645	2.80955	+798	2.90200	961	2.98272	1160	3.06445
−172	2.23552	+272	2.43456	377	2.57634	−498	2.69722	−646	2.81023	799	2.90254	−962	2.98317	1161	3.06483
+174	2.24054	−273	2.43616	−378	2.57749	+506	2.70415	+648	2.81157	800	2.90309	+968	2.98587	−1162	3.06520
175	2.24303	+275	2.43933	+384	2.58433	−507	2.70500	649	2.81224	−801	2.90363	969	2.98632	+1175	3.07003
176	2.24551	−276	2.44090	−385	2.58546	+510	2.70757	650	2.81291	+803	2.90471	−970	2.98677	−1176	3.07040
177	2.24797	+279	2.44560	+387	2.58771	511	2.70842	−651	2.81358	804	2.90525	+975	2.98900	+1183	3.07288
−178	2.25042	−280	2.44715	−388	2.58883	512	2.70927	+656	2.81690	805	2.90579	−976	2.98944	1184	3.07335
+182	2.26007	+284	2.45331	+390	2.59106	−513	2.71011	657	2.81756	−806	2.90633	+979	2.99078	−1185	3.07371
183	2.26245	285	2.45484	391	2.59217	+516	2.71264	−658	2.81822	+816	2.91169	−980	2.99122	+1188	3.07481
184	2.26481	286	2.45636	−392	2.59328	517	2.71349	+663	2.82151	−817	2.91222	+986	2.99387	1189	3.07518
185	2.26717	287	2.45788	+395	2.59659	−518	2.71432	664	2.82216	+819	2.91328	987	2.99431	−1190	3.07554
186	2.26951	288	2.45939	−396	2.59769	+527	2.72181	665	2.82282	−820	2.91381	−990	2.99563	+1196	3.07773
187	2.27184	289	2.46089	+399	2.60097	528	2.72263	666	2.82347	+825	2.91645	+999	2.99956	−1197	3.07809
188	2.27415	290	2.46239	−400	2.60206	+529	2.72345	−667	2.82412	−826	2.91698	1000	3.00000	......	....

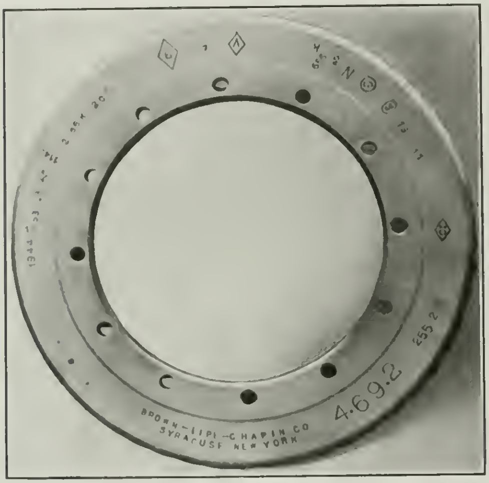
Machinery

Note: Numbers preceded by a minus sign may be used if the hob is of the same hand as the work, and no prime numbers will appear. Numbers preceded by a plus sign may be used if the hob is of opposite hand to the work, and no prime numbers will appear. Numbers preceded by neither a minus nor a plus sign may be used in either case, and no prime numbers will appear.

THOROUGH INSPECTION OF WORK

BY CHESTER S. RICKER*

It has always been a problem with manufacturers of bevel gears for automobiles to properly check back over the process of manufacture, in case something should go wrong with the work while in process, which afterward results in an epidemic of broken, noisy or badly worn gears. When a firm is striving to give its customers the best possible material and workmanship, and is at the same time producing parts in large quantities, it is a very important thing to be able to check back in case of trouble. It is also important to be in a position to fix the blame on the right man when complaints are received. All these requirements are fulfilled by the very complete inspection system which is in use at the plant of the Brown-Lipe-Chapin Co. of Syracuse, New York. An examination of the ring-bevel gear illustrated herewith, which has not been retouched, will give one a good idea of the complete inspection record which is available whenever a gear is returned. It is a complete history of the gear from the engineering department to the user. The abbreviations give the history as follows:



Automobile Ring-bevel Gear made by Brown-Lipe-Chapin Co., showing Thorough Inspection that is made

Starting with the company's name and going clockwise, you come to three round marks. The large one in the center is the impression made by the Brinell ball-test for hardness, and the two punch marks on each side of it are the buyer's inspector's O. K. as well as the O. K. for the toughness of the core.

1944 is the blueprint number from which the gear is made.

12 indicates the back-angle of the gear.

53-13 indicates the number of gear teeth and the gear ratio.

The star indicates that the gear was cut by the night shift.

1142 is the time-clock number of the man who cut the teeth.

2786K indicates the order number on which the gear was made, and in this case that it goes to Weston-Mott Co.

20S means that the cutter was for a 20-degree special tooth.

6 (inside of a diamond) indicates that the gear blank was heat-treated before it was machined.

7 is the time-clock number of the man who O. K.'d the blocking of the teeth.

A (inside of a diamond) indicates that the gear blank was annealed before machining.

K indicates the inspection of the holes, and that they were found satisfactory.

655 is the time-clock number of the man who performed the first operation in the machine shop, consisting of boring out the center hole and facing the back.

40 is the time-clock number of the inspector who passed on the first machining operations.

N designates the character and class of the steel used.

G (inside of a circle) designates the firm who made the forging blank.

39 (inside of an ellipse) is the number of the inspector who passed on the running-in of the gearing.

13 is the number of the inspector who passed on the second operation.

11 is the number of the man who performed the second machining operation of turning the face and back-angle surfaces.

C1 (inside of a diamond) indicates the chief inspector's O. K. on lots of 100.

2-15 indicates the month and year in which the gear was made.

255 is the number of the man who drilled the gear.

4.69.2 is the heat-treating number, and indicates the position in the pot, the location of the pot in the furnace, and the number of the furnace.

A chain is only as strong as its weakest link, and in this factory every means is used to determine where the "weak link" lies so it can be eliminated.

* * *

DROP-FORGING DIES*

The making of the dies for drop-forgings is a matter of first importance: Each design or piece has to be given individual attention in order to promote ease of operation, free flow of the metal while forging, and accuracy in form and dimensions. To permit the easy removal of the forgings from dies, a draft of about seven degrees is usually allowed on the sides or vertical walls, although in some shapes it may be more or less than seven degrees. Ordinarily the draft is secured by adding metal, but where the forging is not to be finished to any particular dimension, or if the metal could be spared at that point, it is sometimes taken off. The allowance for shrinkage is usually 3/16 inch to the foot, but practice varies.

For economical reasons, dies are sometimes made with only a single forging impression; this reduces the first cost of the tool, but the forcing of the hot metal into its final shape without any preliminary operation may sometimes result unsatisfactorily, since it is likely to set up stresses or add to any that may have existed in the bar and thereby establish a center for crystallization when the forgings are in use. By making the dies with at least two impressions, one being merely auxiliary to partially shape the piece, and having the corners, if any, well rounded, to permit a gentle flow of the metal in the dies, and the other impression to give the final shape, the likelihood of any additional stress being set up is diminished, and the life of the dies is lengthened.

For the making of plain pieces, one set of dies is usually sufficient, but in many of the more complicated parts, such as a crankshaft having three or more throws not in the same plane, two or more sets of dies are required, one for each separate operation. Frequently, the intermediate operations may be performed in the press, which is normally an auxiliary of the drop-hammer or it may be desirable to resort to first principles and employ the blacksmith, who is yet, and probably always will be, a very important factor in the working of wrought metals. The variety of shapes that can be made by this process is almost unlimited, though some would require so many operations as to make the cost prohibitive. But where the parts are required in large quantities, this difficulty may be overcome in a measure, even though three or more operations may be required to produce them. Very thin pieces, or those that are thin with heavy sections at intervals, are among the difficult shapes to produce, because of the rapid cooling of the parts in the dies, which prevents the reduction to size without reheating. Such pieces, therefore, are more costly to drop-forge than those of equal weight but more regular in outline and of greater thickness.

* * *

It has been quite conclusively shown that 25 per cent of the yearly coal bill of a factory depends directly upon the skill of the fireman. In New England a man will burn on an average from $40 to $50 worth of coal a day in a 500-horsepower plant. According to his skill, the fireman is able to save $10 and more of this. His pay generally varies from $1.75 a day up to $2.50 a day. Question: If a well paid fireman is equivalent to one who has the requisite skill, how much is saved by paying a fireman a dollar less a day?

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* Extract from paper by A. M. Tilton, read at the Atlantic City, N. J., meeting of the National Machine Tool Builders' Association, May 20-21, 1915.

ROLLING TAPERED FORGINGS*

TYPICAL MACHINES AND EXAMPLES OF WORK PRODUCED ON THEM

BY FRANK H. BLAKESLEE†

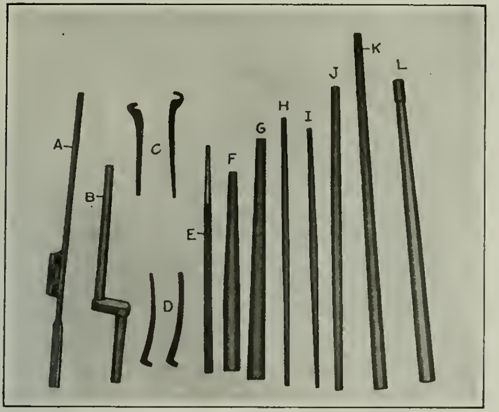

Fig. 1. Typical Examples of Tapered Work produced between Forging Rolls

TAPER forging rolls are advantageously employed for the rapid and economical production of tapered forgings; and typical examples of work which may be produced between taper forging rolls are shown in Fig. 1. Such parts are commonly forged under the hammer, but rolling enables the work to be done in less time and it is claimed that better results can also be produced by this method. The use of forging rolls insures a high degree of uniformity, and in those forgings where the appearance is a matter of importance the rolled work has the further advantage of being entirely free from hammer marks. The taper forging rolls consist essentially of a pair of rolls carried on shafts mounted between heavy housings. The rolls are half cylinders, and the shafts on which they are carried are driven by the usual arrangement of gearing and a flywheel. The rolls are provided with double adjustment, the vertical adjustment being made by raising or lowering the upper shaft bearings in the housings to allow for handling stock of various thicknesses. This adjustment also allows the rolls to be refinished when they become worn. The rolls are held in either a concentric or an eccentric position on their shafts by set-screws; the amount of eccentricity may be adjusted by loosening the set-screws on one side of the shaft and tightening those on the other side. By varying the eccentricity of the rolls different tapers may be produced in any pair of grooves in the rolls.

Fig. 2 shows a typical taper forging rolling machine built by the Ajax Mfg. Co., Cleveland, Ohio. This machine is adapted for either belt or individual motor drive, and is geared down from the flywheel to the rolls so that the latter run at a speed which is convenient for the operator. In making taper forgings on this machine, the stock is pushed through the space between the shafts when the rolls are apart. Then as the rolls come together they catch the work and carry it back toward the operator. It will be seen that the rolls are provided with grooves in which the work runs. At the front of the machine will be seen a cross-bar provided with grooves similar to those in the rolls and in alignment with them. In pushing the work through while the rolls are apart, it is slid along in the groove in the cross-bar corresponding with the grooves in the rolls in which it is desired to forge the work. This provides a rapid though effective method of guiding the work. Where wide, flat stock is to be rolled to a taper on the larger dimension, straightening rolls are provided, between which the work is rolled after each pass through the taper forging rolls, thus providing for keeping the smaller dimensions of the work constant. The standard machines are provided with a shear on the outside of the right-hand housing, which is operated by an eccentric on the upper roll shaft. This shear is found useful in trimming off the rough ends of forgings.

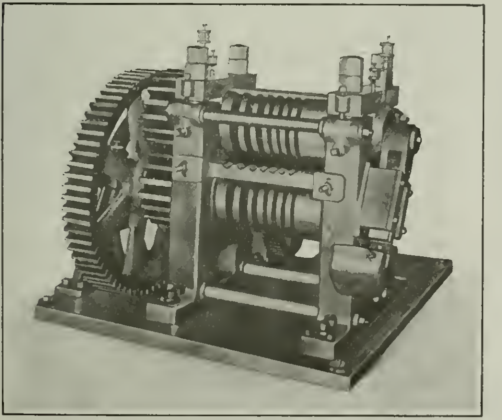

Fig. 2. Tapered Forging Rolling Machine for General Light Work

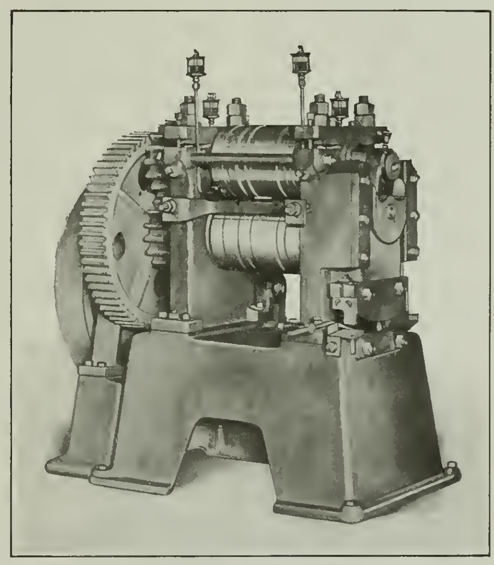

Fig. 3. Special Rolling Machine for forging Tapered Brake Shoe Keys

Referring again to the tapered forgings shown in Fig. 1, the piece marked *A* is a Bailey body-loop used in the manufacture of carriages. The center of this piece is drop-forged, leaving square ends which are easily drawn down to the required oval section by passing the work through the forging rolls. About 1400 of these parts can be turned out in a ten-hour day. Piece *B* is a knuckle, the ends of which are rolled to a taper. The taper on both ends of these knuckles may be produced without requiring the rolls to be changed, as each set of rolls is provided with several grooves so that different classes of work may be accommodated. The tong handles shown at *C* are rolled down from stock of the re-

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[*] For additional information on machine forging published in MACHINERY, see also "Machine Forging Gear Blanks" by D. T. Hamilton, November, 1914; "Cold Heading" by C. L. Lucas and E. W. Duston, published in three installments in May and July, 1913, and February, 1914; "Forging and Machining Automobile Front Axles," December, 1913; and "Machine Forging" by Douglas T. Hamilton, published in six installments in April, May, June, July, September, and October, 1913.

[†] Address: Care of Ajax Mfg. Co., Cleveland, Ohio.

quired cross-sectional area for forging the heads of the tongs. The pieces shown at *D* are brake shoe keys, which were made on the Ajax special brake-shoe key rolling machine shown in Fig. 3. The bar shown at *E* has a round tapered section rolled on the end, this being a typical form of forging used in the manufacture of various agricultural implements. Various forms of tapered pipes are shown at *F*, *G*, *H*, *I*, *J*, and *K*, the tapers on which were produced between taper forging rolls. Tapered pipes are produced by this method in the same manner as the solid bars, except that it requires more passes between the rolls to produce the same taper because there is a tendency to crush the pipe if it is attempted to obtain too great a reduction at a single pass.

The drag bar shown at *L* is an interesting example of a rolled taper forging because of the enlarged section at the small end of the taper. This forging is made by rolling the bar stock down to the required section at the upper end of the piece, this operation being performed in straight grooved rolls of suitable size. After this operation is completed, the rolled end is gripped with a pair of tongs and rolled from the smaller to the larger section. This method of rolling the taper by making a greater reduction during the first part of the rolling operation is at variance with ordinary practice, but is necessary in this case owing to the enlarged section at the small end of the work. The usual practice of rolling from the larger to the smaller section is adhered to in all cases where such a procedure is possible, because of the ease of handling and consequent efficiency of production. In any rolling operation there must be a reduction of the cross-sectional area; and consequently, the stock used for a rolled forging must have a section equal to or larger than the largest cross-section of the tapered forging which it is desired to produce. Many tapered forgings are tapered toward both ends or have a straight extension at one end of the taper; and such forgings can be economically produced by rolling. A back stop is provided at the back of the machine, against which the work is located as it is pushed through ready to be gripped between the rolls.

The manufacture of the brake shoe keys shown at *D* in Fig. 1 is handled very efficiently on the special brake-shoe key rolling machine shown in Fig. 3. Rectangular stock is used, and by heating the bar for a sufficient distance two keys may be finished before it is necessary to reheat the material. After the taper has been rolled on the end of the bar of stock, the key is sheared off, bent, and trimmed by a single stroke of the slide carried on the outside of the right-hand housing. The machine runs at 50 revolutions per minute and it has been found possible to produce 1200 keys in a ten-hour working day.

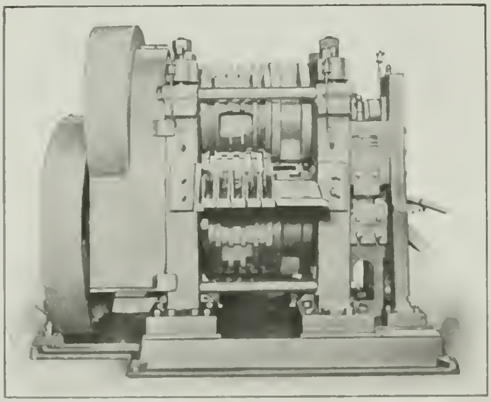

Fig. 4. Machine for forging Brake Levers for Railway Cars and Other Heavy Flat Tapered Work

Another taper forging rolling machine made by the Ajax Mfg. Co. is shown in Fig. 4, the most noteworthy feature of this machine being its unusually large size. This machine is provided with special attachments for use in finishing brake levers for railway cars. Fig. 5 shows a forging which was produced on this machine, and in this connection it may be mentioned that the rolls are large enough to handle taper forging operations on flat stock as large as 10 inches wide by 1½ inch thick. The greatest difficulty encountered in rolling the taper on such large pieces is that their weight makes the handling of the work a difficult matter. This difficulty is minimized on the machine shown in Fig. 4 through the provision of exceptionally long guides in which the grooves are cut deep enough to allow tongs to be used which have a small roller on the under jaw. The material can be brought to the machine by a light traveling crane and rolled between the rolls on the tongs. Owing to the heavy nature of the work, this machine is designed to run at only 25 revolutions per minute. After the taper has been rolled on each end of the work shown in Fig. 5, the piece is transferred to the shear where the ends are trimmed off. Owing to the exceptional weight of the work, it will be seen that an extra housing is provided on the machine to afford outboard support for the eccentric shaft which operates the shear. The off-set in the work is produced by removing the shear blocks and setting up bending dies in their place. The arrangement of the drive of this machine is similar to that of the machine shown in Fig. 3, the gearing and flywheel being completely covered by heavy iron guards.

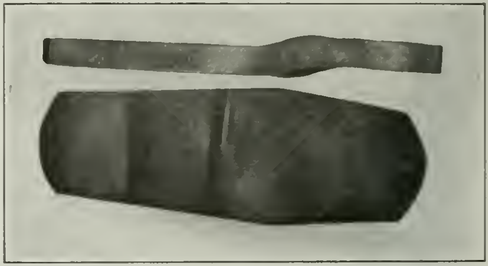

Fig. 5. Example of Tapered Forging rolled on Machine shown in Fig. 4

* * *

Delegates from about twenty technical, national and scientific societies met in the United Engineering Societies Bldg., 29 West 39th St., New York City, May 21, to perfect a permanent organization for the purpose of preparing a classification of the literature of applied science which might be generally accepted by these and other organizations. The idea was expressed that the publishers of technical periodicals could be induced to print against each important article, the symbol of the appropriate class in this system, so that by clipping these articles, a file might be easily made which would combine in one system these clippings together with trade catalogues, maps, drawings, blueprints, photographs, pamphlets and letters classified by the same system. W. P. Cutter, librarian of the Engineering Societies library, read a paper "The Classification of Applied Science," in which he outlined a plan whereby the central office could collate all existing classifications, and with the help of specialists in the various national societies interested, might compile a general system which would meet with general acceptance and adoption. A permanent organization was effected by the election of officers: Chairman, Fred R. Low; secretary, W. P. Cutter. The name adopted for the organization is "Joint Committee on Classification of Technical Literature," and the temporary address of the secretary, W. P. Cutter, is 29 West 39th St., New York City.

* * *

The sixteen-inch gun built at the Watervliet Arsenal about ten years ago has been taken to the Panama Canal for coast defense. This is the only sixteen-inch gun built by the United States. The remaining defenses at Panama will consist of fourteen-inch guns. These guns cost approximately $45,000 each and their carriages $85,000 each. The cost of a powder charge is approximately $175, and the cost of an armor-piercing projectile about $500. The cost of the powder charge of the sixteen-inch gun is about $250 and the cost of its armor-piercing projectile about $800.

INTERLOCKING MILLING CUTTERS*

BY CORRESPONDENT

The extent to which interlocking milling cutters have come into use of late years is remarkable. The chief cause for this is undoubtedly a closer study by the users of milling cutters of the advantages derived from the use of interlocking types; another cause is to be found in the more and more universal use of high-speed steel in milling cutters, which, owing to the extra cost over cutters made of carbon steel, makes it imperative that the cutters last longer than formerly.

Cutters are generally made interlocking for three reasons: (1) For the maintaining of a certain width. (2) To be able to mill two or more distinct widths with the same set of cutters. (3) To be able to make cutters of unusually long dimensions in sections, and at the same time insure as good results in milling as with a solid cutter.

The first reason—probably the most frequent one—is very simple of explanation. Cutters in use naturally wear and become dull, etc., and hence have to be sharpened, and from this operation they naturally become under size as far as width is concerned. A solid cutter would become under size after the first sharpening, and hence useless, and a new cutter would have to be procured; an interlocking cutter, on the other hand, can be used after several grindings, or practically until worn out. The second reason is similar to the first and, of course, gives the same advantages, except that when the cutters are set for the largest width of cut, the extent to which the cutters can be sharpened may be somewhat limited, depending upon the depth of the interlock in relation to the largest width. Using an interlocking cutter in this case makes a saving of one solid cutter plus the advantages set forth in reason No. 1. Cutters of long dimensions are generally made in sections. If made, however, as shown in Fig. 1, the result in the work being milled will after a very short time be a ridge in the flat surface, as the extreme corners of the cutters, even if in absolute line with each other, become rounded; this trouble is avoided by making the sections interlocking. The corners of the cutters when they become rounded have no effect upon the work being milled, if so made. Other reasons for making cutters of extreme length dimensions interlocking or in sections, are naturally the greater ease with which they can be made, and the elimination of risk in the hardening operation.

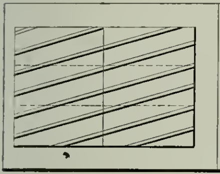

Fig. 1. Milling Cutter in Two Sections, not interlocked

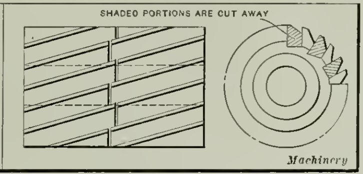

Fig. 2. Cutter in Fig. 1 interlocked to prevent Formation of Ridge in Flat Surface being milled

Most cutters, as before mentioned, are made interlocking in order to be able to maintain a certain width; this makes it quite necessary that the two or more interlocking sections run true, so that the cutter will cut a slot to the exact width of the assembled cutter. In order to insure the trueness of the sections, it is advisable to make the hubs or resting surfaces between the sections as large as possible. Figs. 2 and 3 show such interlocking cutters which are not only easy to make, but which make the maintenance of the trueness of the cutter when expanding them or contracting them a simple operation. For the expanding of these cutters as well as the one shown in Fig. 4, thin paper or metal washers, true in thickness, are used.

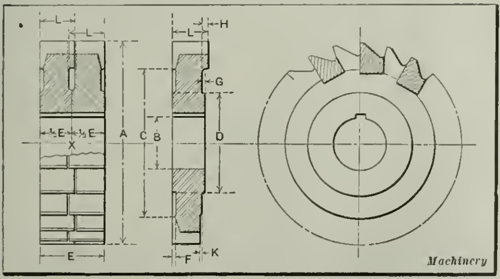

Fig. 3. Interlocked Side Milling Cutter

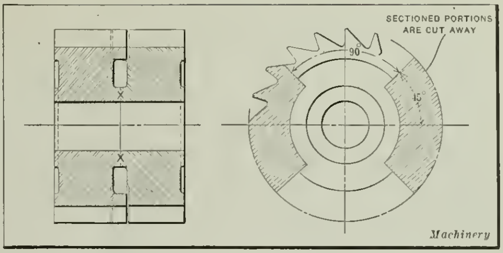

Fig. 4. Another Method of interlocking Milling Cutters

It can be readily seen that while the interlock as shown in Fig. 5 looks very simple, it is, in fact, a most expensive one to make accurately, and it by no means insures accuracy when expanding as do the other interlocks shown; in this case, pieces of paper or sheet metal inserted between surfaces *X* are used when expanding. It is comparatively easy to grind the surfaces on section *Y* true with the hole, this being done on an arbor, but when one tries to grind the surfaces on section *Z* true with the hole, the problem is quite difficult and expensive. If these surfaces as well as those in Figs. 2, 3, and 4 do not run true, the result will be an untrue cutter, bent arbor, etc., as any mechanic knows.

The depth of the interlock varies according to the purpose for which the cutters are made interlocking. If made interlocking for the purpose of maintaining a certain width, the depth need only be large enough to allow for several grindings or sharpenings, or until the outside teeth have been ground away to make the cutters practically useless. If cutters are made interlocking in order to obtain two or more distinct widths, the depth of the interlock is, of course, controlled by the difference between the widths desired. This difference should in ordinary cases, however, not be over ¼ to ⅜ inch, as the higher the projecting sections of the members of the cutter are, the weaker they will become. On interlocking cutters of large dimensions or of heavy construction, these dimensions can naturally be increased; on the other hand, on thin cutters they will have to be materially decreased. Cutters of large dimensions as to length, and for this reason interlocked, need have the recesses or depth of the interlock only deep enough to prevent ridges from forming when milling.

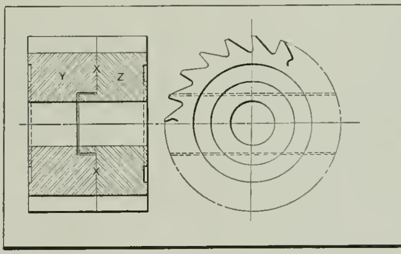

Fig. 5. Interlocking Method in which True Surfaces are Difficult to obtain

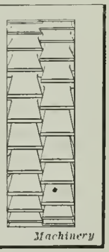

Fig. 6 Simple "Interlocked" Cutter

Of the various interlocks shown, the one shown in Figs. 2 and 3 is undoubtedly the most universally used, owing to its simplicity and consequent cheapness; one finds this style

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* For information on this subject previously published in MACHINERY see "Milling Cutters," April, 1906.

DIMENSIONS OF INTERLOCKED MILLING CUTTERS
(See Fig. 3 for Notation)

A	B	C	D	Width and Depth of Square Keyway	Number of Teeth
2	5/8	1 1/2	1 1/16	1/8 x 1/16	20
2 1/4	5/8	1 21/32	1 1/8	1/8 x 1/16	20
2 1/2	3/4	1 15/16	1 5/16	1/8 x 1/16	22
2 3/4	3/4	2 1/16	1 3/8	1/8 x 1/16	22
3	1	2 1/4	1 5/8	5/32 x 5/64	22
3 1/4	1	2 3/8	1 3/4	5/32 x 5/64	22
3 1/2	1	2 5/8	1 3/4	5/32 x 5/64	24
3 3/4	1	2 7/8	1 7/8	5/32 x 5/64	24
4	1 1/4	3	2	3/16 x 3/32	24
4 1/2	1 1/4	3 5/16	2 1/4	3/16 x 3/32	24
5	1 1/4	3 11/16	2 1/4	3/16 x 3/32	26
5 1/2	1 1/4	4	2 3/8	3/16 x 3/32	26
6	1 1/4	4 3/8	2 3/8	3/16 x 3/32	28
6 1/2	1 1/4	4 1/2	2 3/8	3/16 x 3/32	28
7	1 1/2	5 1/16	2 3/4	1/4 x 1/8	28
7 1/2	1 1/2	5 9/16	3	1/4 x 1/8	28
8	1 1/2	6 1/8	3 1/4	1/4 x 1/8	28
8 1/2	1 1/2	6 1/2	3 5/8	1/4 x 1/8	30
9	1 1/2	7	3 3/4	1/4 x 1/8	30
9 1/2	1 1/2	7 3/8	3 7/8	1/4 x 1/8	30
10	1 1/2	7 7/8	4	1/4 x 1/8	30
10 1/2	1 1/2	8 1/4	4 1/8	1/4 x 1/8	32
11	1 1/2	8 3/4	4 1/4	1/4 x 1/8	32
11 1/2	1 1/2	9	4 3/8	1/4 x 1/8	32
12	1 1/2	9 5/8	4 1/2	1/4 x 1/8	32

Machinery

of interlock on the cutters most often made interlocking—straddle milling cutters or side mills. The accompanying tables give practical dimensions for these cutters, and the faults generally found with these cutters as supplied for the market—too small hubs and lack of system for the dimensions of the recess in relation to different diameter holes—have been remedied.

In Fig. 6 is shown an interlocking cutter which anyone can procure at small expense. It consists of two ordinary side mills placed side by side with their hubs ground down so that the teeth of one of the cutters interlock into the spaces or between the teeth of the other. In this kind of interlocking cutter it is natural that the depth of the interlock cannot be very great, this depending upon the depth of the side teeth and the shape of the teeth.

* * *

Since the European war began, states the *Iron-monger*, people interested in the German silver trade in Great Britain have ceased to describe this product as German silver and have substituted for it the term nickel-silver. The term German silver dates back to 1830, when Herr Guitike, from Berlin, brought to Sheffield the first sample of this metal. The alloy came originally from China where its composition is said to have been known from time immemorial.

DIMENSIONS OF INTERLOCKED MILLING CUTTERS
(See Fig. 3 for Notation)

E	F	G	H	K	L
3/8	1/32	1/32	1/16	1/64	7/32
7/16	1/32	1/32	1/16	1/64	1/4
1/2	1/32	1/32	1/16	1/64	9/32
9/16	3/64	1/32	1/16	1/64	5/16
5/8	3/64	3/64	3/32	1/64	[illegible]
11/16	3/64	3/64	3/32	1/64	[illegible]
3/4	1/16	3/64	3/32	1/64	[illegible]
13/16	1/16	3/64	3/32	1/64	[illegible]
7/8	1/16	3/64	3/32	1/64	[illegible]
15/16	1/16	3/64	3/32	1/64	[illegible]
1	[illegible]	3/64	3/32	1/64	[illegible]
1 1/8	5/64	1/16	1/8	1/64	5/8
1 1/4	5/64	1/16	1/8	1/64	[illegible]
1 3/8	5/64	1/16	1/8	1/64	3/4
1 1/2	5/64	1/16	1/8	1/64	[illegible]
1 5/8	5/64	5/64	3/16	1/64	[illegible]
1 3/4	[illegible]	5/64	3/16	1/64	[illegible]
1 7/8	[illegible]	5/64	3/16	1/64	1 1/32
2	[illegible]	5/64	3/16	1/64	[illegible]
2 1/4	[illegible]	1/8	1/4	1/64	1 1/8
2 1/2	[illegible]	1/8	1/4	1/64	1 3/8
2 3/4	[illegible]	1/8	1/4	1/64	1 1/2
3	[illegible]	1/8	1/4	1/64	1 5/8

Machinery

INSTRUMENT FOR SOLVING SPIRAL GEAR PROBLEMS[*]

METHOD OF DETERMINING THE REQUIRED HELIX ANGLES OF THE GEAR AND PINION

BY GEORGE M. BARTLETT[†]

The determination of the tooth angles of spiral gears, where the distance between the shafts is unalterable, is usually a troublesome problem, no royal road having yet been found to the exact solution, except by the "cut-and-try" method which is not very well understood. It is the purpose of this article to describe, first, a graphical solution of the problem, which depends for its correctness only upon the accuracy of the diagram as laid out; and second, an instrument based on this graphical method which, if accurately made, will give the required spiral angles with a sufficient degree of accuracy for all practical purposes.

Let θ = angle between shafts;

C = center distance;

$$V = \text{ratio}\ \frac{\text{R. P. M. of pinion}}{\text{R. P. M. of gear}};$$

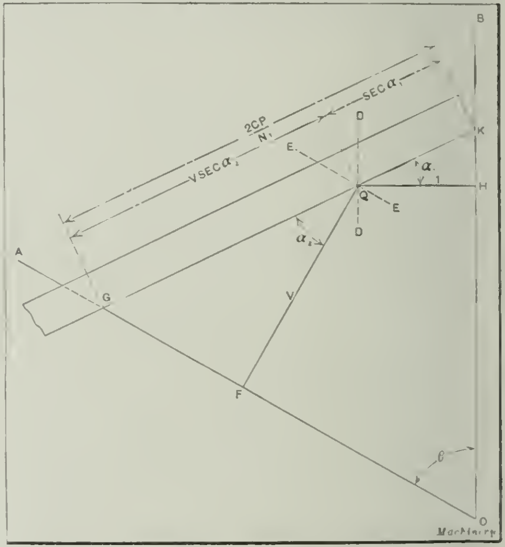

Fig. 1. Graphical Method of determining Helix Angles of Pair of Spiral Gears to fulfill Specified Conditions

P = diametral pitch of cutter;

α_1 = angle between tooth helix and axis of pinion;

α_2 = angle between tooth helix and axis of gear;

N_1 = number of teeth on pinion;

N_2 = number of teeth on gear.

The preliminary procedure is as follows: Given the velocity ratio V, the angle θ between the shafts, and the center distance C; provisional values for the tooth angles α_1 and α_2 are first assumed as nearly equal as possible, and such that $\alpha_1 + \alpha_2 = \theta$. The pitch of the cutter is also assumed.

$$N_1 = \text{the nearest integer to}\ \frac{2\,CP\cos\alpha_1}{1 + V\dfrac{\cos\alpha_1}{\cos\alpha_2}}.$$

$$N_2 = VN_1.$$

If the value for N_1 chances to be an exact integer, the assumed values of α_1 and α_2 will be correct, and no further work will be necessary. If not, it will be necessary to find new values of α_1 and α_2 that will satisfy the equation:

$$\frac{2\,CP}{N_1} = \sec\alpha_1 + V\sec\alpha_2.$$

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[*] For additional information on the subject of spiral gear design published in MACHINERY, see "Tables of Spiral Gears Having a Ratio of 2 to 1," June, 1914, "Formulas for Spiral Gear Combinations," March, 1913; "Spiral Gear Design," December, 1912, and January, 1913; and other articles there referred to.

[†] Address: 2609 North Delaware St., Indianapolis, Ind.

This may be done by a series of trials, which in time will lead to a very accurate determination of the required angles; but the graphical construction shown in Fig. 1 will give the result more quickly. Draw OA and OB, making the angle between them equal to the angle θ between the shafts. Draw DD parallel to OB and at a distance of unity from it. Draw EE parallel to OA and at a distance of V units from it. These lines intersect at a point Q. From this point drop perpendiculars QF and QH to OA and OB, respectively. Now take a strip of paper with a perfectly straight edge, and lay off upon it a distance GK equal to $\frac{2CP}{N_1}$. Place this strip so that its edge touches the point Q, and so that the points G and K lie on the lines OA and OB, respectively. Then the angles KQH and GQF will be equal to the required angles α_1 and α_2, respectively. An inspection of the figure will show this to be correct.

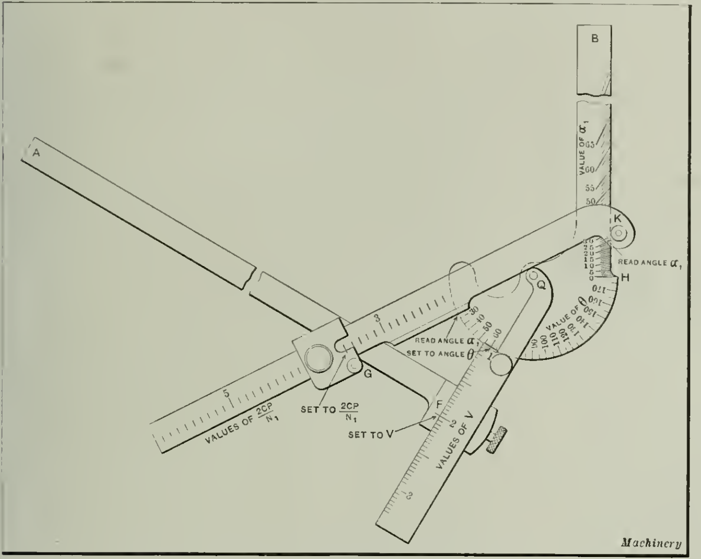

Fig. 2. Instrument for determining Required Helix Angles for Spiral Gears, based on Graphical Method illustrated in Fig. 1

To illustrate the use of this method in determining the proper helix angles for a pair of spiral gears, we will employ it in solving the following problem: Consider a case in which the velocity ratio is 2; the angle θ between the shafts, 60 degrees; the center distance C between the shafts, 7 inches; the diametral pitch of the gear cutter, 6; the helix angle α_1 of the pinion, approximately 30 degrees; and the helix angle α_2 of the gear, approximately 30 degrees. By calculation we find that the number of teeth N_1 on the pinion is:

$$N_1 = \frac{2\,CP \cos \alpha_1}{1 + V \dfrac{\cos \alpha_1}{\cos \alpha_2}} = \frac{2 \times 7 \times 6 \times 0.866}{1 + 2 \times \dfrac{0.866}{0.866}} = 24.248.$$

From the preceding calculation we see that the number of teeth N_1 on the pinion is 24 (taking the nearest integer); and $N_2 = N_1 \times V = 24 \times 2 = 48$. We must now proceed to find all values for α_1 and α_2 which will satisfy the following equation:

$$\frac{2\,CP}{N_1} = \sec \alpha_1 + V \sec \alpha_2.$$

Proceeding according to the graphical method of solution illustrated in Fig. 1, we lay off OA and OB, making the angle between them equal to the shaft angle θ or 60 degrees. Next draw the line DD parallel to OB and at a distance of 1 inch from it. Then draw EE parallel to OA and at a distance of 2 inches from it, bearing in mind that the velocity ratio V is 2. By calculation we find that the distance GK which must be laid off on the strip of paper is:

$$\frac{2\,CP}{N_1} = \frac{2 \times 7 \times 6}{24} = 3.5 \text{ inches.}$$

This strip of paper is then applied to the diagram as previously explained, and the angle KQH or α_1 (Fig. 1) is found to be 27 degrees, 25 minutes. $\alpha_2 = \theta - \alpha_1 = 60$ degrees $- 27$ degrees, 25 minutes $= 32$ degrees, 35 minutes.

Fig. 2 illustrates a direct-reading steel instrument which is designed for use in determining the value of α_1, after which the value of α_2 is found by taking the difference between θ and α_1. In using this instrument it is only necessary to make three settings, *i. e.*, one for the value of the shaft angle θ, one for the value of the velocity ratio V, and one for the fraction $\frac{2\,CP}{N_1}$. After making these settings, the loose blade GK is moved so that the button K at one end is in contact with the vertical blade B, with the middle portion of the loose blade touching the curve at Q, and the button G which is set to correspond with the value of the fraction $\frac{2\,CP}{N_1}$ in contact with the straight edge of the blade AF. After the instrument has been adjusted in this way, the value of the helix α_1 on the pinion is read on the scale B of the instrument. It will be found that there are in general two positions of the loose blade which will fulfill all conditions, and in either of these positions correct determinations may be obtained for the values of the helix angle α_1 on the pinion and the helix angle α_2 on the gear. The best results will be obtained by using the pair of values for these angles which are most nearly equal. It will be evident that the reference letters in Fig. 2 correspond with those of Fig. 1, from which the analogy between the method of solving the problem with the instrument and by the graphical method will be seen.

* * *

The manufacturer who intends to go into the export trade should remember that the three cardinal sins charged against American firms are that they do not always ship exactly what is ordered; that they are liable to substitute goods to suit their own judgment; and that they are not careful as to packing.

* * *

UNEMPLOYMENT IN FIFTEEN CITIES OF THE UNITED STATES

The Bureau of Labor Statistics of the United States Department of Labor is making a series of investigations into unemployment. The second study of this series, which was undertaken for the bureau by the Metropolitan Life Insurance Co., includes the following fifteen cities outside of Greater New York and the Metropolitan district of Northern New Jersey, which territory was covered in the first study of unemployment published in Bulletin 172. The cities are: Boston, Bridgeport, Chicago, Cleveland, Duluth, Kansas City, Milwaukee, Minneapolis, Philadelphia, Pittsburg, St. Louis, Springfield, Mo., St. Paul, Toledo, Wilkesbarre. The cities include 399,881 families, in which there were found 644,358 wage earners. Of this number, 73,800 or 11.5 per cent of all wage earners in the families visited were wholly unemployed and in addition thereto 106,652, or 16.6 per cent were reported as part-time workers. The highest per cent of unemployment was found in Duluth, Minn., where 20.3 per cent of the wage earners were without work, and 17.8 were working part time only. The lowest percentage of unemployment was found in Bridgeport, Conn., where only 4.3 per cent were unemployed, and 19.9 per cent were working only part time. This report was published May 31, 1915.

LUBRICATION OF BALL BEARINGS

BY L. O. LONG*

It is not so very many years ago that we were told that ball bearings required no lubrication, and if kept free from dirt, moisture, etc., were more efficient when run perfectly dry. Experience has proved this to be erroneous, and it is now generally accepted that lubrication is absolutely necessary when high speeds are to be maintained or heavy loads carried. Just why this is so is easily understood if we stop to consider the construction and operation of a ball bearing under load and motion. In order that the balls shall maintain their distributed relation to one another, some sort of spacer or distance piece is inserted between the respective balls. This spacer may be of one piece or it may be made up of several pieces, and various types are to be found in bearings of different makes; but practically all ball bearing manufacturers have adopted some kind of spacer in their annular type of bearings.

Were no spacer used, it is evident that the balls would rub against one another, and it is just as evident that they must rub against the spacer, producing a certain amount of friction which might be very slight, but still less harmful if the rubbing surfaces are lubricated. While the material from which both balls and races are made is very hard, it is to a certain extent elastic, and consequently subject to slight deformation. Theoretically, a ball bearing has purely rolling contact and the path of the balls about the races is a line, but in actual practice, when subjected to a load, each ball is compressed as it comes under the load, and the line path becomes appreciably wider. This constant and rapid compressing and releasing of the balls tends to cause "fatigue" in the metal just the same as under repeated hammer blows; and it also tends to generate heat, which is more readily dissipated in the presence of a lubricant. As each ball passes out of the zone of pressure, it is snapped out much as one snaps a melon seed from between the fingers, ending up with a smart blow against the retainer, the action being repeated very rapidly, and in high-speed bearings this is yet another source of heat.

We must grant that the bearing makers have provided wonderfully in this regard with their special heat-treated steels and scientifically made retainers, so that when a bearing load is kept within rated guarantees, and a good lubricant is used, cool and quiet running bearings result. But instead of the theoretically free rolling frictionless contact, we have some such condition as the following: Each ball in its turn is forced under the load, where it undergoes a deformation due to the load pressure, and as it passes from under the load it is snapped very smartly against the retainer. All of these operations are repeated many times per minute in a ball bearing under load and motion, and can easily become destructive if the bearing is allowed to run dry. Yet all of these pressures, frictions and blows need not cause worry to the bearing user if his bearings are properly mounted, loaded and lubricated, as it is only when the load becomes sufficient to cause permanent deformation to either balls or races that trouble occurs, or when lubrication fails to take care of the heat and friction. The successful operation of ball bearings depends upon proper mounting, safe loads and proper lubrication.

Requirements of a Satisfactory Lubricant

It is not the writer's intention to lay stress on the fact that lubrication is necessary, as this is generally accepted, but only to tell why and to emphasize very strongly that *proper* lubrication is the crying need, and also endeavor to explain what constitutes a proper lubricant. Too many have believed that oil is just oil, and that grease is simply grease; and that what is good enough for the bearing of the wheelbarrow, the tram car or lineshaft is all right for ball bearings, but let us consider the requirements of the ball bearing carefully before we load it up with cheap cup grease. A modern ball bearing is one of the finest examples of workmanship and accuracy in the machinery art, the world is searched for the purest iron from which the steel is made, and the most exact care is taken in handling at each step from the ore to the finishing processes. Expensive and minutely accurate machinery, elaborate processes of refining, the most skilled workman, the most careful inspection and efficient engineering have produced this highly accurate bearing. Does not a part of a machine that requires such extreme accuracy to produce deserve careful attention from the user?

Ball bearing makers have spent thousands upon thousands of dollars in order to be able to produce balls that are accurate with one another within limits of 0.0001 inch; in order to produce ball races that are of uniform and exact hardness throughout and with microscopically perfect surfaces; and in order to assemble these balls and races without clearance between them, so that a quiet running bearing can be obtained. They have done these things to produce the most efficient bearing, but is it reasonable to expect it to remain efficient or to be a bearing at all if it is clogged and fouled with gummy, dirty or impure lubricants? If this bearing is to retain its efficiency and give service year after year, its highly finished surfaces must be kept clean and bright. This precludes the use of any lubricant containing either alkali or acid or any substance which upon becoming rancid will produce acid. In this class fall most of the so-called cup greases, being alkaline from the soap used in their formation. Moisture, dust, dirt and abrasives must also be excluded from the bearing.

The oil or grease that is used as a lubricant should be of such a nature as to offer the least resistance to the free movement of the balls around their path that is consistent with its ability to remain in the bearing enclosure. When the design of a ball bearing mounting will permit the use of a fluid oil and oil can be retained in the enclosure or housing, it is a very desirable lubricant, as it is not so difficult a matter to obtain high-grade lubricating oil, but it is very unusual indeed for a horizontally mounted bearing not to leak along the shaft when thin oil is used. The difficulties met with along this line have led most builders of ball bearing machinery to the use of grease or non-fluid oils, finding also that a greater quantity can be put in the enclosure at a time, thus doing away with the necessity for such frequent attention. Unfortunately for the ball bearing, it is very little understood by the average machine user; and it is also unfortunate that he knows very little about greases and of what they are made. He is more than likely to fill his ball bearings with a grease that has been found satisfactory for other purposes without possessing any knowledge of its fitness for ball bearings.

There are many heavily filled soap stock greases which give excellent results in some bearings that will absolutely destroy a ball bearing in a short time, and the majority of the greases on the market are unsuited for the requirements of ball bearings in one or many ways. Of two hundred different commercial greases examined, less than a half-dozen have been found suited to ball bearing use. This looks as though there is scant chance for the user to obtain a suitable grease, but such is the condition and there is much more poor than good grease in use. The best of our ball bearing makers are anxious that their bearings shall have the best lubricant and will generally advise a brand when asked to do so. The best cannot be expected for the least money, nor does it follow that the most expensive is the best, but it is much more likely to be.

Bearing in mind the accuracy of parts, the extremely fine finished surfaces and the close fits of the balls in a ball bearing, it is clear that we do not want anything in a grease that will act as an obstruction, such as chalk, cork, mica, graphite, etc., which are often of coarse consistency. Neither do we want any acid or alkali that would attack the polished surfaces. The majority of greases are alkaline, due to soap used to thicken them, and as a pure mineral oil cannot be saponified some vegetable or animal fat has to be added to make a soap. These organic fats are very likely to become rancid upon exposure, especially in warm weather, and develop destructive acids. Drying oils, thickeners, emulsions and various fillers are added to give the desired consistency and "body" to the grease; and these in themselves are not lubricants, but remain in the bearing and not only act as obstructions but give a false impression as to the amount of lubricant in the bearing. What we must have is as nearly a pure mineral oil as possible, which is of a consistency that will remain in the bearing at any temperature likely to be encountered. Were it not for the low melting point of petrolatum or vaseline, it would be the ideal lubricant.

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* A[illegible] Automobile Co., Indianapolis, Ind.

Method of Testing Lubricants

While it is necessary that the lubricant for ball bearings or roller bearings be properly prepared for the purpose, the retention of this lubricant is just as essential, and the same is true of the necessity for the exclusion of moisture or dirt from the bearings. To make a bearing housing oil, moisture and dirt tight, and still maintain a filling port, which is necessary where a fluid oil is used, is a very difficult piece of work and not often accomplished in practice. The grease-packed bearing for horizontal construction is generally preferred, as such close fits are not required and much less attention is required in service. The selection of the grease is a more difficult matter than the selection of an oil, and it is safe to say that any good engine oil is suitable for ball bearings, taking into account the load and speed. In general, heavily loaded bearings require a heavier oil than the high-speed lighter loaded ones. The specifications for a good ball bearing grease would be as follows: A pure mineral oil, free from acid, alkali or filler, which contains no substance that will act as an obstruction to the free movement of the balls or that will become rancid with age; and which is of such a consistency that it will be easily retained in the housing; the grease should not melt below 250 degrees F. In order to determine if we have such a product, a few simple tests can be made upon a sample of the grease.

Select a sample which will be an average of the package and examine it first for the presence of acids or alkalies as follows: Shake into a test tube half filled with warm distilled water about a thimbleful of the clean grease, and stir until it is well washed into the water. Test the water with both red and blue litmus paper (which may be obtained at most drug stores) when a change of color of the paper from red to blue or *vice versa* will indicate the presence of either alkali or acid, according to which paper is affected. A few drops of phenol-phthalein indicator dropped into a test tube of greasy water will show pink in the presence of alkali.

Next we would test for the presence of fillers or organic fats. Fill the test tube half full of 86-degree specific gravity gasoline or petrolic ether; stir into this a thimbleful of the grease and continue stirring until the grease is fully dissolved. Then pour into the tube a teaspoonful of 10 per cent solution of phosphoric acid in alcohol and shake vigorously for about three seconds. If the grease contains no filler or organic fats, the solution will remain unchanged in appearance and the phosphoric acid and alcohol will settle to the bottom of the tube; however, should there be a precipitate or a coating on the tube walls, it indicates the presence of an undesirable substance. The nature of this precipitate and the quantity could be determined, but for our purpose it is sufficient to determine its presence only. A grease is generally a saponified oil, and as mineral oil is not saponifiable, a vegetable or animal fat is used to make a soap and part of this mixed with mineral oil acts as a thickener.

The melting point may be determined by heating a quantity of the grease in a vessel and noting the point on a stirring-rod thermometer where the grease becomes fluid and again where it changes from an oil to a grease in cooling down. All tests should be conducted with cleanliness, and a checking test should be made at the same time on a sample of commercial vaseline. Also a test carried through on a sample of known adulteration will act as a further check on the accuracy of the result. The usual condition of adulteration will be found as organic fats, as tallow, wax, resin-oil, wool-grease, horse-oil and some seed- and fish-oils; the fillers are talc, mica, rubber, and sometimes cork or fine sawdust. A pure mineral grease is expensive to make, while cup greases are very cheap but look and feel as good. Don't judge by appearances or the feel of greasiness to the fingers, or by your experience in lubricating plain cylindrical bearings; use the tests, and if still in doubt get the opinion of a chemist.

Ball bearings are forging rapidly to the front in machine practice and making headway in spite of the poor attention they frequently receive. Faulty lubrication can be traced as the cause, either directly or indirectly,, of the largest per cent of failures. Ball bearings have been put to use in places where plain cylindrical bearings were formerly used, given about the same kind of lubrication but much less attention, and then they have been condemned when they failed. This is unfair, as the construction of ball bearings is so different from any plain type of bearing that their lubrication needs cannot be judged from the same standards.

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AUTOMATIC INDEXING MULTIPLE DRAWING DIE*

BY JOSEPH M. STABEL†

The upper and lower members of a multiple drawing die for performing six drawing operations at one stroke of the press are shown in Figs. 1 and 2. The lower member, Fig. 1, contains the punches and is equipped with an automatic indexing mechanism which serves to carry the work around so that it is acted upon by the six punches and dies which successively reduce the size of the drawn part. Inasmuch as all of the punches and dies operate simultaneously, evidently a drawn piece is produced at each stroke of the press. Eight operations are required to complete the drawn part and their successive order is indicated by Figs. 3 and 4. The first operation is done in a compound blanking and drawing die equipped with a roll feed; the six operations following are

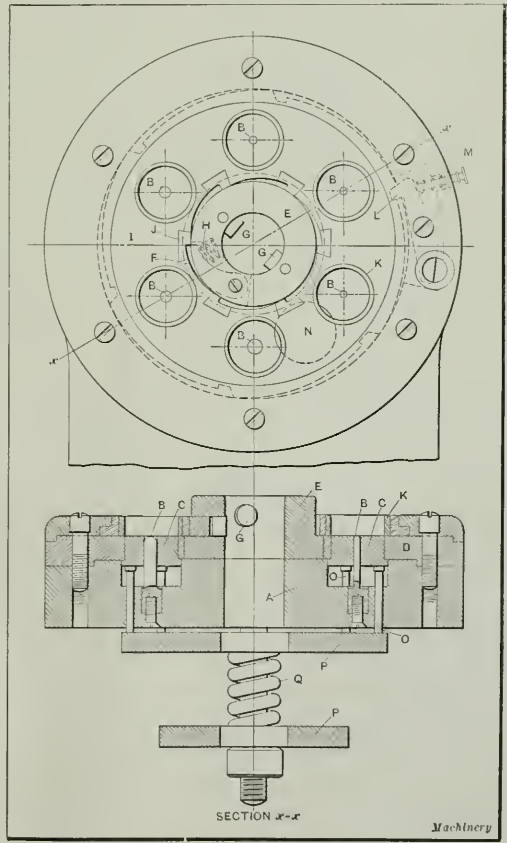

Fig. 1. Lower Member of Multiple Drawing Die

performed in the automatic indexing die, which is the subject of this article, and the eighth or final operation, which consists of turning down a flange and leveling the bottom, is done in another separate die.

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* For additional information on dies, see the following articles previously published in MACHINERY: "Deep Drawing in Combination Dies," April, 1915; "Dies for Drawing Flanged Shells," March, 1915; "Press Tools for Making a Roller Bearing Cage," March, 1915; "Formulas for Blank Diameters of Drawn Shells," January, 1915; "Edge Radius of Drawing Dies," October, 1914; "Sub-press Dies for Armature Manufacture," July, 1914; "One-piece Armature Disk Tools," March and January, 1914.

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The automatic indexing die has a shoe *A* which rests on the bolster of the press and serves to hold six equally-spaced drawing punches *B* and their respective stripping collars *C*. These stripping collars are held in place by retaining ring *D* which also provides a bearing for pawl carrier *E*. This carrier is hardened and ground and has attached to it a pawl *F* (see plan view) and also two hardened pins *G* which engage spiral grooves formed in extension *W* of the upper member (see Fig. 2). The pawl *F* is normally held outward by spring *H* and engages hardened teeth *J* inserted in plate *I*. These teeth take the end thrust of pawl *F* as the latter with carrier *E* is revolved when the press ram ascends. Plate *I*, which is the index plate, has six holes into which are pressed the hardened bushings *K*. On the periphery of this plate there are six slots, engaged by the end of locating lever *L* which serves to hold the plate firmly in position and locate the work accurately relative to the drawing dies. The thumb-nut *M* connecting with lever *L* is used for disengaging the lever when it is desired to turn the index plate by hand, in case it is necessary to remove the drawn parts.

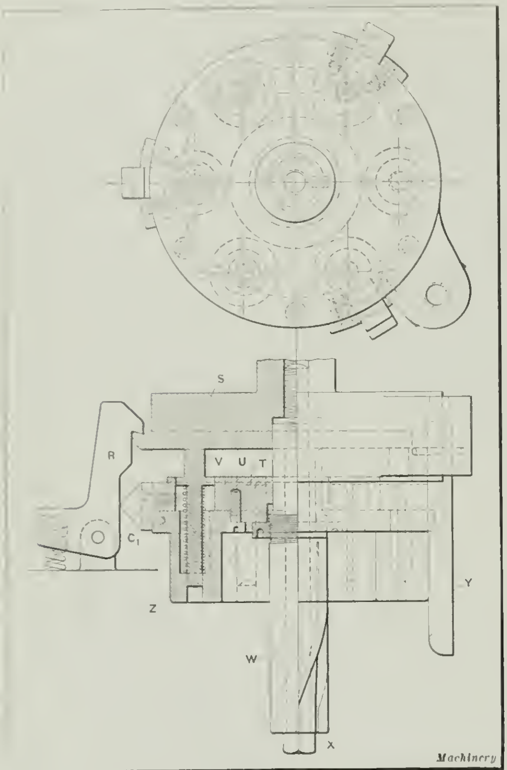

Fig. 2. Upper Member of Multiple Die

During one revolution of plate *I* each of the six holes passes over the clearance hole *N* which is just beyond the final drawing die, thus allowing the drawn part to drop out of the die and into a box beneath the press. The stripping collars *C* for the punches are actuated by three springs *Q* that are located on a circle underneath plate *P* and are held in position by three studs. These springs normally hold plate *P* upward and also collars *C*, by means of pins *O*.

The steel plate *T* (Fig. 2) is held to punch-holder *S* by screws and serves as the holder for the six drawing dies *Z*. Between holder *S* and plate *T* a space is cored out to receive stripper plate *U* which rests upon the strippers *V*. (The action of this plate will be referred to later.) The driver *W* has two spiral grooves milled in it which engage pins *G* (see Fig. 1) and operate the pawl carrier as previously mentioned. The bolt *X* provides adjustment for this driver. The hardened rod *Y* serves to release the locating lever *L* on the lower member so that index plate *I* may be revolved.

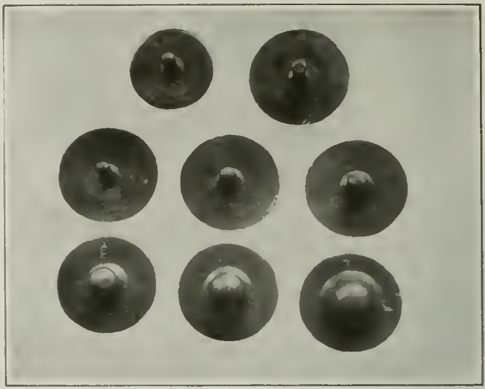

Fig. 3. Successive Operations—Six of which are done in Multiple Die of Automatic Indexing Type

The operation of the dies is as follows: When the upper member descends, the successive drawing operations on the six parts are performed (assuming that the die is completely loaded) and at the same time plate *E* and index pawl *F* are turned backward into engagement with the next tooth *J* on plate *I* preparatory to indexing. The rod *Y* also engages the end of locating lever *L* and withdraws it from the index plate. When the upper member ascends the drawn parts are stripped from the punches and dies and plate *E*, with index pawl *F*, is turned forward, thus indexing the six drawn pieces from one die to the next by the rotation of index plate *I*. When lever *L* is released by the upward movement of rod *Y* it drops into a notch and accurately locates and locks the index plate in position. This cycle of movements is repeated for each stroke of the press.

In designing this die, one of the points which had to be considered very carefully was to secure a rapid and positive stripping action for the dies in the upper members; in fact, the drawn parts have to be stripped from the dies as soon as the press slide starts upward so that the work will not be disarranged by being carried up out of the index plate. This positive stripping action was effected by means of plate *U* in conjunction with three levers or pawls *R*. These levers are pivoted to the lower member and as the upper member descends they are forced outward by three cams C_1. At the end of the downward movement, levers *R* are in engagement with plate *U*, as the illustration Fig. 2 indicates. When the slide begins to ascend, plate *U* and the strippers *V* are held stationary while the dies *Z* move upward, thus ejecting the drawn parts. When the cam surface on lever *R* is engaged by cam C_1, it is forced outward, thus releasing plate *U*. In this way the strippers are actuated at the beginning of the upward stroke so that the drawn parts are pushed from the dies without leaving the index plate. As the slide continues to ascend the index plate is revolved into position for the next drawing operation.

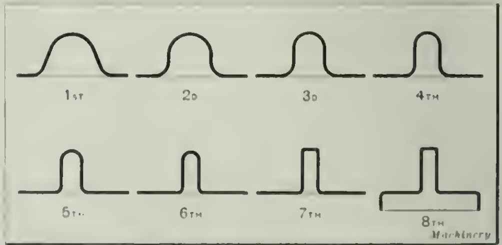

Fig. 4. Sectional Views corresponding to Operations illustrated in Fig. 3

LETTERS ON PRACTICAL SUBJECTS

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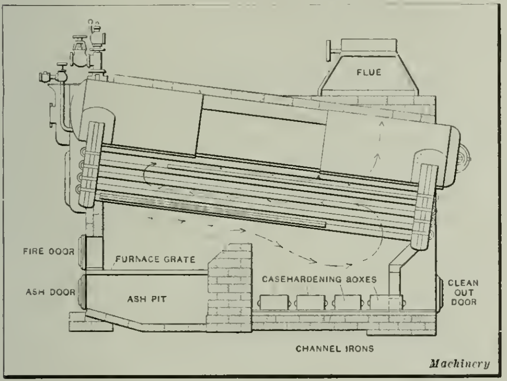
CASEHARDENING IN THE COMBUSTION CHAMBER

We recently started the manufacture of a new line of work which required several parts to be casehardened. We tried hardening a few sample pieces by the cyanide process, but found it too slow and expensive. We were considering the installation of a hardening furnace, but while thinking over the relative merits of installing a furnace or sending the work out to be hardened, the writer hit upon the scheme of conducting the casehardening operation in the combustion chamber of the furnace of one of the steam boilers. We packed the work in a mixture of ground bone and charcoal and placed the boxes in the combustion chamber.

We allowed the work to heat for about 18 hours, after which the casehardening boxes were removed, and at this point we had some trouble. It was necessary to allow the fire to go down in order to remove the boxes, and in this way the work was also cooled to such an extent that it had to be re-heated before quenching. To overcome this difficulty, we constructed a frame from 8-inch channel irons level with the "clean out" door through which the pots were put in the furnace. Handles were placed on the sides of the pots so that a hook could be used to pull them out of the furnace by sliding them along the channel iron frame. This did away with the necessity of letting the fire go down and since adopting this expedient, we have found the method entirely satisfactory.



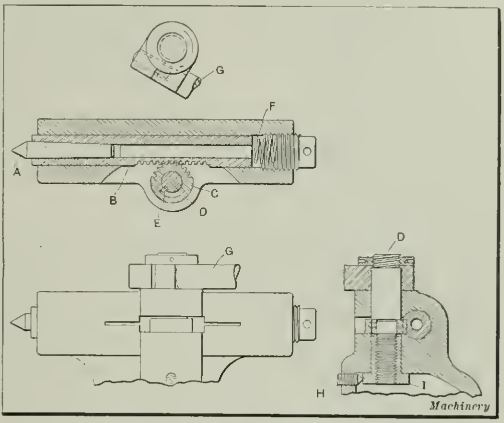
Casehardening Boxes set in Combustion Chamber of Boiler

Newark, N. J. GEORGE WERNER, JR.

QUICK-ACTING LATHE TAILSTOCK

The accompanying illustration shows an improved form of tailstock for use on lathes and other machine tools where a number of pieces of standard length are to be held between centers. With the ordinary tailstock, two operations are necessary—one to adjust the center and the other to clamp it in place. With the present design, one movement of a lever accomplishes both operations. The center *A* is carried in a sleeve *B* on which gear teeth are cut to mesh with the pinion *C* which moves the center. The stud *D*, which actuates the pinion *C*, has a small pin *E* forced into it. This pin is allowed to move in a slot in the pinion. When the tailstock is released, the spring *F* forces the center forward into contact with the work.

The operation of this tailstock is as follows: The tailstock is set so that the spring *F* will bring the center *A* into contact with the work. In order to release the work from the centers, the lever *G* is moved in the direction indicated by the arrow to draw the center *A* back against the resistance of the spring *F*. The next piece of work is then put in place and the lever *G* released; the spring *F* will now return the center *A* into contact with the work. To clamp the tailstock, the lever *G* is moved in the opposite direction to that indicated by the arrow. During this movement, the pin *E* moves in the slot in the pinion *C*, thus allowing the lever *G* to move a certain distance without actuating the pinion *C*. The tailstock casting is split, and this movement of the lever *G* turns the binding screw at the bottom of the stud *D*, thus binding the sleeve *B* and center *A* in place. The screw *H* enters one of a series of slots in the head of the binding nut *I* to prevent it from turning.

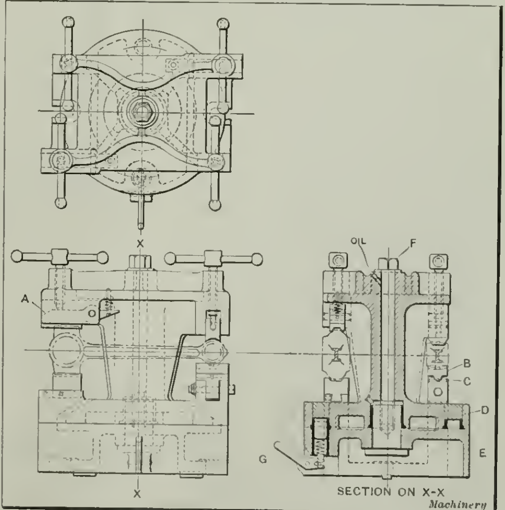


Improved Lathe Tailstock for Rapid Handling of Duplicate Parts

M. C. T.

CONNECTING-ROD MILLING FIXTURE

The accompanying illustration shows a fixture used for straddle-milling connecting-rods which has been in use by one of the leading automobile manufacturers of Detroit for the past two years. Reference to the illustration will make it clear that two connecting-rods are carried in the fixture at the same time. The ends of the rods are reversed, and after the cut has been taken on one end the fixture is indexed through 180 degrees and a cut taken on the opposite end of



Indexing Milling Fixture used for machining Connecting-rods

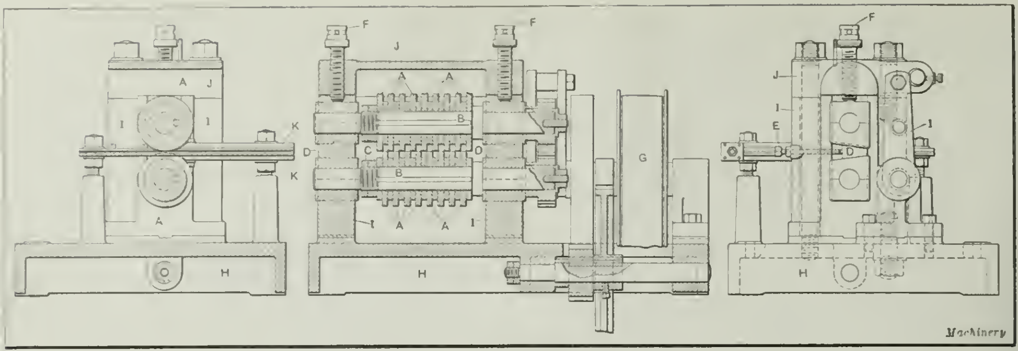


Fig. 1. Machine for cutting up Sheet Stock 6 Inches Wide by 0.012 Inch Thick into Ribbon Stock 0.39 Inch Wide

the rods. Two fixtures are used, one on each end of a No. 3 Cincinnati milling machine, and while the cut is being taken on the work held in one fixture, the other fixture is either being loaded or indexed ready for the succeeding operation. The provision of interchangeable V-blocks for holding the work enables the same fixture to be employed for milling three different sizes of connecting-rods.

In order to be sure of obtaining a firm grip on the work, the upper V-blocks which engage the large ends of the connecting-rods are provided with elongated holes, through which they are pivoted to the fixture, the idea being clearly shown at *A*. It is obviously necessary to prevent twisting the connecting-rods while clamping them in the fixture, as otherwise an inaccuracy would result after the work had been machined and the clamps released. For this purpose, the V-blocks which fit under the small end of each rod have a rocking motion which allows the rods to seat themselves in such a way that there will be no tendency to twist the work. This construction is clearly shown at *B*. The pins *C* under these V-blocks simply serve to prevent endwise motion. In operating the fixture, the body *D* swivels on the base *E* and is clamped by means of the bolt *F*. There should be a clearance of 1/64 inch between the body *D* and base *E* so that the bearing will come on the rim of the base when the bolt *F* is tightened. It will be evident from the illustration that the indexing is done by means of the small lever *G* which withdraws the locating plunger to allow the fixture to be swiveled through an angle of 180 degrees, as previously mentioned.

Detroit, Mich. K. W. Clarke

RIBBON STOCK CUTTING MACHINE

The machine illustrated in Fig. 1 was designed for the purpose of cutting up sheet metal stock 6 inches wide by 0.012 inch in thickness into ribbons 0.39 inch in width. The machine consists of two sets of steel cutters *A* which are keyed to the shafts *B*. These shafts run in bronze bushings and the cutters are locked longitudinally on the shafts by means of the nuts *C*. Means are provided for adjusting the vertical position of the shafts by wedges *D* which are actuated by the horizontal and vertical screws *E* and *F*. The machine is driven by a belt running over the pulley *G*, from which the power is transmitted to the cutter shafts through a train of gearing which rotates the shafts in opposite directions. The entire mechanism is supported on a base *H* and pedestals *I*, these pedestals being separate from the base to facilitate assembling. A cap *J* is securely bolted to the top of the pedestals.

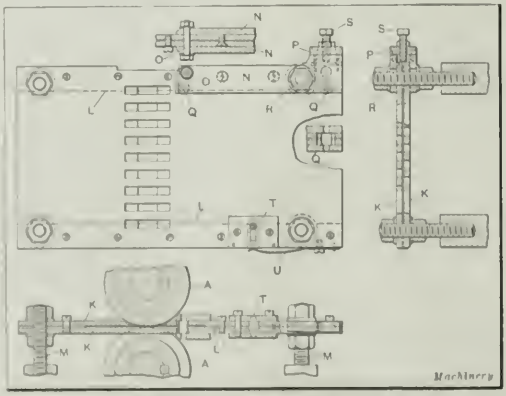


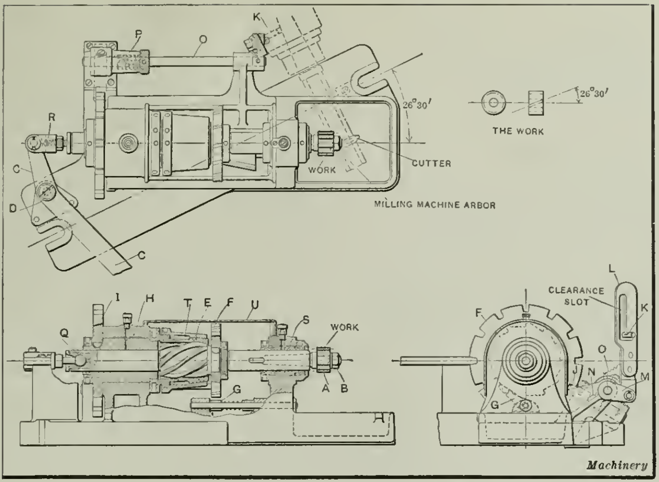
Fig. 2. Mechanism for guiding Stock into Machine

The mechanism for guiding the stock into the cutters and stripping it after the slitting operation has been performed is shown in Fig. 2. It will be seen that this consists of two plates *K*, held a suitable distance apart by means of liners *L* that run the entire length of the stripper. The plates *K* have openings machined in them to receive the cutters *A*. The guiding mechanism is mounted on the threaded studs *M* which are screwed into pillars cast integral with the base *H*. There are two plates *N* on the right-hand side of the guiding mechanism which are movable about a bolt *O* and fastened securely together by a tie-plate *P*. These two plates *N* carry two hardened steel rolls *Q* between them. After loosening the nut *R* which locks the plates in any desired position, they may be adjusted either in or out by regulating the set-screw *S*. A third roll *T* is mounted on the left-hand side of the guiding mechanism and pressed inward by means of a flat spring *U*. The sheet stock is fed between the plates *K* and advanced until the rolls secure a good grip on it, then by adjusting the position of the plates *N* and consequently of the rolls *Q*, the stock is caused to travel through the machine and comes out at the back split into ribbons of uniform width. Johnson Barre

FIXTURE FOR MILLING SPIRAL GEARS

The following describes a fixture for the rapid cutting of spiral gears on a hand milling machine, which possesses the advantage of enabling this work to be done on an inexpensive machine and handled by an unskilled operator. The fixture has given very satisfactory results where small spiral gears are manufactured in large quantities. The table of the hand milling machine on which it is used is locked in position, and the work is held on the arbor *A* by means of nut *B*; and it is fed under the cutter by swinging the lever *C*, which is pivoted at *D*. As the work moves forward, it is caused to revolve by the heavy thread which is machined on the center of the arbor. This thread has the same lead as the teeth of the spiral gears which are to be cut; as a result the gear blank is rotated under the cutter to produce the required form of teeth. Reference to the illustration will show that the arbor is set at an angle with the base of the fixture, thus holding the work at the proper angle for cutting the spiral teeth.

On the cutting stroke the arbor *A* is rotated through the movement of the screw through the nut *E*. The arbor carries a ratchet *F* which has the same number of teeth as the gear which is to be



Fixture for Rapid Cutting of Spiral Gears on Hand Milling Machine

milled; and as the arbor revolves one tooth of the ratchet snaps under the pawl *G*. On the return stroke—after the cut has been made—the ratchet and pawl prevent the arbor from turning back to its original position, and to provide for the return of the arbor the nut *E* is allowed to rotate as the arbor is drawn through it. From this it will be seen that the nut can turn backward but is held against rotation in the forward direction, while the ratchet and pawl prevent the arbor from turning backward. As the nut turns, it carries with it the sleeve *H* and index dial *I*, thus indexing the work automatically, ready for milling the next tooth when the arbor again moves forward.

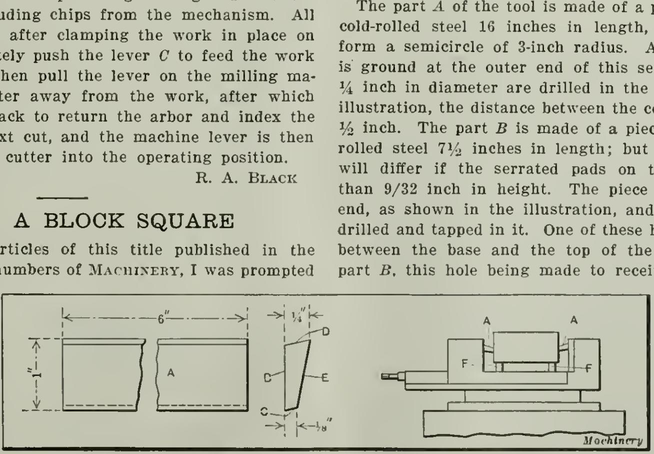
The milling cutter is raised from the work during the return stroke of the arbor by means of a lever provided on the machine for this purpose. When the cutter is raised the index plunger *J* is also automatically withdrawn from the notch in the dial by the same movement. This is accomplished by the mechanism at the back of the fixture. A pin *K*, which is pressed into the housing of the milling machine spindle, travels up and down when the cutter is raised or lowered; and this pin carries the connecting-rod *L* with it. By means of the two arms *M* and *N* and the shaft *O*, the motion is transmitted to the index plunger *J*. The torsion spring *P* insures having the index plunger enter all the way into the notch in the dial. When it is required to raise the cutter high enough to remove the finished work and replace it by a fresh blank, the connecting-rod *L* is swung away so that the pin *K* lies in the clearance slot and the cutter can then be raised as high as necessary.

Th connection between the operating lever *C* and the arbor *A* is a ball joint *Q* which permits of a swinging action of the link *R* in addition to allowing a rotary motion of the arbor. There is an adjustable bearing *S* at the front end of the arbor to provide compensation for wear. The split nut *E* is also made adjustable, compensation for wear being secured by tightening the taper sleeve *T*. The sheet metal cover *U* serves the double purpose of providing a safeguard over the moving parts and excluding chips from the mechanism. All the operator has to do after clamping the work in place on the arbor is to alternately push the lever *C* to feed the work under the cutter and then pull the lever on the milling machine to raise the cutter away from the work, after which the lever *C* is pulled back to return the arbor and index the work ready for the next cut, and the machine lever is then operated to return the cutter into the operating position.

Detroit, Mich. R. A. Black

PLANING A BLOCK SQUARE

After reading the articles of this title published in the October and February numbers of Machinery, I was prompted to write the following description of a simple little tool which I use when planing up castings that require two opposite sides to be exactly parallel. As the castings are generally tapered slightly on the sides, owing to the clearance allowed for removing the pattern from the mold, difficulty is experienced in holding the casting down in the vise. The device used to overcome this trouble consists of a pair of tapered strips *A* which are made of tool steel and planed straight on the bottom side *B* with the edges *C* and *D* parallel to each other but at an angle of about 2 degrees with the side *B*. The side *E* is planed to form an edge about ⅛ inch wide at *C*, which allows the holding of thin pieces of work if necessary.



Hold-down Strip for Use in planing up a Square Block, and Way in which these Strips are used

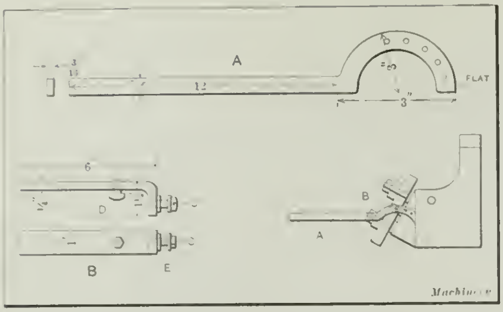
When placing the work in the vise, one of the strips *A* is placed between each jaw and the work, as shown in the small view at the right-hand side of the illustration. The small edges *C* of each of the strips are in contact with the work and the sides *B* are underneath. Under these conditions, it will be found that the work will be held down tightly against the bottom of the vise; after planing one side the work is turned over and two parallels *F* are put under it. The strips *A* are then used in the same way as before, and the vise is tightened to hold the work for planing the second side. A convenient size for these strips is about 1 inch wide by 6 inches long with the thick edge *D* about ¼ inch wide. The time spent in making a pair of these strips is very slight in comparison to the time spent in forcing the work down into the vise only to have it spring up and result in the production of a defective job.

Pittsburg, Pa. Fred Boehmer, Jr.

A T-SLOTTING KINK

When T-slotting, planer operators in many shops attach an extension stud to one of the tool-post studs which is used to raise the tool-post and hold it up clear of the work while the table is making its return stroke. This is not nearly such a convenient method as the one which can be used in connection with the tool that I am going to describe for the benefit of readers of Machinery.

The part *A* of the tool is made of a piece of ⅝ by 3/16-inch cold-rolled steel 16 inches in length, with one end bent to form a semicircle of 3-inch radius. A flat ¼ inch in width is ground at the outer end of this semicircle and five holes ¼ inch in diameter are drilled in the positions shown in the illustration, the distance between the centers of the hole being ½ inch. The part *B* is made of a piece of 1 by ¼ inch cold-rolled steel 7½ inches in length; but the thickness required will differ if the serrated pads on the tool-post are other than 9/32 inch in height. The piece *B* is bent over at one end, as shown in the illustration, and two ¼-inch holes are drilled and tapped in it. One of these holes is located midway between the base and the top of the perpendicular arm of part *B*, this hole being made to receive the pivot on which part *A* is mounted. The first hole in part *A* was made to give the tool-post a slight lift when the lever *A* is pushed down and comes into contact with the clapper box.



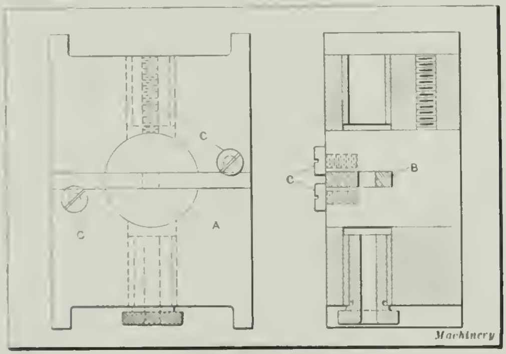
Lifter for raising Tool from Work during Return Stroke of Table

A second hole is drilled and tapped in the part *B* to fit a ¼-inch set-screw, this hole being drilled so that when the part *B* is slipped behind the tool in the tool-post ample room will be left for the movement of the tool. The set-screw *D* is provided to secure the device to the tool-post. It will also be noticed that there are washers *E* on the set-screw *C* to allow the lever *A* to swing freely on the pivot. To set up this device all that is necessary is to slip the holder *B* into place behind the tool and tighten the set-screw *D*. The lever *A* is then adjusted by placing the set-screw *C* in either of the five holes to provide for swinging up the tool to any required height. It will of course be evident that when the planer tool reverses to make its forward stroke lever *A* is swung up to drop the tool down ready to take its cut.

Covington, Ky. F. Augustine Coldehoff, Jr.

DRILL JIG FOR MAKING SHRAPNEL BORING-BARS

In machining 18-pound English shrapnel shells, we experienced considerable trouble with the boring-bars and cutters employed for the operation of machining the inside powder cup. The boring-bar cutters broke off frequently and this caused a considerable loss of time. The government specifications under which these shells are made require very close dimensions, and in order to provide for replacing broken cutters in the boring-bars and have them capable of working to the required dimensions without preliminary adjustment, it was necessary to provide a jig for drilling the bars and cutters so that they would be interchangeable. The accompanying illustration shows the jig designed for this purpose. The frame *A* is a cast-iron block of convenient size, in which the hole is centrally located and bored to exactly the right size to fit the boring-bar. The cutter *B*, which is to be drilled ready for assembling in the boring-bar, is held in place in the jig by two fillister head screws *C*. In this way, the cutter is made to locate the boring-bar in the proper longitudinal position in the jig. The hole is then drilled and reamed through the boring-bar and cutter to receive the tapered pin which is employed to hold the cutter in place in the bar. With this jig it has been possible to secure absolute interchangeability of boring-bars and cutters.



Drill Jig used for making Interchangeable Shrapnel Shell Boring-bars and Cutters

Hamilton, Ont., Canada. James Hamilton

MILLING FIXTURE FOR SPLITTING CYLINDRICAL WORK

The milling fixture illustrated in Fig. 1 was designed to provide a rapid means of splitting cylindrical steel pieces of the form shown in Fig. 2. Referring to the illustration, it will be seen that provision is made for splitting four pieces at a time, but the same form of fixture could be employed for splitting various numbers of pieces. The maximum number will, of course, depend upon their sizes and the capacity of the milling machine on which the fixture is used. Referring to Fig. 1, it will be seen that the fixture consists of a cast-iron base which has steel strips *A* inserted in it. The purpose of these strips will be evident by reference to the diagram of the first and second operations shown at the right-hand side of Fig. 2. Here it will be seen that the cutter is fed a little more than half way through the work, after which the work is turned over to enable the milled slot to be dropped over the steel insert in the base of the fixture. This locates the work in position for the second operation which finishes splitting the work into two equal parts.

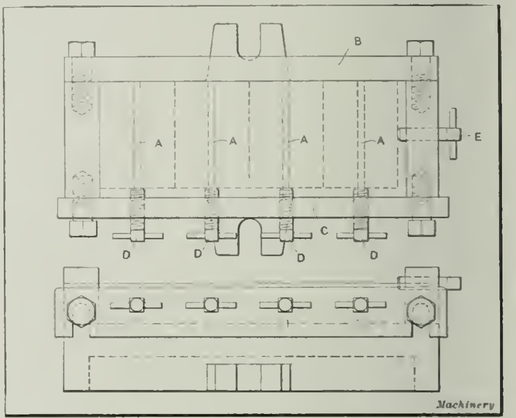


Fig. 1. Milling Fixture for Rapid Production in splitting Cylindrical Work

Referring to Fig. 1, it will be seen that the steel back plate *B* is made separate from the base to which it is secured by two cap-screws. The steel clamping plate *C* is provided with slots so that it can easily be lifted off the cap-screws which secure it to the base of the fixture, to provide for brushing out the chips; and this also facilitates the removal of finished work and the setting up of fresh blanks. The cap-screws which secure the plate to the base of the fixture should be screwed in just far enough to give sufficient clearance to enable the plate to be removed easily when the clamping screws *D* are loosened. When the work to be split is placed in the fixture, the screw *E* is tightened up just enough so that the pieces rest snugly against each other, and the cutters should be set to run 3/16 inch below the center line of the work, so that they do not have to be adjusted to complete splitting the work on the second operation.

Toledo, Ohio. William H. Wolfgang

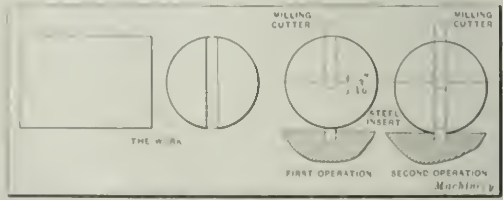


Fig. 2. Work to be split, and Diagrams showing First and Second Operations together with Method of Indexing

CAM INSPECTION FIXTURE

In gas engine factories, automobile plants, and other establishments using large quantities of cams, accurate inspection offers a very difficult problem owing to the length of time that is required to measure up the cams by hand. The device shown in the accompanying illustration performs this operation with accuracy and great rapidity. It consists of a pivoted arm *A* that is raised or lowered by the thrust of the cam which is being tested, and held in contact with the cam by a helical spring. The cam is carried on the shaft *B* which is provided with a key *C*, the cam being slowly rotated by means of a small motor located behind the slate base to which the entire mechanism is fastened.

Connection is made with an electric battery in such a manner that when the cam raises and lowers the arm *A* it closes electric circuits by making contact with the adjusting screws *D*, *E*, *F* and *G*. If the throw of the cam is too slight, no contact will be made with either of the adjusting screws *D* and *E*. If the throw is that desired, contact will be made with the screw *D* and the green electric lamp on the top of the board will flash; if the throw is too great, contact will be made with both the screws *D* and *E* and result in flashing both the green and red lamps. In the same manner, the lamps at the bottom of the board are flashed; if the diameter of the cam is too great, neither light flashes; if correct the green light shows, and if too small both the green and the red lights show. Fig. 2 shows a detail view of the contact screws. This testing device is adjusted by a master cam which has been carefully measured by hand and found to be perfect. By the use of this device the number of cams that an inspector can test is increased about fifteen times.

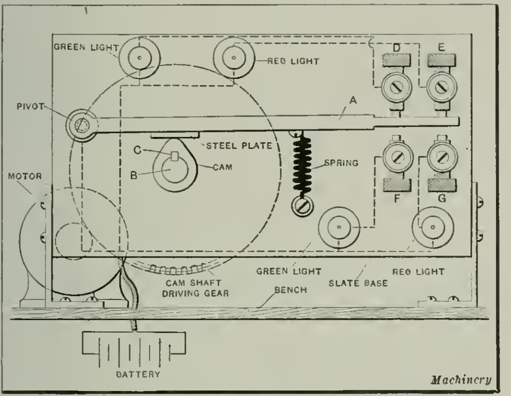


Fig. 1. Cam Testing Fixture; Heavy Broken Lines indicate Concealed Wiring

Houston, Tex. F. B. Hays

A FLEXIBLE SHAFT COUPLING

A flexible coupling for use on the driving shaft of a motor boat, and for similar classes of service where the alignment is likely to vary, is illustrated herewith. Where this coupling is used the variation of the alignment of the two parts of the shaft must be small, as the coupling is not in any sense adapted to replace a universal joint, its function being merely to compensate for slight errors in alignment of the shaft due to bending, etc. It will be seen that this coupling differs from the ordinary type of flanged coupling in that a steel ball is placed between the ends of the shafts, which are drilled in such a way that less than half of the ball drops into each hole. As a result, the two coupling members are slightly separated and the bolts may be tightened up as required by various errors of alignment. Varying the depth of the holes drilled in the ends of the shafts, and the diameter of the ball, will determine the error in alignment that can be compensated for. In assembling the coupling, the flanges are first put on the shaft as usual; then the two flanges are brought together with the ball in place and secured by bolts in the manner shown. Rubber washers are placed under the nuts and these washers are compressed and expanded as the shaft rotates.

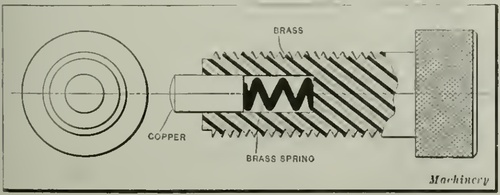
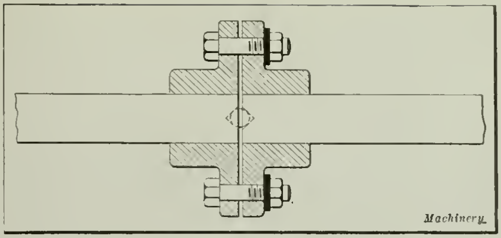


Fig. 2. Detail of Contact Screws

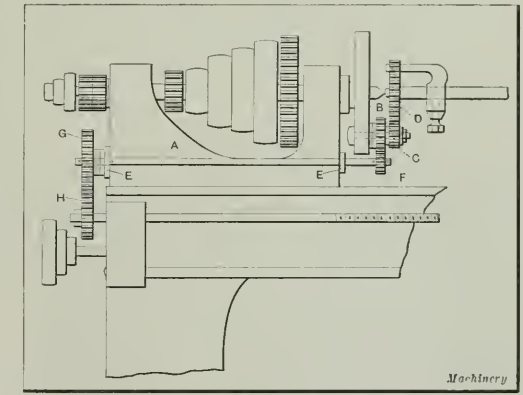


Flexible Shaft Coupling for correcting Slight Errors in Alignment

Owego, N. Y. Sidney K. Eastwood

CUTTING COARSE THREADS ON A STANDARD LATHE

It was required to refinish a double threaded worm with a lead of 7 inches, and former attempts to do this on the milling machine had not produced a satisfactory surface on the work. As a result, we decided to try to handle this job on a lathe and eventually selected a standard 16-inch machine for this purpose which was rigged up as shown in the accompanying illustration. The power was applied directly to the lead-screw, from which it was transmitted to the arbor on which the work was supported by means of gearing and a special shaft *A*. The spindle of the lathe was locked to prevent it from rotating, and it carried a large faceplate in the usual way.



Arrangement of Special Gearing for cutting a Worm of 7-inch Lead on a Standard Lathe

The necessary gearing for driving the arbor was attached to the faceplate. For this purpose, an intermediate stud taken from the quadrant of another lathe was secured in one of the faceplate slots and the first gear *B* placed on this stud had 90 teeth, while the second gear *C* had 24 teeth. A 96-tooth gear *D* taken from the change gears was fitted to the end of the arbor, the arbor being allowed to project slightly through the gear to bring the latter into line with the 24-tooth gear or stud. The arbor was driven by a dog so arranged that the end of the bent tail would pass through the spokes of the gear *D*, care being taken that the tail of the dog did not extend too far beyond the spokes of the 96-tooth gear.

Connection was made between this set of gears and the regular change gears of the lathe by means of a piece of 1-inch cold-rolled shafting *A* which was held in place by passing through holes drilled near the ends of two iron straps *E* made of 2 by ½ inch stock; these were clamped to each end of the headstock by means of long bolts reaching from one strap to the other. A 30-tooth gear *F* was used on the faceplate end of the temporary shaft and an 84-tooth gear *G* on the opposite end, these gears being obtained from the change gear set. The 84-tooth gear was arranged to mesh with the gears on the quadrant, while the 30-tooth gear was brought into mesh with the 90-tooth gear *B* carried on the faceplate. As the shaft had to transmit only a little power, a single pin was used for driving each gear, the pin being simply driven into the shaft and filed off to serve as a key.

Washers were placed between the 84-tooth gear and the left-hand strap *E* which forms one of the shaft bearings, a cotter pin at the right-hand side of this bearing acting in conjunction with another cotter pin at the left of the 84-tooth gear to effectually prevent endwise motion of the shaft. The 30-tooth gear on the faceplate end of the shaft had a cotter pin on each side of it. A 24-tooth gear *H* was put on the lead-screw, making the ratio of the train of gears $\frac{24}{84} \times \frac{30}{90} \times \frac{24}{96} = \frac{1}{42}$. Then with the lead-screw having six threads per inch, the required lead of 7 inches was obtained for the work that was to be refinished.

Power was applied to the lead-screw by throwing in the regular slip gear, connecting the lead-screw to the feed cone. The feed cone was brought into line with the large step of the main driving cone on the overhead countershaft by sliding the lathe endwise on the floor, and when connected up it was found that a 1-inch belt provided ample power. The length of the worm to be finished was 8½ inches and the carriage was set to travel 10½ inches, after which the lathe was stopped and the carriage returned by hand. This brought alternate threads on the worm into position to be cut. The feed of the cutting tool was obtained by using the compound rest which was set to afford the desired angle on the sides of the worm thread.

Scranton, Pa. LUTHER C. SCOTT

DEVELOPING A NEW MACHINE

In looking over the March number of MACHINERY, my attention was caught by James Dangerfield's article entitled "Developing a Typewriter." With the amount of information given in this article it is difficult to form a reliable opinion, but my experience in the development of new machines leads me to believe that $1400 was excessive for the amount of work that had to be done, as the "cut and try" method of development is quite likely to be; and the results obtained are almost sure to be less satisfactory than the work done by the experienced designer who has the cooperation of the other members of the staff of the machine building factory.

It has been my privilege to assist in the development of numerous inventions, including some of my own, and this experience has strengthened my opinion that a systematic method of designing is the best possible plan to follow in machine development. The following is a case in point. An exceptionally clever mechanic conceived a general idea for a new article of commercial value, but realizing that its success depended upon a low selling price he set about the development of an automatic machine for use in its manufacture. Now the building of this automatic machine was purely a designing proposition which required no inventive ability; but although this was the case the mechanic spent all of his spare time during four years, and all the money he could save, in building the model. To show how this loss of time occurred it may be mentioned that there were fourteen cams on the machine and the mechanic had cut each of these out of a block of hard wood and then used the wooden cam as a pattern.

While on the subject of cams the writer recalls a case in which he was engaged to redesign a machine in which a number of cams were used. In doing this work an operation sheet was made, from which all the cams were laid out in the proper relation of the keyways. The superintendent of the shop in which this machine was made was one of the old school of mechanics who had to fit everything in order to be sure that it was right, and he flatly refused to "spoil" all of these cams by keyseating them before they were properly timed on the shaft. It was finally necessary to go to the general manager before the superintendent could be induced to follow instructions; but when he was finally won over and the work was done it is needless to say that the results were entirely satisfactory.

In machine developments, above all things, it is impractical to follow any one general rule; but there are certain principles which may be generally applied with satisfactory results. These may be briefly outlined as follows: First, be sure there is a market for the product or that a market can be developed after it has been perfected. Second, procure the services of a high-grade machine designer or of a machine development organization of recognized ability to perfect the idea. Third, build a model and try it out under the most adverse working conditions; and while conducting this part of the work note all possible points of weakness in the construction or method of operation. Fourth, redesign the machine with a view of overcoming all points of weakness which have been discovered, paying particular attention to all points which will affect the cost of the finished machine when it is made on a manufacturing basis. Fifth, build a second model and put it to work under actual conditions for at least six months.

If at the end of this trial period the machine has demonstrated that it is of practical value, the time is ripe to consider the design of tools and the development of the methods for manufacturing the machine for the market. An inventor should rarely, if ever, be allowed to pass on the practical value of a machine or have a voice in the selection of methods of manufacture, as he will quite naturally cling to certain refinements which are of no practical value, and which add to the cost of the finished machine. To be at all sure of success, the best plan is to work slowly, to endeavor to profit by the other fellow's mistakes, and to keep "everlastingly" at it, always bearing in mind that paper, pencils and erasers are far cheaper than metal and machine work.

Woonsocket, R. I. WILLIAM C. GLASS

FIXTURE FOR MACHINING MOVING-PICTURE MACHINE CROSS-PINS

The piece shown in Fig. 1 is known as a "cross-pin" and is used on a moving-picture machine to carry the sprocket that moves the film past the aperture plate. The cross-pin is indexed through an angle of 90 degrees sixteen times per second by means of a cam which engages the short pins; and owing to the severity of the service it was found that the shaft, head and pins had to be made in a single piece. The location of the projecting pins has to be extremely accurate because the picture is magnified 250 times and sixteen pictures are shown per second. The light is shut off between each picture, and if an error occurred in the spacing of the pins it is evident that the succeeding pictures would not be shown in the same location on the screen. As the error would be magnified 250 times, an error of 0.001 inch in the pins would cause the pictures on the screen to jump through ¼ inch, which would be excessively trying to the eyes.

According to the original method of production, ten machining operations were involved in finishing the cross-pins. This method had several bad features, and as the demand for moving-picture machines increased it became imperative to develop a more efficient method of producing these parts. Several ideas were tried out which finally resulted in the development of the fixture illustrated in Fig. 2. The following operations are involved in finishing one of the cross-pins: first, the work is set up in the fixture and the tail end of the work is faced and centered on the drill press, after which

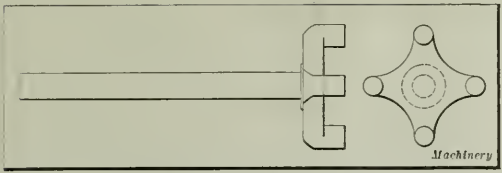


Fig. 1. One of the Moving-picture Machine Cross-pins to be milled

the head end of the work is faced and centered with the lid *B* of the fixture in the working position; the lid *B* is then swung back and the lid *A* raised into the operating position, to allow the four pins to be finished with a hollow mill; second, the shaft is turned to 0.008 inch over size on an engine lathe; third, the back of the head and shoulder are faced on the lathe; fourth, the sides of the head are milled to the required shape; fifth, the head and pins are hardened; sixth, the shaft is ground to size; seventh, the pins are ground to size, a special eccentric fixture being used.

The double lid *A* and *B* provided for the fixture was necessitated by the fact that the five bushings which are necessary could not be carried in a single lid owing to the manner in which their centers are spaced. Using this fixture, the rough forging is set up and the pins are hollow-milled while the shaft has all of its original strength, thus eliminating any tendency to spring the work during the milling operation. Since the finished shaft is only 0.3125 inch in diameter, having an extra 1/16 inch of metal present while the pins are being milled is of considerable importance in assisting the shaft to support the strain of the cut. A knurl-headed plug was made to fit freely in the bushing in the lid *B*, and a slot just large enough to receive the cross-pin was milled in the end of this plug central with its diameter, in order to enable the rough forging to be located in the fixture before the clamp *F* is tightened.

Holders were made to fit the bushings *C* and *D* to hold an ordinary combination center drill and reamer. The center drill was ground off rather short to avoid the chance of breakage. Special facing mills were made to fit the bushings, and as the centering was done first the mills did not have to cut right to the center. Suitable hollow mills were also made for finishing the pins, these mills entering the bushings in the lid *A*. All of the tools were provided with adjustable stop-collars which make contact with the bushing heads. Great care was taken to have the bushings and V-blocks properly located. The clamping device *F* afforded a rigid method of securing the work without permitting any tendency toward twisting or slipping. Two flat springs *E* hold the lids when they are swung down out of the way. It was found that this fixture reduced the cost of producing these parts 40 per cent, and the saving effected in machining the first three hundred pieces paid for the new tools.

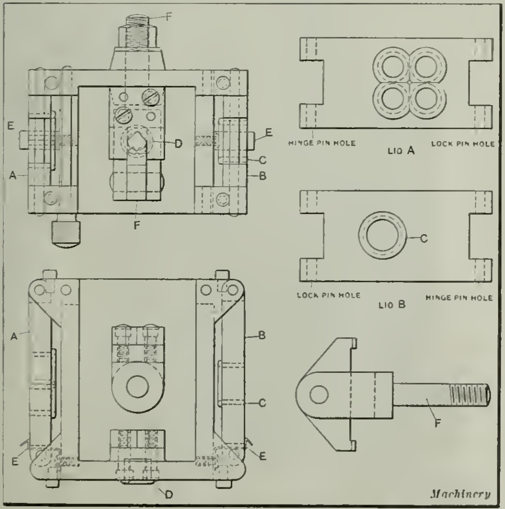


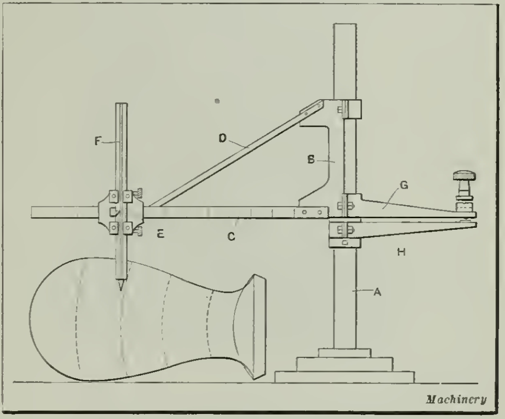
Fig. 2. Fixture and Detail Views of Lids A and B and Clamp F

Caldwell, N. J. Harry G. Thayer

THE PITCHOMETER AND ITS USE

The accompanying illustration shows a novel and convenient device for measuring the exact pitch of propeller blades. This device is a refinement of many crude fixtures made by different foremen of the machinery division of the Boston Navy Yard, and it has proved very useful in connection with the machining of built-up propellers, as it is a simple matter to establish the center line of the blade, as well as the shaft line. It will be noticed that the illustration shows a single blade set up under the arm and adjusted to the required pitch. Having the blade set up to the required pitch, the steel square is placed on the platen and a line erected through the center of the palm, which will be used for establishing the lay-out for the bolt holes as well as for setting up in case the blades are to be planed.

The general construction of this pitchometer is as follows: The tube *A* is about 5 inches in diameter with walls ¼ inch thick, the bottom end being turned tapering and fitted into the cast-iron base. The tube is threaded and has a nut fitted at the bottom for the purpose of removing the tube from the base. The tube shown in the illustration is about 8 feet long. The light cast-iron bracket *B* is machined to revolve snugly on the post *A*. Attached to this bracket is a light T-iron *C* and its supporting bar *D*. The part *E* is a light cast-iron head that slides freely on the bar *C* and carries a hard-wood T-bar *F*. Secured to the bar *F* is a 36-inch scale on which the reading can be taken from a pointer shown in the center of the head *E*. It will be noted that the T-bar *C* is graduated, the graduations reading out from the center of the post. A light cast-iron fixture *G* is secured to the bracket *B*, the end of which carries a pointer. This pointer can be notched into the graduations on the quadrant *H*; the quadrant *H* is secured to the post *A* and its upper surface is graduated from 0 to 45 degrees each way from its center.



Method of using Propeller Pitchometer

When testing the pitch of solid propellers the post is simply removed from its base and the hub of the propeller placed on the base, after which the post is inserted. The operation of measuring the pitch of a propeller is as follows: Place the slide *E* at the required diameter and then set the quadrant graduations at 0. See that the pointer rests on the blade surface and note the measurement on the scale; then swing the arm through 15 degrees, drop the pointer until it comes in contact with the surface of the blade, and the reading may be taken from the scale. For instance, say you find the drop is 8 inches in 15 degrees; by dividing 360 degrees by 15, you will find 24, and multiplying 8 by 24 gives 192 inches or 16 feet as the pitch.

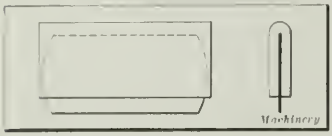
Somerville, Mass. N. I. Mosher

SHOP AND DRAFTING-ROOM KINKS

INGENIOUS MEANS AND SHORT CUTS FOR SAVING LABOR AND MATERIALS

AN EFFICIENT ERASING KNIFE

The draftsman or tracer who wishes to produce work of neat appearance will avoid making ink erasures as far as possible. But although he may be careful in making his tracings, there will always be a few places where a line extends slightly beyond its connecting line or where the arc of a circle is not exactly tangent to a straight line. In such cases, the use of a coarse ink eraser will not only mar the drawing, but it will frequently necessitate patching the tracing at the point where the erasure was made.



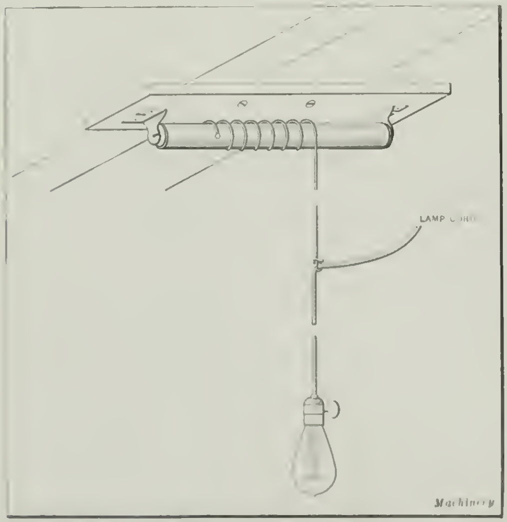
Erasing Knife made from Safety Razor Blade

Where there is not too much ink to be removed, it is best to scrape the ink off before starting to use a rubber. This can be done with a pocket knife if it is kept very sharp, but I have obtained much better results by the use of a discarded safety razor blade. With a pocket knife or other instrument which has not an exceedingly keen edge, it is difficult to remove the ink without scratching into the cloth. But with the safety razor blade, the coating of ink can be scraped off without damaging the cloth in any way. The four corners of a double edge blade can be used for a long time and the blade can be fastened into a holder to protect the fingers.

McKees Rocks, Pa. A. H. Anger

LAMP CORD ADJUSTER

The accompanying illustration shows an inexpensive form of lamp cord adjuster for use in regulating the position of an electric light over the drafting table, a machine tool or any other location where good lighting is essential. This consists of an ordinary window-shade roller, cut as short as the spring will allow and fastened to the ceiling or any other convenient support. One end of a strong cord is attached to the lamp wire and the other end to the roller. Then the lamp can be adjusted by raising or lowering it the same as a window shade. Some forms of lamp cord adjusters have a tendency to destroy the cord, but the one here described has no destructive effect on either the wires or installation.

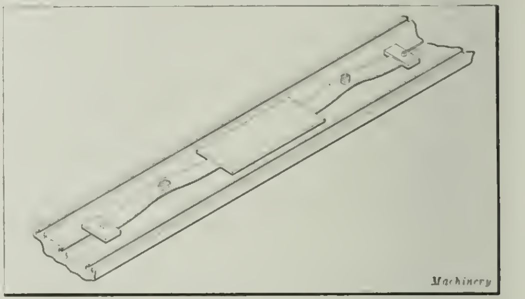


Use of a Window Shade Roller as a Lamp Cord Adjuster

South Norwalk, Conn. E. J Erickson

SPRING CLAMP FOR THIN WORK

Possibly some readers of Machinery who occasionally have to do a surface grinding job without the aid of a magnetic chuck will be interested in this description of a spring clamp which we use for work that is too thin to permit of the use of a regular clamp or too large for the vise. The work is laid loosely between two strips of cold-rolled steel about 1½ inch wide by 1/16 inch thick. The ends of these flat strips which come next to the work are supported on cross wires laid alongside of the work; and the opposite ends of the strips abut against blocks which are bolted down securely to the table. After the nuts which hold the strips have been tightened, the work is rapped down to secure a bearing on the table, after which the cross wires are pulled out to allow the strips to spring down. It will then be found that the work is held firmly in place. As compared with any other method which we have tried, this clamp possesses the advantage of being simple and of having no parts which are likely to be accidentally struck by the wheel.



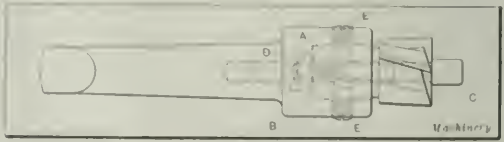
Spring Bunter for holding Thin Work, where a Magnetic Chuck is not available

Brooklyn, N. Y. John Hunting

A USEFUL FORM OF COUNTERBORE

The counterbore shown in the accompanying illustration is one that has been successfully used in our shop and given less trouble than any other type that we have tried. The parts of this counterbore are made interchangeable so that it is possible to assemble them in various combinations. The shank *A* of the cutter fits into the holder *B* with the end of the shank bearing against the shoulder in the holder which carries the thrust; and it will also be seen that the neck of the shank is slightly under-cut to facilitate grinding. The comparatively long shank of this counterbore insures perfect alignment, and yet the over-all length is only about 2 inches, which means quite a saving in the cost of tool steel. The teeth of the cutter have a rake of 15 degrees and are formed to make them free-cutting on practically any material and still afford the necessary strength and chip space. As the cutter is ground, the pilot *C* can be taken up by means of the nut *D* which bears against the back of the cutter, allowing the threaded end of the pilot to enter a hole in the holder. This holder or driver is made of mild steel carbonized and hardened, and carries two screw pins *E* which enter corresponding holes in the shank of the cutter. These pins are of ample size to drive the cutter and are hardened to prevent them from wearing.

Caleb Young



A Useful Type of Counterbore

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

CURTIS AUTOMATIC SHRAPNEL-SHELL CUTTING-OFF MACHINE

The features of this machine are that the cutters are fed in and returned automatically, the operator merely being required to place the rough forgings in the machine and remove the trimmed shells. The cutter head carries four cutters which work simultaneously, and enable a high cutting speed to be employed. As the cutter head rotates and the heavy work remains stationary, the consumption of power is reduced to a minimum. One operator can attend to three machines, each of which has a capacity for trimming from forty to sixty shells per hour.

Those manufacturers who are working on orders for shrapnel shells find high-speed production of more than usual importance, due to the fact that most of the contracts call for the delivery of large numbers of shells at frequent specified intervals. As a result, machines which are to give satisfactory service must turn out the work with the greatest possibile rapidity. Shrapnel manufacturers who are making shells by the forging process will find that this point has been particularly well provided for in the automatic cutting-off machine which has been placed on the market by the Curtis & Curtis Co., 8 Garden St., Bridgeport, Conn. With this machine, the work of cutting off the rough edges of the forged shells to reduce them to standard length can be done very quickly.

Front and rear views of the Curtis cutting-off machine are shown in Figs. 1 and 2. In the operation of this machine the workman is merely required to place the rough forging in the vise and tighten the movable jaw by means of a capstan wheel at the top of the machine. The feeding of the cutters into the work is automatically controlled by a continuous cam, which feeds them in at a uniform speed, and returns them at high speed after the cut has been completed. The cutters then start at once on their next stroke without requiring the machine to be stopped. The cam employed for this purpose is shown in Fig. 3. The maximum travel of the cutters is ½ inch, which provides plenty of time in which to put in and take out the work, and compensates for irregularities in the thickness of the rough shrapnel shell forgings. A stop-bar *A* carried by the bracket shown in Fig. 1, locates the shell ready to be trimmed down to the required length. This stop-bar extends back through the vise and comes up against the inside of the base of the shell to locate it for cutting off. The rough shells can be delivered down an inclined chute to the machine, so that the attendant does not have to leave the operating position at any time.

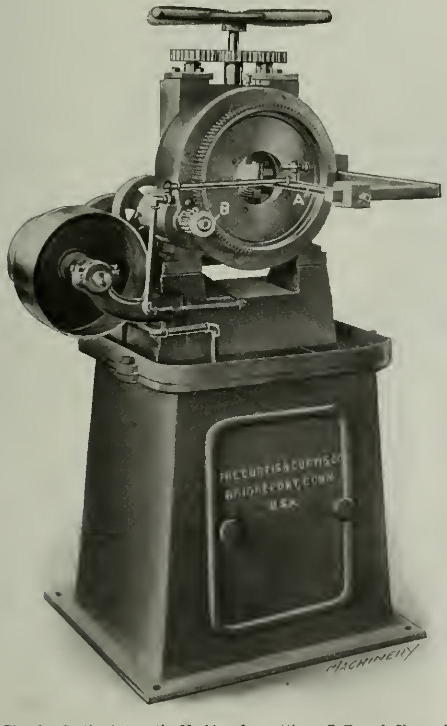


Fig. 1. Curtis Automatic Machine for cutting off Forged Shrapnel Shells to Standard Length

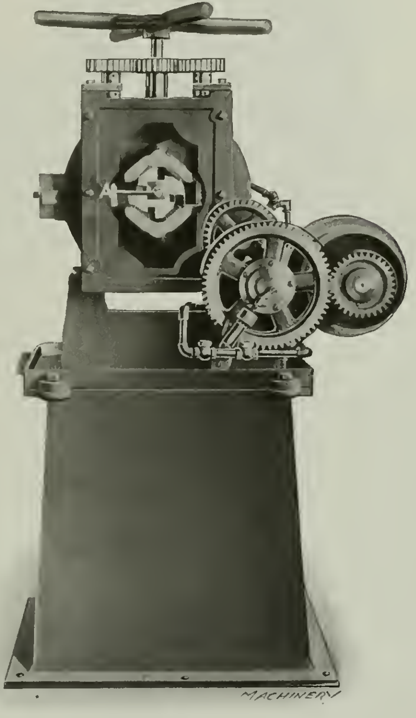


Fig. 2. Operating Side of Machine, showing Length Stop which locates Work in Vise

In these machines, the principle of rotating the light cutter head around the heavy work has been adopted, rather than rotating the heavy work inside of the cutter head. This is the means of reducing the amount of power required to drive the machine to a minimum. The cutter head is driven by a gear meshing with a pinion on the driving shaft *B*, and a second pinion carried on the outer end of the same shaft engages with gear teeth cut in the periphery of the feed cam. The ratio of these gears is such that the feed cam runs slightly faster than the cutter head, thus providing the necessary relative motion to permit the cam to feed the cutters into the work, and return them at high speed, in the manner which has already been described. This cam mechanism is a patented construction. The cutters are arranged in two pairs, one pair being pointed and the other square, in order to break up the chips and enable them to

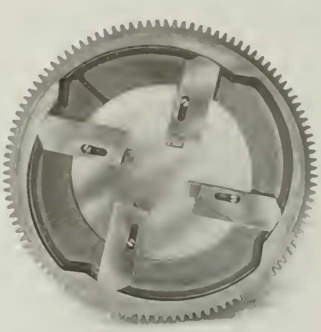


Fig. 3. Cam that controls Continuous Feed, on which a Patent has been granted

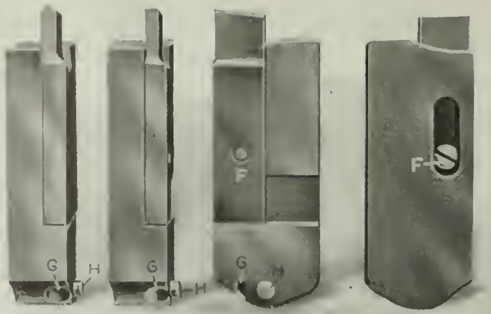


Fig. 4. Cutters removed from Head to show Adjusting and Clamping Screws; one Pair of Cutters is Sharp and the other Square

clear easily. This is in accordance with the best practice of designing tools for cutting-off machines.

It requires 1½ minute for the cam to feed the cutters in to the end of their stroke and return them to the starting position. Of this time, forty seconds is required for making the cut, leaving fifty seconds for the operator to remove the trimmed shell from the vise and replace it by a fresh forging. This is more time than is actually required, a liberal allowance having been made so that one operator will have plenty of time when operating more than one machine. The pinion which meshes with the gear that drives the feed cam is provided with a clutch shown at *C* in Fig. 5, so that the machine may be set to complete its cutting stroke at any desired time, relative to the time at which other machines in the same battery complete their cutting strokes. It has been mentioned that one operator can attend to a battery of three machines, and the provision of this clutch for synchronizing the machines is to enable the cutting strokes to be completed in rotation, so that the operator can move from machine to machine and replace the trimmed shells with fresh forgings, as fast as they are required. In this way, both the machines and the operator are kept constantly employed.

The speed of the machine is limited only by the rate at which the high-speed steel cutters can be run without requiring an excessive amount of regrinding. Machines can be built to provide any speed or feed which is required, but unless otherwise specified they will be designed for a cutting speed of 20 feet per minute, and timed to cut off a 3¼-inch shrapnel shell forging in forty seconds, giving a capacity of from forty to sixty shells per hour. Referring again to Fig. 3, which shows the cam for feeding the cutters in to the work, it will be seen that there is a groove *D* in the cam that receives a pin *H*, Fig. 4, on each of the cutter holders, to provide for holding them in contact with the cam surface. It will also be noticed that there is a transverse groove *E* which enables the pins to leave the retaining groove. This is provided for the purpose of removing the cutters from the cutter head when they need sharpening. For this purpose the faceplate of the machine has four graduations spaced 90 degrees apart. When one of these graduations is brought into coincidence with the index mark on the cutter head, it means that the groove in the cam is in such a position that one of the cutters can be removed.

The four cutters are shown in detail in Fig. 4. It will be seen that holders are provided for carrying high-speed steel blades. As the blades are ground it will be evident that compensation must be made for the amount of metal which has been removed. This is done by first loosening a binding screw *F* in the holder and then screwing in the backing-up screw at *G* to bring the cutter into the required position. After this has been done, the binding screw *F* is re-tightened to secure the cutter in place in the holder. The regular equipment of the machine includes a countershaft, oil pump, and one set of adjusting tools. The approximate weight is 1200 pounds, and the floor space required is 36 by 24 inches. In addition to its application in cutting off shrapnel shells, the machine is adapted for working on all classes of tubular stock; and when cutting such material it can work at a much higher speed.

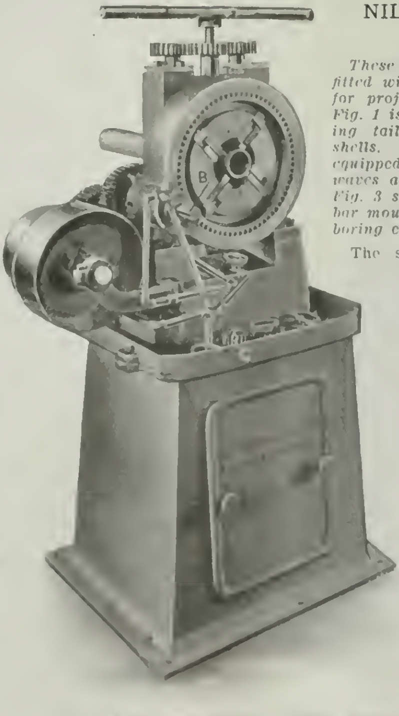


Fig. 5. Machine with Faceplate and Cam removed to show Drive for Cutter Head

NILES-BEMENT-POND PROJECTILE LATHES

These are standard Niles-Bement-Pond tools fitted with special attachments to adapt them for projectile work. The machine shown in Fig. 1 is a 26-inch lathe equipped with a boring tailstock for machining high explosive shells. In Fig. 2, a 30-inch lathe is shown equipped with an attachment for cutting the waves and grooving the band seats in shells. Fig. 3 shows a 36-inch lathe with the boring bar mounted on the carriage and arranged for boring either straight or taper shells.

The standard engine lathe can be made more efficient on shell work when equipped with certain special attachments. These attachments can be readily removed at any time and standard parts applied, thus making the machine ready for any regular engine lathe work. The Niles-Bement-Pond Co., 111 Broadway, New York City, is furnishing its lathes equipped with several types of attachments which adapt them for high production of duplicate work in the finishing of shrapnel and all sizes of high explosive shells, both of the solid and hollow forged types.

Boring Tailstock

Fig. 1 shows a 26-inch double back-geared engine lathe equipped with a boring tailstock for boring high explosive shells, either from the solid bar, or where the shells to be bored are of the hollow forged type.

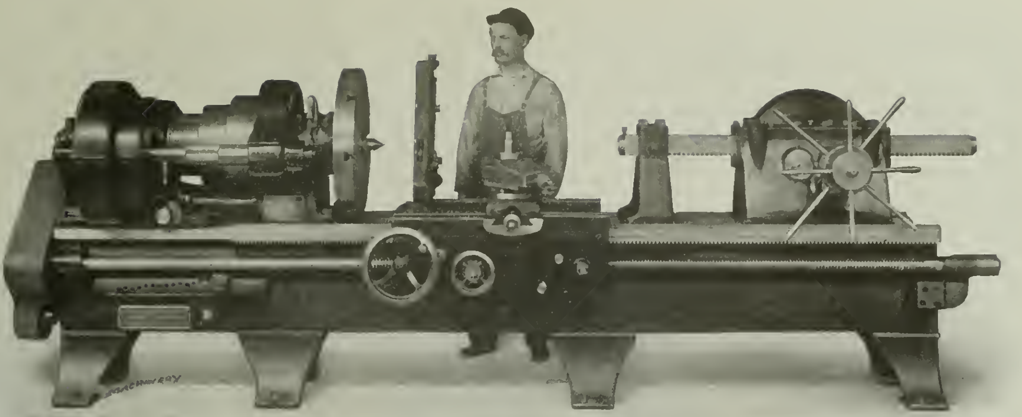


Fig. 1. Niles-Bement-Pond 26-inch Double Back-geared Lathe equipped with Boring Tailstock for machining High Explosive Shells

With the exception of the tailstock, the lathe is the standard type with certain improved features incorporated in the design. The boring tailstock and support can be readily removed and a standard tailstock applied for regular lathe work. The interior contour of the shell is obtained by the use of bottoming and forming tools built to suit the requirements of each individual job that is handled.

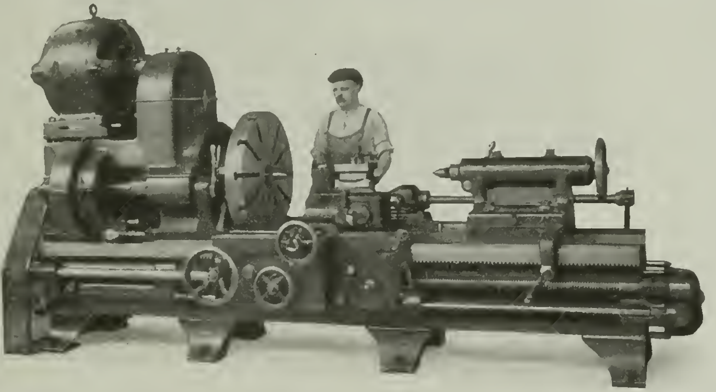


Fig. 2. Niles-Bement-Pond 30-inch Double Back-geared Lathe equipped with Attachment for cutting the Waves and Band Seats in Shells

The tailstock is fitted with a square forged steel boring ram which has power feed transmitted by a shaft geared to the driving works and running along the rear of the bed. The shaft drives through a worm and worm-wheel to the pinion and rack on the ram, which gives a smooth positive motion. Large pilot wheels are provided for hand traverse of the ram and for starting and stopping the feed. The lathe is equipped with a quick-change gear feed mechanism. To prevent vibration of the tools, the boring ram is provided with a support which can be adjusted along the bed to a position near the work. The lathe is also equipped with a standard tool carriage for turning operations; and there is also a steadyrest for supporting either a pot chuck or the shell itself as the case may be.

Attachment for Straight or Taper Boring

Fig. 3 shows a 36-inch triple-geared engine lathe equipped with a boring-bar mounted on the carriage and arranged for either straight or taper boring of shells. The boring-bar is carried in a bearing with a swiveling base mounted in the carriage. Two supports are provided for the bar, one on each side of the carriage, which consist of a bearing for the bar mounted on a slide which has cross adjustment on a substantial base. For taper boring, the support near the shell is shifted to one side of its central position and the other end support shifted to the other side of its central position. The support bearings have means of swiveling through a sufficient range for all classes of shells. The central bearing of the bar is arranged to slide in and out on the carriage with the bar. The bar can be adjusted bodily across the lathe so that the cutter can be traversed inside the shell and fed into the work, and at the same time always remain at a given taper. This is accomplished by having the slides of the supports connected by screws and gearing so that they move together when adjusted by the wrench shown on the support nearest the headstock.

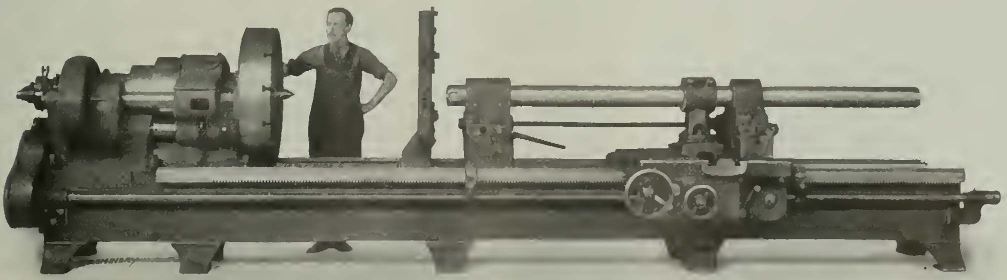


Fig. 3. Niles-Bement-Pond 36-inch Triple-geared Lathe equipped with Boring-bar mounted on Carriage

Attachment for Cutting Waves and Grooving Band Seats

Fig. 2 shows a 30-inch double back-geared lathe equipped with an attachment for cutting the waves and grooving the band seats in shells. The standard compound tool-rest has been removed from the carriage and a special rest substituted. This consists of a lower slide which is mounted directly in the carriage and has cross adjustment by a hand screw. Mounted on this lower slide there is a tool-slide. In order to obtain the wave effect, this tool-slide is given a reciprocating motion parallel with the bed while the projectile revolves. This motion is obtained by means of an eccentric carried on a cross-shaft which is journaled in the cross-slide. This cross-shaft is driven by bevel gears from a shaft located along the back of the lathe. The latter shaft is geared to the main spindle of the head and suitable change gears are provided for obtaining the number of waves per revolution required on different sizes and types of shells. The eccentric is adjustable to produce the desired amount of wave. The depth of the wave rib is determined by the shape of the formed tool. On lathes equipped with this attachment, it is customary to furnish also a four-sided turret toolpost on the rear of the carriage, as shown in the illustration. This permits all the operations on the band seat to be performed at one setting of the projectile in the lathe.

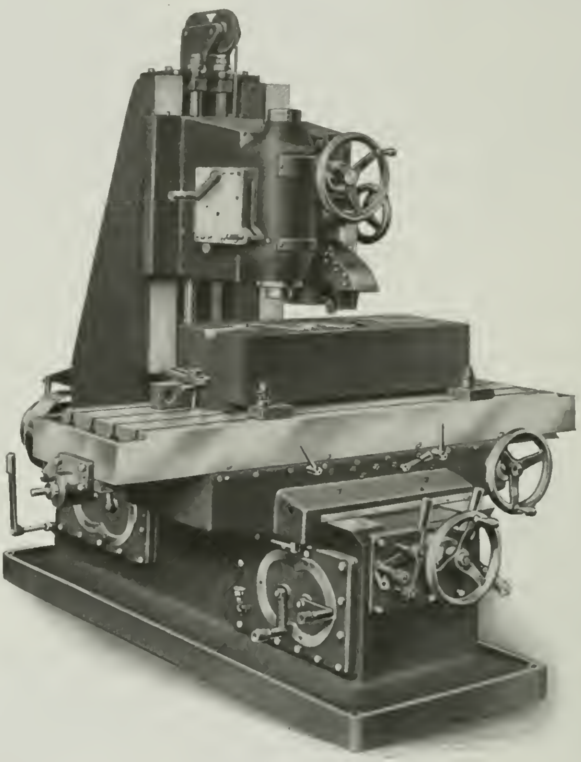


Fig. 1. Jackson No. 8 Duplex Die-sinking Machine

JACKSON DUPLEX DIE-SINKING MACHINE

This machine is known as the No. 8 Jackson die-sinker and is particularly adapted for working on heavy drop-forging dies of the type used in the manufacture of camshafts, crankshafts, front axles, etc. It differs from other die-sinking machines of this company's manufacture in that the vertical feed is obtained by the travel of the head on the column, instead of employing the knee form of construction. The head is equipped with a vertical spindle and a cherrying attachment.

For use in making the drop-forging dies employed in the manufacture of crankshafts, camshafts, front axles, and similar parts, the Jackson Machine Tool Co., Jackson, Mich., has developed a duplex die-sinking machine which is known as the No. 8 Jackson die-sinker. To provide for supporting the large die blocks required for the class of dies made on this machine, the design has been worked out with the view of obtaining ample rigidity in all parts of the machine. The base is heavily ribbed and contains the gears which provide the changes of speed and feed. These gears are of coarse pitch, and made of hardened high carbon steel. The gears run in oil, and the shafts on which they are carried are hardened and ground. The present machine differs from the smaller die-sinkers of this company's manufacture in that it has no knee, the vertical movement being obtained by the movement of the head on the column. On this machine it is possible to do all of the work on a die at one setting.

The saddle has a bearing 24 inches long by 23 inches wide on the base, and the sides are extended to support the table. The working surface of the table is 18 by 64 inches; it is heavily ribbed and of exceptional thickness. The T-slots have a liberal amount of metal above them so that there is no danger of breakage when heavy strains are applied for holding large work. It will be seen that the head is of the duplex type, in which there is a vertical spindle carried in taper boxes to provide compensation for wear, and a ball thrust bearing to carry the end load. The spindle has a hole through its entire length, so that a draw-in chuck can be used, the hole being No. 13 B. & S. taper. A chuck and five collets are furnished with the machine as part of the regular equipment. The cherrying or secondary head is provided with a vertical movement of about 3/16 inch on the return stroke, so that the cutter is cleared from the work. When not in use, this head is raised about 3 inches so that it is out of the way while the vertical spindle is at work. It will be noticed that the housing of the cherrying head is cut away at the front in order to allow the head to be operated close up to a breakdown when the die on which the machine is working is made in this way.

Power is delivered to the machine from the 14-inch Edgemont clutch pulley which should run at 270 revolutions per minute. The clutch can be controlled from either the front or back of the machine, the levers provided for this purpose being shown at *A* and *B* in Fig. 2. The drive is carried to the speed-box *C* where provision is made for obtaining any of nine changes of speed for the spindle or cherrying strokes. Spindle speeds of 45, 64, 84, 110, 157, 206, 270, 385, and 505 revolutions per minute are available. The obtainable strokes of the cherrying attachment are as follows: 15, 21, 28, 36, 52, 69, 90, 128, and 168 strokes per minute. The drive is carried from the speed-box to the head through a train of bevel and spur gears and a vertical shaft, the end thrust of the shaft being carried by ball bearings in the base.

A second shaft leads from the speed-box *C* to the feed-box *D* at the front of the machine, in which gears are provided that give nine changes of feed in all directions, as follows: the vertical feeds per stroke range from 0.0003 to 0.010 inch, and the horizontal feeds from 0.001 to 0.030 inch. The speed reduction is taken care of before reaching the feed-box, so that the feed gears run at relatively slow speeds. All feed motions are controlled by levers located at the front of the table where they are within easy reach of the operator. The cross-feed is controlled at *E*, the vertical feed at *F*, and the table feed at *G*. All feed motions are reversible. The saddle is counterbalanced and provided with hand adjustment in addition to the power feed. The provision of the clutch lever *H* makes it impossible for the operator to engage the cherrying attachment and the vertical spindle at the same time.

The design of the cherrying attachment is shown in Fig. 3. The power is delivered to the cherrying spindle by a link and crank motion which is operated by a cam. This repre-

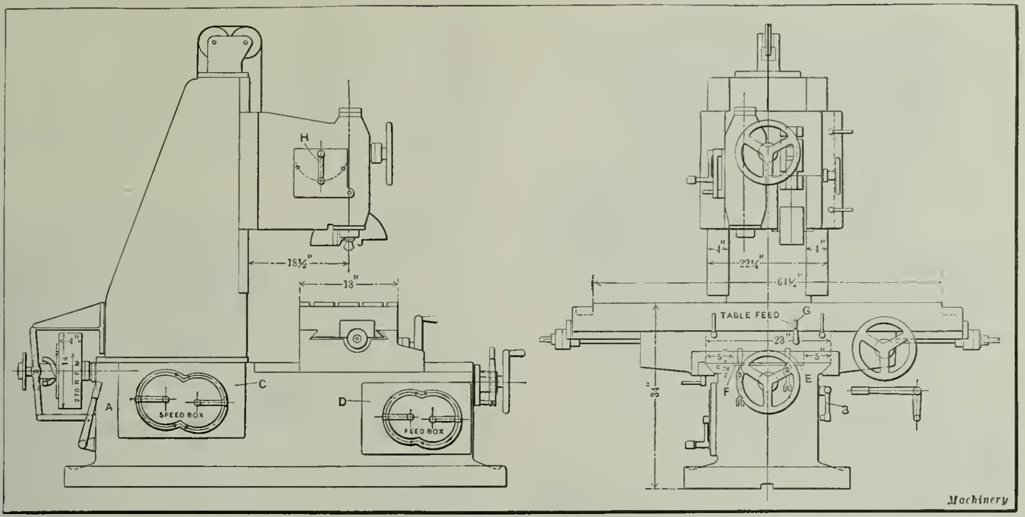


Fig. 2. Side and Front Views of the Machine, showing Arrangement of Drive and Control of Various Movements

sents a departure from the design employed on other die-sinking machines manufactured by the Jackson Machine Tool Co., in which the motion is obtained through a rack and pinion. The cherrying attachment can be raised by the hand-wheel *J* and held up by the locking pin *K*, so that it is flush with the base of the saddle and does not interfere with the working of the vertical spindle. It will be seen that a square section has been cut away from the cherrying attachment at *L* to allow the cutter to operate close up to a breakdown when dies are so made. A vertical movement of 3/16 inch is provided for the cherrying cutter so that it clears the work on the return stroke.

The principal dimensions of the Jackson No. 8 die-sinking machine are as follows: vertical movement of head, 22 inches; cross travel of table, 18 inches; longitudinal travel of table, 56 inches; working surface of table, 18 by 64 inches; distance from center of spindle to face of column, 18½ inches; size of driving pulley, 14 inches diameter by 4 inches face width; capacity for driving cutters from ¼ to 4 inches in diameter; and net weight of machine, 8000 pounds. If the machine is arranged for individual motor drive, a five-horsepower constant-speed motor should be employed.

BRIDGEPORT UPRIGHT SURFACE GRINDER

The machine shown in the accompanying illustrations is a recent product of the Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn., and is adapted for surface grinding operations on work that can be held by hand or laid on the grinding face of the wheel. The wheel is held in a Bridgeport chuck, the body of which is a solid steel casting that is made thicker near the front edge where most of the strain comes. The chuck is turned to a uniform taper on the inside and is provided with a number of plain independent jaws, the number depending upon the diameter of the chuck. These jaws are operated by a screw in the back end of the body casting, which moves them in or out as desired. A long hub on the inside of the body is splined on the spindle, and affords a long bearing surface to keep it in alignment. The outside of this hub is threaded so that a backing-up plate can be screwed onto it. This plate is screwed up against the back of the wheel as fast as the wheel is worn away, and provides a very satisfactory means of supporting the thrust of the work against the wheel.

The chuck is mounted on a steel spindle which runs in bearings of ample proportions. The upper bearing is made with a taper bronze bushing and lock-nuts to provide means of compensating for wear. The lower bearing is equipped with a radial and a thrust bearing. As the wheel wears away, it is raised to the proper height by releasing the chuck jaws and advancing the back plate on the threaded hub in the manner which has already been described. The spindle is locked during this operation by means of a pin or bolt on the side of the base, which slides into a hole

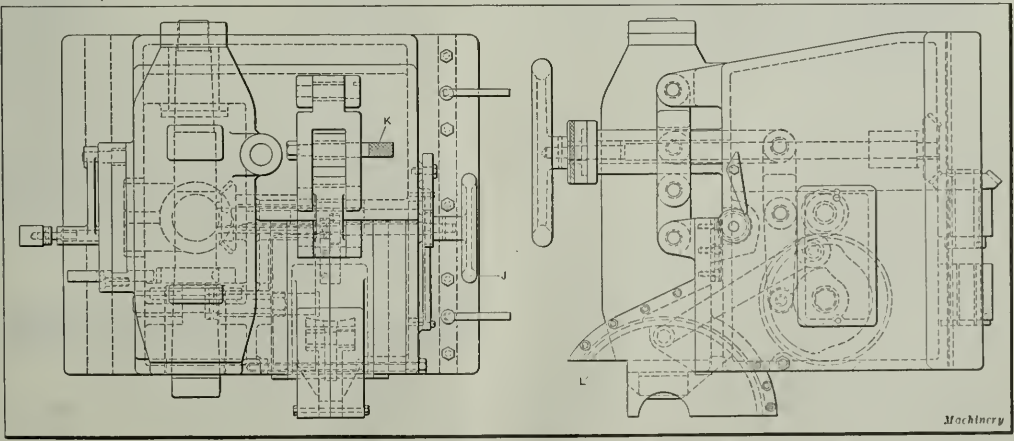


Fig. 3. Design of Cherrying Attachment; note Provision made at L for operating close to a Breakdown

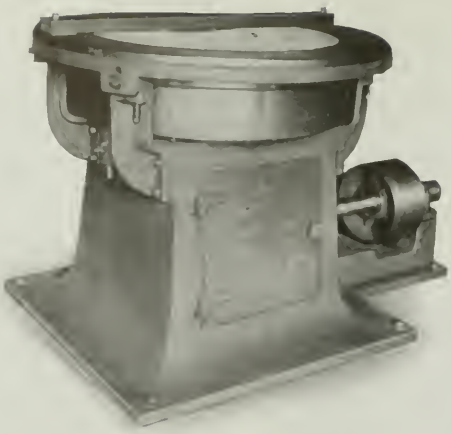


Fig. 1. Bridgeport Upright Surface Grinding Machine

on the under side of the chuck.

There is a steel cross bar 1¼ by 3 inches in size, which is bolted across the top of the work-table. A slide rest is attached to this bar to provide for carrying the wheel truing device. This cross bar also forms a stop for large work placed on the wheel, so that the work can come up against it and be prevented from moving with the wheel. A large circular table surrounds the wheel, and the work can be set on this table preparatory to moving it over the wheel. The principal dimensions of the machine are as follows: height from floor to top of table, 37½ inches; size of grinding wheel, 30 inches diameter by 8 inches face width, with a hole 10 inches in diameter; diameter of work-table, 42½ inches; floor space occupied, 65 by 40 inches; and weight of machine, 3550 pounds.

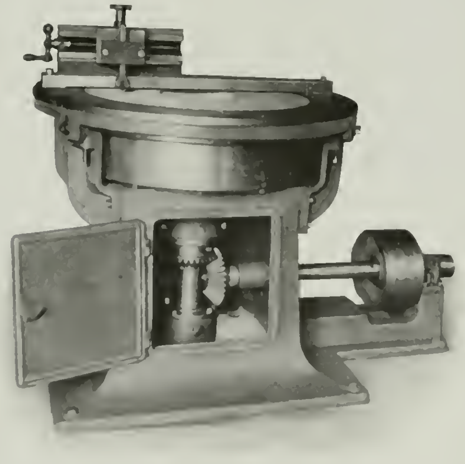


Fig. 2. Machine shown in Fig. 1 with Wheel Truing Device in Place on Cross Bar

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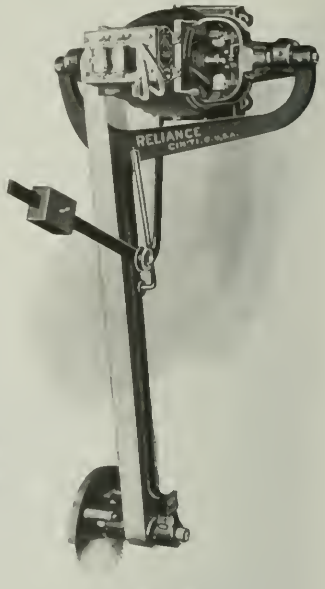
RENO-KAETKER SWING SAW

The swing saw which is shown in the accompanying illustration is manufactured by the Reno-Kaetker Electric Co., 610-616 Haymiller St., Cincinnati, Ohio, and is known as the "Reliance" swing saw. The design of this machine has been worked out to meet the requirements of the packing rooms of manufacturing plants in which the product is being crated for shipment. It will be seen that the motor and saw are combined in a single unit which can be set up in any convenient position. As it is merely necessary to carry two power wires to the motor, it will be evident that the installation is a very simple matter. The whole outfit is held in place by four bolts.

The motor is equipped with an automatic starter, and is started and stopped by an ordinary knife switch. The frame is made up of a cast-iron base and a cast-iron arm. The saw is counterbalanced so that it swings back automatically when the handle is released. These saws are made in three different sizes to provide for cutting practically all thicknesses of lumber. The No. 201 saw is adapted for 10, 12-, or 14-inch saw blades; it is equipped with a 2-horsepower motor, and will cut lumber up to 2 inches in thickness. The No. 203 saw is adapted for saws from 16 to 24 inches in diameter; it is equipped with a 3- or 5-horsepower motor, depending on the kind of material to be cut, and is adapted for all work up to 5 and 6 inches in thickness. The No. 204 saw will take blades from 24 to 36 inches diameter; it has a 7½- or 10-horsepower motor, and is suitable for use in railroad shops or lumber mills where heavy work is done.

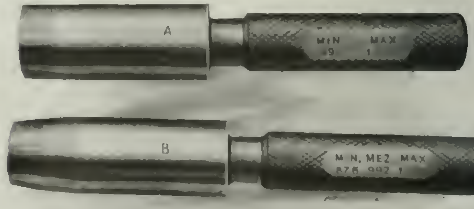


"Reliance" Swing Saw made by the Reno-Kaetker Electric Co.

ROGERS TAPER-END PLUG GAGES

The taper-end plug gages, which are illustrated and described herewith, are made by the John M. Rogers Works, Inc., Gloucester City, N. J. These gages are tapered at the end which enters the work, making it possible for the mechanic to quickly insert the gage into the hole and determine the amount of stock which still remains to be removed. In this way they serve the same purpose as the standard form of plug gage, and at the same time provide for determining the amount of stock which remains to be removed. Obviously they can be used far more rapidly than a caliper, and there is no chance for making a mistake in transferring sizes.

In addition to the advantages which have already been mentioned, the taper end of the Rogers plug gages makes it an easy matter to enter them into accurately finished holes. The gage marked *A* is intended for testing the size of work on which an accurate finishing operation is being performed. The end of this gage has a single taper. If, however, the gage is required for testing work on which



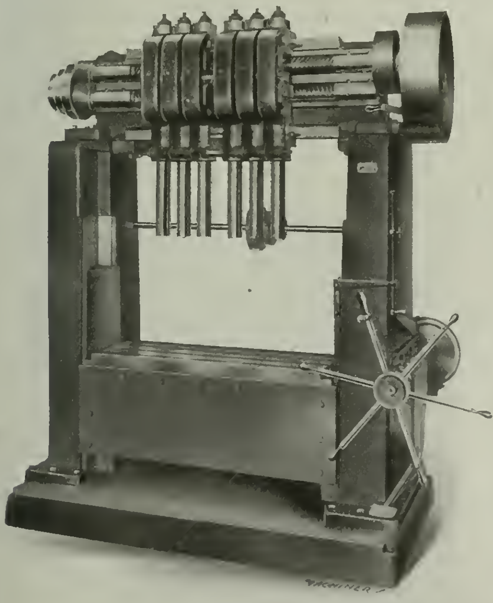
Rogers Plug Gages. Gage A is for Finished Work and Gage B for Work on which both Roughing and Finishing Cuts are to be taken roughing cuts are being taken, as well as work on which finishing operations are being done, the gage employed is of the form shown at *B*. It will be seen that this gage has a double taper, the amount of each taper being altered to suit the requirements of different classes of work. The maximum and minimum sizes are marked on gage *A*; and gage *B* has these sizes indicated, in addition to the intermediate size which is marked "mez."—an abbreviation of mezzo or medium.

MOLINE CYLINDER BORING MACHINE

The machine which forms the subject of this article is a recent product of the Moline Tool Co., Moline, Ill. It is known as the No. 5-D cylinder borer and was designed to give a high rate of production on automobile cylinders—especially on the type where six cylinders are cast *en bloc*, with the crank-case an integral part of the cylinder block. When working on cylinders of this type with many types of machines, there is an excessive amount of overhang, but in the Moline No. 5-D cylinder borer this difficulty has been overcome.

The machine is made in one standard length with 4 feet between the knees; but it is built with different heights from the table to the spindles in order to accommodate different styles of cylinders. The knees have a bearing 42 inches in length and are provided with bronze tapered wedges to take up side wear. The feed is obtained by double 6-pitch racks which have a face width of 3 inches; these racks mesh with pinions cut in the 3½-inch feed shaft. Nine changes of feed are provided, ranging from approximately 1/64 to 3/16 inch per revolution of the spindle. The spindles are driven by 4-pitch bronze and steel spiral gears. The table is of box section; it is 18 inches wide by 4 feet long and about 18 inches deep.

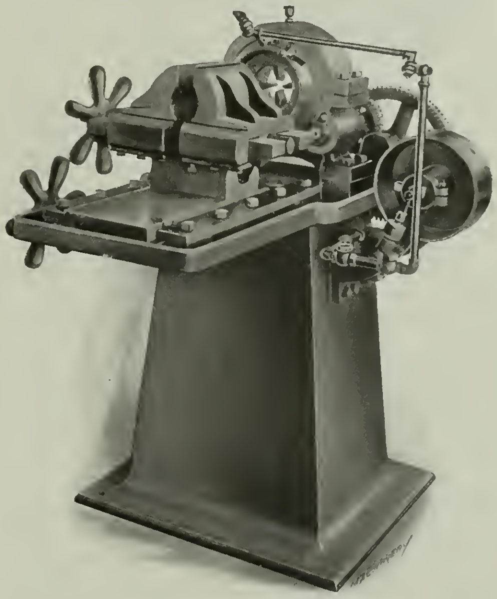
Two types of heads are furnished on the machine, one with the sleeve extending down to the spindle nose, and the other with the spindle nose extending beyond the bearing, so that it can be guided in a bushing in the jig if so desired. Different sizes of heads can be furnished, ranging from a minimum adjustment of 3 inches up to any size that is required. The pilot wheel is located at the right-hand side where it will not interfere with setting up work on the machine and removing the finished cylinders. The drive is from a two-speed friction countershaft which carries pulleys 24 inches in diameter by 6 inches face width. A brake is provided on the main driving pulley to enable the machine to be stopped quickly. All thrust loads are carried by ball bearings, and all high-speed bearings are bronze bushed, while the low-speed bearings are bushed with cast iron.



Moline No. 5-D Cylinder Boring Machine

CURTIS PIPE AND BOLT THREADING MACHINE

A recent addition to the line of pipe machines made by the Curtis & Curtis Co., 8 Garden St., Bridgeport, Conn., consists of a bed-type of machine which is illustrated and described herewith. In operating this machine, the work is clamped in the vise by hand, and the feed of the work to the die head is also hand operated. After the threading operation has been completed, the die head is opened; and in cases where the machine is working from bar stock or a long piece of pipe, the work is then moved on through the die head into such a position that the cut-off attachment can be employed to cut off a piece of the required length.

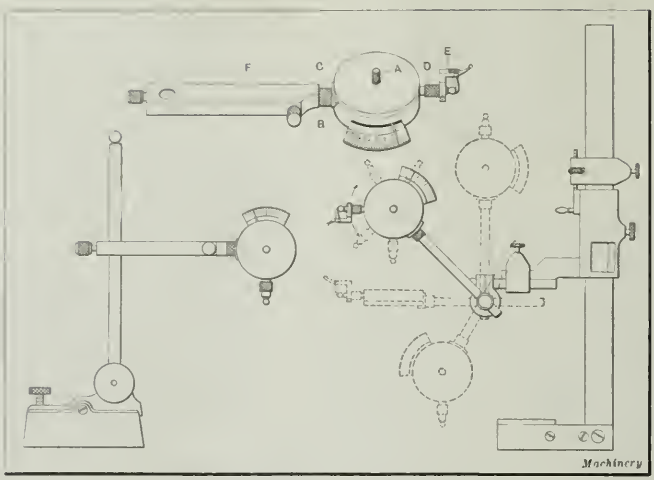


Curtis Pipe and Bolt Threading Machine

The die head employed on this machine is of the well-known type which has been used on Curtis & Curtis pipe-threading machines for a number of years. The head is graduated so that it can be set for threading pipe or bolts of any diameter; and after this preliminary setting has been made, the dies are clamped in the required position. A stop is then set for this position. Then in the operation of the machine it is merely necessary to close in the dies until the stop is engaged, after which the die head is clamped in position for the threading operation. After the thread has been cut, the clamp is released to provide for opening the dies. The benefit of this arrangement is that it enables the die head to be set much more rapidly than could be done if it were necessary to refer to a graduated collar every time the dies were opened. Furthermore, the setting may be made rapidly in a place where the light is very poor.

FUCHS UNIVERSAL TEST INDICATOR

In the universal test indicator which has recently been placed on the market by the Leon Fuchs Mfg. Co., P. O. Box 216, Dayton, Ohio, the following are features which are of importance to the user: Accuracy, high magnifying power, extreme sensitiveness, and universal adjustability, combined



Fuchs Universal Test Indicator and Two Methods of mounting it

in a simple instrument which is constructed to withstand hard usage. There are no intricate parts to get out of order or delicate parts which are likely to be broken. The indicator is applicable for measuring either flat or curved work, and can be employed for making internal or external measurements. The contact feeler for both internal and external use may be adjusted to any radial position throughout an entire circle without changing the position of the indicator, making it easy to read. It is accurate in all positions.

To adjust the contact feeler, the knurled stud *A* is loosened and the head rotated to the desired position. The stud *A* is then tightened to secure the feeler in the required position. In order to vary the tension of the rotatable head, the friction shoe *C* is adjusted by means of the knurled nut *B*. The internal feeler *E* may be slipped off the stem *D*, or it may be rotated to different positions, as desired. The holder *F* is used in securing the instrument in the toolpost of a machine. When the indicator is to be used on a stand of a surface gage, height gage, or other tool of this character, the holder *F* is removed. The readings of the instrument are in 0.001 inch, and the range is 0.024 inch. The pointer is provided with an automatic take-up which eliminates undue vibration and lost motion. All bearings and contacts are made of hardened steel, and the instrument responds quickly to any variation in the work. A plush-lined case can be supplied for the indicator, although this is not regularly provided.

BROWN & SHARPE SPIRAL MILLING ATTACHMENT

A recent addition to the line of milling attachments manufactured by the Brown & Sharpe Mfg. Co., Providence, R. I., is a spiral milling attachment designed for handling heavy classes of spiral cutting. This attachment, which is used in combination with a spiral head, is made in four sizes, making it adaptable to practically the entire line of plain and universal milling machines manufactured by this company. Fig. 1 shows the attachment in place on the machine. It will be noted that the method of clamping to the overhanging arm as well as to the face of the column insures rigidity, and makes the attachment practically a part of the machine. To facilitate handling, provision is made for fastening a hook at the top of the attachment. The spindle is hardened, ground, and runs in phosphor-bronze boxes having means of compensation for wear. It is driven from the machine spindle by hardened steel spur and bevel gears, as shown by the vertical section, Fig. 2; and can be set at any angle in a horizontal plane, the position being indicated by graduations reading to one-half degree.

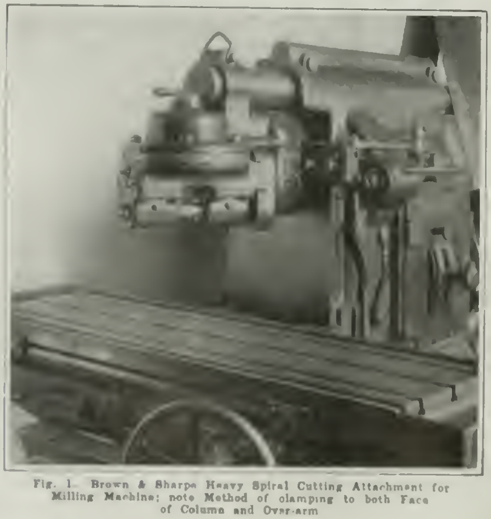


Fig. 1. Brown & Sharpe Heavy Spiral Cutting Attachment for Milling Machine; note Method of clamping to both Face of Column and Over-arm

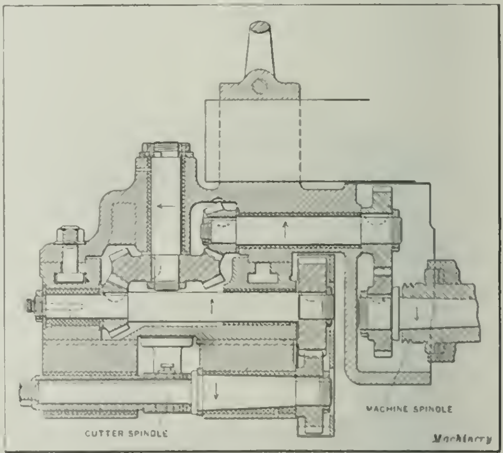


Fig. 2. Vertical Cross-sectional View of Attachment, showing how Drive is taken from Machine Spindle

To insure rigidity and to enable heavy cuts to be taken, the cutter spindle is provided with an outer bearing which can be easily removed when placing a cutter in position. The inner spindle bearing is adjustable, the adjustment being made by a screw having a graduated dial on the front end of the attachment which reads to 0.001 inch. This adjustment is valuable when setting the cutter central with the swiveling point or when off-setting the cutter any definite amount. A suitable gage is provided to enable the cutter to be set central with the swiveling point. This gage slides in V-ways on the attachment, a thumb-screw clamping the gage at any desired distance from the cutter spindle. The regular machine spindle speed change mechanism is used to obtain the different cutter speeds. All gears and wearing surfaces are enclosed, preventing injury from dust and dirt, as well as giving a neat and compact appearance, as will be seen from the illustration.

PERSONS-ARTER "MODEL A" ROTARY SURFACE GRINDER

The following are features of this machine which add to its efficiency of operation. The wheel-slide is provided with a reversing mechanism which enables it to work on an exceptionally short stroke, the range being for strokes from ½ inch up. To provide for truing the wheel, the drive for the chuck spindle and wheel-slide are independent so that the truing device may be mounted on the chuck and have the wheel reciprocated across it. The belt tension is maintained by a compensating idler which absorbs all shocks and gives an unusually smooth drive. All parts of the machine are made exceptionally heavy so that the maximum rigidity is obtained.

The rotary surface grinder shown in the illustrations presented herewith is the product of the Persons-Arter Machine Co., Worcester, Mass., and is one of a line of grinding machines that this company is putting on the market. This machine is intended for the rapid and accurate grinding of such work as the ends of bearing races, thrust washers, piston rings, etc. The "Model A" machine has a capacity for handling work up to 8 inches in diameter. It is believed that 90 per cent of the commercial rotary surface grinding done comes under 8 inches in diameter and for that reason an 8-inch machine was designed. Although the nominal capacity in diameter is 8 inches, the machine has a swing clear of the front edge of the wheel of 10¾ inches, allowing of grinding work which projects beyond the circumference of the chuck. A 10-inch chuck can therefore be used on the machine if required. As the vertical travel of the table is 11¼ inches, with a 12-inch wheel on the spindle, the highest piece of work that can be ground with a full size wheel is 11 inches, while work up to 13 inches deep can be ground by using a smaller wheel.

From Fig. 1 which shows the front view of the machine and Fig. 2 which shows the machine from the rear, it will be seen that the design is especially heavy. The base casting weighs 985 pounds; and the head is proportionately heavy. By following these heavy construction lines throughout, maximum rigidity for the machine is secured, which assists in eliminating vibration when grinding.

Fig. 3 shows the machine in front, rear and side elevation. In the end elevation the relation between the sliding head and the base of the machine is readily apparent. The distance between the centers of the ways is 10 inches and one way is of V-type while the other is flat—thus insuring a true movement of the head. The head and base have a sliding contact of 27 inches and even when working at maximum diameter, the ways are not uncovered for a length of more than 1 inch. Dust and grit are effectively kept from both slides by a canvas protection, attached at one end to the front of the head and at the other end to the top of the chuck spindle slide.

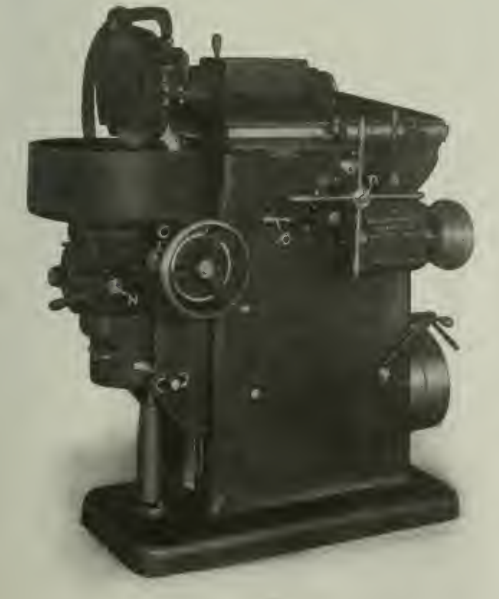


Fig. 1. Persons-Arter "Model A" Rotary Surface Grinder

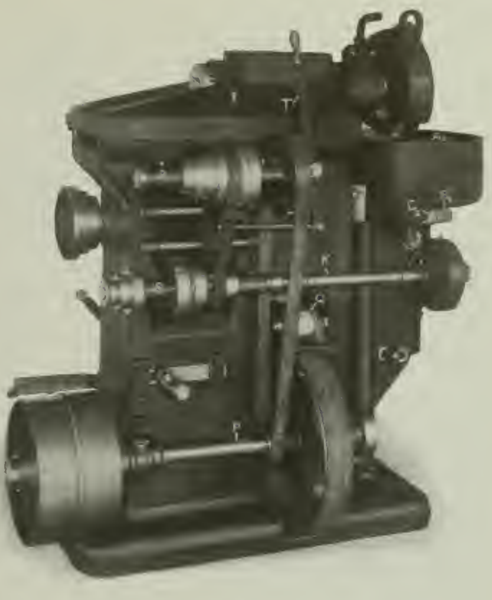


Fig. 2. Opposite Side of Machine shown in Fig. 1

The Spindle and Its Bearings

The wheel spindle is shown in detail in Fig. 4. It is mounted as low on the sliding head as is practicable, and is 2 3/16 inches diameter, made of chrome-nickel steel, heat-treated, and runs in bronze bearings 4½ inches long and located 16½ inches from center to center. These bearings are of the split tapered type, thus providing for take-up in case of wear. The spindle and its bearings are protected from dust for the full length and yet are readily accessible by the removal of a plate from the top of the slide. Attention is called to the precautions taken for keeping dust from the spindle bearings. At the head end of the spindle the front face of the bearing cap is channelled out to allow a projection *A* on the spindle nose to pass it. This spindle nose projection has a groove *B* to pocket any dust or grit before it can pass the "lock." A second safeguard is a groove *C* on the spindle beyond the lock and should any dust pass this point, a deep internal groove *D* in the bearing cap forms another and third obstruction. The grinding wheel is entirely enclosed but can be exposed by loosening a thumb-nut at the front and removing the wheel cover plate.

Referring now to the opposite end of this illustration, Fig. 4, the method of controlling the end thrust of the spindle may be seen. A hardened and ground bearing flange *E* is bolted to this end of the spindle and a bronze nut *F* on the outer end locates the flange against a bronze seat on the end of the slide. The spindle bearings are oiled directly through oil holes leading to the top of the slide.

The Chuck Spindle Mechanism

Fig. 5 shows the chuck spindle and its operating mechanism in section. The chuck spindle slide runs in broad bearings and the adjusting gib is made "fool-proof" by being tapered from end to end, and therefore, for adjusting requires only the turning of a screw at the top that advances or withdraws the gib—automatically changing the adjustment equally at all points of the slide. The slide is raised or lowered by the handwheel shown in front of the machine in Fig. 1. This handwheel turns a short shaft on which is a bevel gear that meshes with the bevel gear *G* that may be seen on the elevating screw *H* in Fig. 5. The thrust is taken against a ball

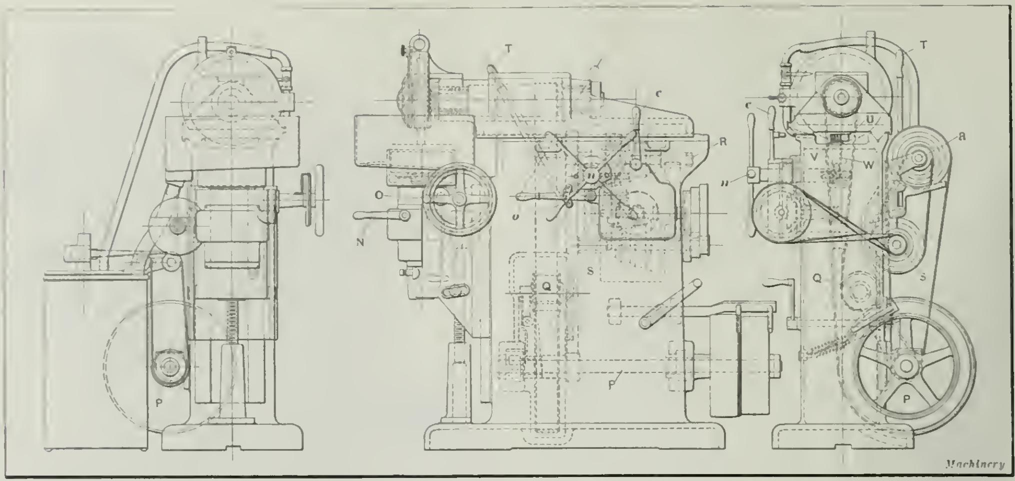


Fig. 3. Front, Rear and Side Views of Persons-Arter "Model A" Rotary Surface Grinder

bearing *I*. The chuck spindle, as shown in Fig. 5, is guided at the top by a bearing of tapered type, having a bearing angle of 65 degrees from the horizontal. The lower bearing, 12 inches below, is made of cast iron, as its only work is to steady the spindle. The top bearing receives the spindle thrust by means of a hardened and ground tapered collar *J*. Lubrication is by means of a spiral oil groove in the bearing collar that carries the oil up to the top of the collar; it then flows back down the bearing by means of a straight groove. The bearing is thus lubricated by the oil going up as well as coming back.

From Fig. 2 an idea of the way the chuck spindle drive is secured may be obtained. At the front end of the machine may be seen the driving shaft *K* for the chuck spindle. This terminates in a spiral gear of bronze that meshes with a cast-iron spiral gear *L* running loose on the chuck spindle, as shown in Fig. 5. Midway on the spindle is a clutch collar *M* slidably keyed to the spindle, and when the clutch lever *N* is thrown, teeth on the lower face of the clutch collar engage teeth on the upper face of the gear, and the gear is thus made to rotate the spindle. This permits the chuck spindle to be stopped independently of the wheel-slide traverse; this is one of the important features of the machine. One of the advantages in being able to stop the chuck spindle independently is in truing the wheel, when, of course, it is desirable to stop rotation of the chuck spindle and still have an automatic traverse to the slide carrying the wheel spindle.

The entire chuck spindle and its mechanism is pivoted at pin *O* on the slide so that any degree of concave or convex surface may be obtained within a range of 5 degrees in either direction from the center. Finished bosses are left on the main casting of the machine near the chuck slide, so that a vertical feeding mechanism may be applied if desired. The wheel spindle slide drive and the chuck spindle drive are from the same shaft, being thereby interlocked so that the same relative feeds between the chuck spindle and the wheel spindle slide drive are maintained, being proportionate to the number of revolutions of the chuck.

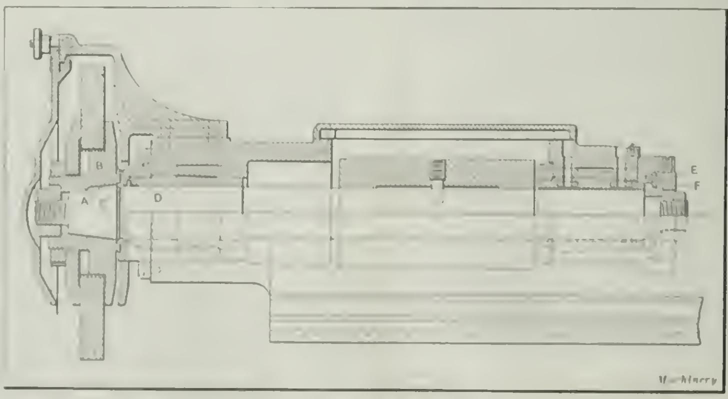


Fig. 4 Design of Wheel Spindle

The Wheel Spindle Drive

Having now taken up in detail the construction of the wheel and chuck spindles and their slides, it will be in order to describe the mechanism for driving the spindle. This can best be studied from Figs. 2 and 3 that show the rear side of the machine. The main drive shaft *P* may be seen low down upon the machine, and rotation is received over a tight and loose pulley at the left-hand end. An extremely large diameter pulley on the opposite end of this shaft transmits the drive directly to the wheel spindle of the machine. The arrangement of this drive may best be seen in Fig. 3, which shows the machine in end elevation. A feature of this drive is the application of a flexible idler pulley *Q*, whose function it is to keep the belt under the proper driving tension all the time, and to receive all shock or strain that might be transmitted to the spindle from the inaccuracy of the belt drive. As shown in Fig. 3, this idler is spring-controlled and the arm upon which it is mounted is free to change its position under any pressure. The machine is stopped or started by throwing the belt from the loose pulley to the tight pulley, or *vice versa* by means of a hand lever that is best shown in Fig. 1 at the front of the machine. This lever operates a shifter bar that acts directly on the belt. The main drive is transmitted through a 3½-inch belt, while the wheel spindle is driven by a 3-inch belt, thus supplying ample power for taking heavy "hogging" cuts.

From the driving shaft, rotation is carried to an intermediate shaft *R*, plainly shown in Fig. 2, and on this shaft is a four-step cone pulley that carries rotation to the chuck spindle operating shaft *S* below. On this shaft there is a corresponding four-step cone pulley, and a hand lever *T* operating the belt connecting the two pulleys gives, at a moment's notice, any of four different rates of feed. It should be

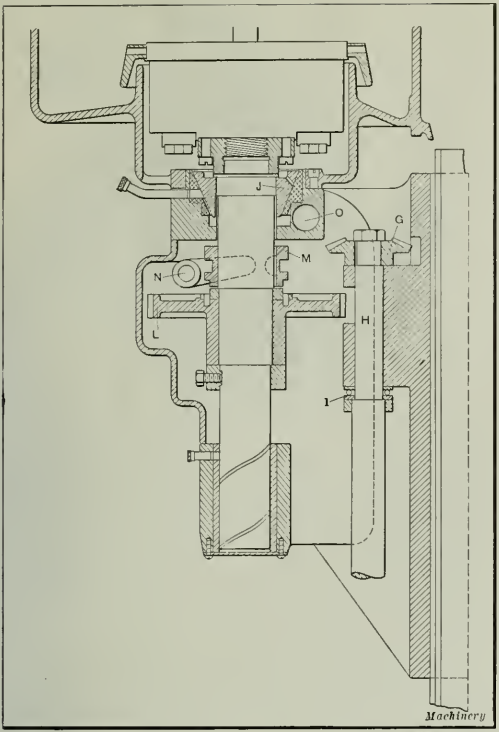


Fig. 5. Cross-sectional View of Chuck Spindle and Operating Mechanism

noticed that the column of the machine is relieved to allow this chuck spindle operating shaft *S* to lie in the same vertical plane as the axis of the spiral gear at the opposite end of the shaft. This operating shaft is connected with the chuck spindle drive-shaft *K* by flexible joints, but as it is in the same vertical plane, any raising or lowering of the chuck slide simply causes the shaft to be operated at an angle varying in one plane only. From the left-hand end of this shaft the drive is carried to the slide traversing mechanism at the front of the machine. This is done through the medium of three-step cone pulleys so that a combination of twelve different feeds may be given to the wheel-slide traversing mechanism.

The Wheel-slide Reversing Clutch

By turning now to Fig. 6, which shows the slide controlling mechanism with the cover plate removed, one of the strongest features of the machine may be seen. As was mentioned in connection with Fig. 2, rotation is carried to this mechanism from the three-cone pulley on the end of the chuck spindle driving shaft *S*. As may be seen in the extreme right-hand section of Fig. 3, the wheel-slide is traversed by a rack *U* and a pinion *V*. This pinion is located on a vertical shaft *W* that is driven by worm-gearing extending through the machine, and terminates at the front of the machine in the large bevel gear *X* that may be seen in Fig. 6. This bevel gear and the horizontal shaft to which it is keyed may be driven in one direction or the other by means of two bevel pinions *Y* and *Z*, both of which are always in mesh with the gear *X*. When one of these is driving the bevel gear, the other is running idle. A double faced clutch *a* that may be seen in the center, is slidably keyed to the shaft *b* and engages the clutch teeth on the inner faces of the bevel pinion *Y* or *Z* according to the direction in which the wheel-slide is being traversed. The method of shifting this clutch is by means of the central lever *c* that is actuated by dogs *d* upon the wheel-slide. This lever is fulcrumed near its center at *f*, and at its lower end is a pin *g* whose function it is to throw up either of two latches *h* or *i* that alternately catch the ends of the clutch bearing. The clutch is thus thrown from one direction to the other, under pressure of the spiral spring *j*.

The operation of this mechanism is as follows: When the lever c is thrown to one extreme by contact with one of the stop dogs or by hand, it causes one of the latches *h* or *i* to be raised and the clutch collar *a* flies over, and consequently the shaft and clutch collar are directly geared to one of the bevel pinions *Y* or *Z*, and the table is then traversed. When the opposite dog is reached, the lever is again thrown over, causing pin *g* to raise the other latch, and the clutch flies in the opposite direction under the action of the spring, the table travel again being reversed. The fact that the clutch sleeve is operated by a single spring is the principal feature of this mechanism. It avoids a difficulty which has heretofore been experienced with similar mechanisms in which independent springs have been used to throw the clutch part in opposite directions, and in which it was found that the reversing mechanism often failed to work owing to the fact that these springs worked in opposition to each other or that one spring was stronger than the other.

The action of this single spring reversing mechanism is so positive that even as short a distance as one-half inch may be traversed without difficulty. This is especially valuable when grinding work like piston rings on which a further traverse would be a waste of time. Another feature is the design of the dogs that limit the travel of the wheel-slide. These operate in connection with an inverted rack on the side of the wheel-slide. By depressing spring knobs *k* at the top, they are released from contact with the rack and can be moved to any position. Releasing pressure on the knob causes a toothed lock to snap back in place and hold the dog stationary. For securing limitations of travel more exacting than one tooth of the rack, a small adjusting screw *l* on the dog is turned, allowing the trip *m* to swing back slightly or advance to get any desired reversing point.

In addition to the power traverse of the wheel-slide, there is a hand traversing wheel *n*, Fig. 1, and during the operation by hand, the power traversing mechanism must be thrown out by means of a clutch lever o, shown just beneath the hand traversing wheel, that operates a clutch on the vertical shaft within the column of the machine. It may here be mentioned that in cases where the operator must stand in front of the machine for facilitating rapid production, a treadle lever may be used in place of the hand lever o for operating the power feed clutch, and provision has been made for the

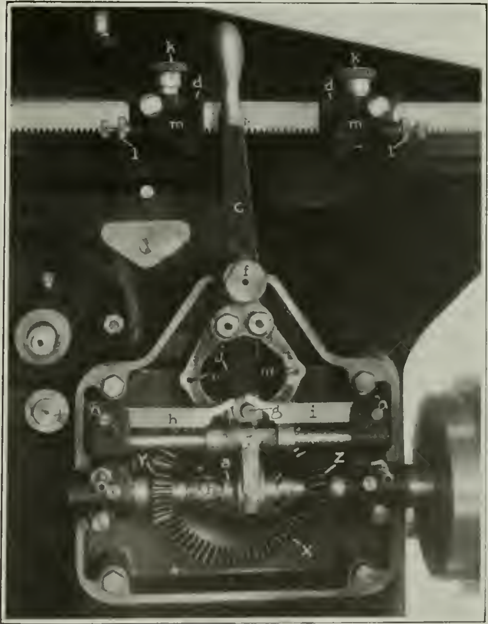


Fig. 6. Slide Controlling Mechanism with Cover Plate removed

application of this particular feature. Also located on this vertical shaft is a friction, so that if for any reason the wheel-slide is advanced far enough to run into the water guard, the pressure between the front of the slide and the water guard will cause the friction to slip and no damage will be done.

Special attention has been given to the design of the water pan for carrying away the water used for cooling, and also with respect to the protection of the chuck and its electrical connections, and convenience in their examination or removal. All wiring is contained in the water pan, A_2, Fig. 2, and the magnetizing of the chuck is performed by means of an extra heavy, double pole switch which has a quick-action demagnetizing feature. The wiring is protected by means of a fuse B_2, which is placed on the same base as the plug socket C_2. The brushes are so arranged that they can readily be examined from underneath the water pan, and if found necessary, they may be removed without disturbing any other part of the machine. The bottom of this pan slopes in both directions to carry the water quickly down to one corner, where the outlet is located. The approach to the outlet is cored away so as to break up any tendency of the water to "eddy." The water tank is of large capacity and is placed conveniently beside the machine. The water pump is of sufficient size to carry as heavy a stream of water as is necessary for any grinding. Except for the water tank, the machine is self-contained in every way, making it ready for immediate use by simply belting from the lineshafting to the drive-shaft.

NEIL & SMITH HEAVY-DUTY GRINDER

The most noteworthy feature of the "Ideal" heavy-duty grinders manufactured by the Neil & Smith Electric Tool Co., Cincinnati, Ohio, is the provision of means for varying the speed so that the operator is able to maintain the correct peripheral speed of the grinding wheel as it wears down, or to vary the speed of the wheel until it reaches the number of surface feet per minute that is most effective for the class of work that is being done. The means for regulating the speed is such that the speed can be stepped off a revolution at a time, if such a fine adjustment is necessary; and the change of speed can be made while the grinder is in operation. The control is obtained through a mechanical device embodied in the construction of the grinder and is not dependent upon the rheostat.

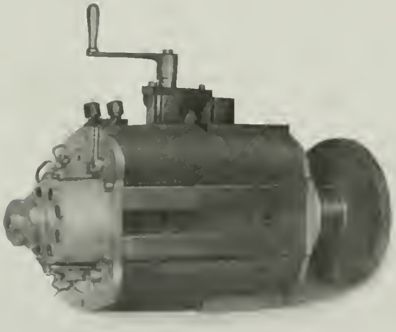


Fig. 1. Neil & Smith "Ideal" Heavy-duty Grinder

In designing this grinder particular attention has been paid to the problem of reducing overhang as far as possible. With this object in view the motor housing has been designed to bring the wheel spindle as near to the operating side as possible. Thus in the largest size of this line of grinders, which is driven by a three-horsepower motor, the distance from the spindle to the face of the housing is only 2¾ inches. Exceptionally small diameter wheels can also be employed, and these two features are the means of obtaining exceptional rigidity.

The spindles are made of tool steel hardened and ground, and carried by bronze bearings provided with means of adjusting for wear. In addition, a ball bearing is provided to carry the weight of the armature when the grinder is used in a vertical position. The bronze bushing is tapered on the outside and split through one side; it is loosely mounted in a collar that screws on the outside of the rear head of the motor. The bushing and collar being a single unit, adjustment of the bearing can be made by simply tightening or loosening the collar. These grinders are made in four different sizes which are driven by one-quarter, three-quarter, one and one-half, and three-horsepower motors, respectively.

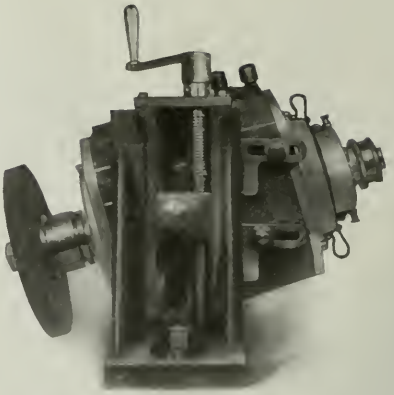


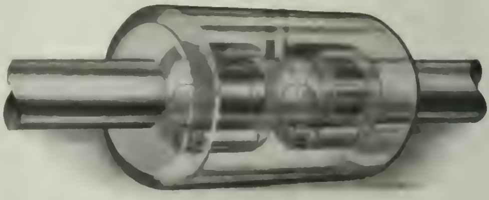
Fig. 2. Opposite Side of Neil & Smith Grinder shown in Fig. 1

AUTOMATIC SHAFT COUPLING

In the "Bull Dog" shaft coupling which is made by the Automatic Shaft-Coupling Co., Alexandria, Va., and for which the Campbell Machinery Co., 5-7 Beekman St., New York City, has the exclusive sales agency, the clamping action is secured by hardened steel rollers which are carried in eccentric chambers in the body of the coupling. Three of the most important features of this coupling are that it can be applied by hand without requiring the use of any tools; that it is unnecessary to cut any keyways in the shaft; and that there are no projecting set-screws or other parts which can catch in the workman's clothes and cause injury.

The coupling provides for holding the shafting in perfect alignment, and when a suitable reducing coupling is employed, shafts of different diameters may be connected. The coupling is of simple construction, consisting merely of a metal cylinder with the eccentric chambers in which the clamping rollers are carried. There are no wearing parts and hence the expense of renewals is practically eliminated. It is never necessary to make adjustments of the coupling, and oil or dampness cannot affect it. In addition to the regular purpose for which it is intended, another use of this coupling is in making emergency repairs on broken shafts. The coupling can be slipped over the fracture and tightened, making it possible to put the shaft into commission in a short time.

In applying the coupling, the first step is to remove all burrs on the shafting, after which the ends are slightly chamfered with a file. The chambers and bore of the coupling, as well as the ends and shafting which enter it, must be thoroughly cleaned, after which the rollers are put in place and the coupling is slipped onto the shaft. The rollers and bore of the coupling, and also the ends of the shafts, are


"Bull Dog" Shaft Coupling made by the Automatic Shaft-Coupling Co.

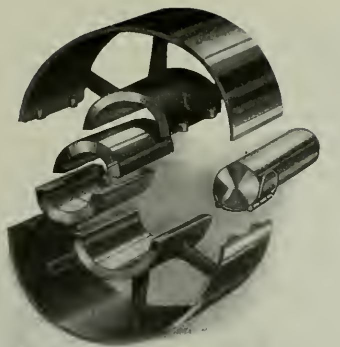


Fig. 2. "Bull Dog" Split Pulley Bushing

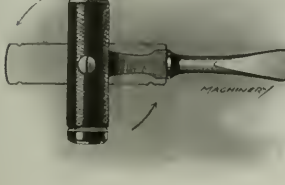
oiled with a heavy oil; and care is taken to have the ends of the shafts directly under the pin hole in the center of the coupling. When the pin hole is at the top of the coupling, the rollers are in the deepest part of the eccentric chambers and the coupling is loose on the shafts. After the coupling has been put on in this way, it is merely necessary to turn on the power and the resistance binds the rollers in the eccentric chambers and locks the shafts firmly in place.

To remove the coupling, the driven pulley is turned forward, while the driving pulley remains stationary. This is done by putting a lever through the spokes and giving a quick jerk, which results in loosening the binding rollers on the driven side of the coupling. A pin or small bar is then put in the pin hole in the top, and struck with a hammer in the opposite direction, and this loosens the coupling.

These couplings are made in nineteen stock sizes with capacities for coupling shafts ranging from 1 3/16 to 8 inches in diameter. Smaller or larger sizes are made to special order. Reducing couplings for connecting two different sizes of shafts are also made; and the same clamping device is employed in set collars which are manufactured in fifteen stock sizes ranging from 1 3/16 to 6 inches in diameter. Special sizes are also made to order.

Still another application of this clamping device is in the "Bull Dog" split pulley bushing shown in Fig. 2. This is intended for use in connection with split pulleys, and it may be just as easily applied as an ordinary bushing. When the pulley is bolted together, the bushing does not bind on the shaft; it is just free enough to allow the pulley to be moved to the required position. The same arrangement of an eccentric chamber and clamping roller is provided in the bushing, and when the pulley has been set in the required position a slight turn binds it securely on the shaft. The strain of the drive keeps the pulley locked tight, but if it is desired to release the clamp, it is merely necessary to put a bar through the spokes of the pulley and give a sharp pull in the opposite direction to that in which the shaft runs. An important feature of "Bull Dog" shaft couplings, set collars and pulley bushings is the time saved in installation.

CRESCENT HAMMER-HANDLE SCREW-DRIVER



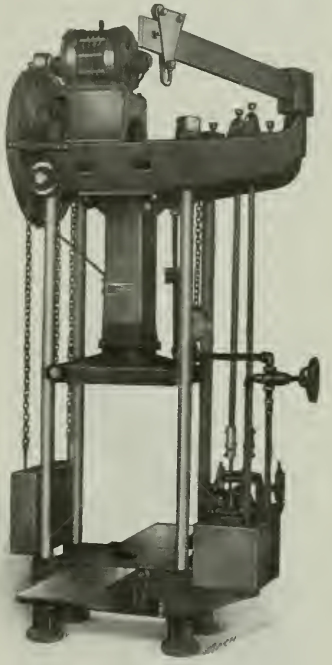
Crescent Hammer-handle Screw-driver

The accompanying illustration shows a combination hammer and screw-driver which has been placed on the market by the Crescent Tool Co., Jamestown, N. Y. This tool can be used in the same way as an ordinary screw-driver, but for heavy work—such as driving a screw into hard wood or starting a screw that has become rusted—the handle may be turned down at right angles to the blade to afford additional leverage. In this position, the tool gives very satisfactory service as a light hammer and will be found convenient for starting to drive wood screws. A strong spring holds the handle in place.

The blade of the screw-driver is of drop-forged steel, hardened and tempered in oil. The handle is knurled to afford a good grip, and the entire tool is nickel plated. The length of the blade is 6 inches, over-all length 10 inches, thickness of point 5/64 inch, and weight 14 ounces.

HYDRAULIC INVERTED FORCING PRESS

The accompanying illustration shows an inverted hydraulic forcing press which is a recent addition to the line of the Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. The press is a self-contained unit which requires no auxiliary water or power supply. It is usually equipped with electric motor drive, but belt drive may be applied when so desired. It will be seen that the press is of the inverted type in which the base or platen is located close to the floor, so that heavy work can easily be put in place. Detachable extension shelves, 12 inches wide by 30 inches long, are joined to each side of the press, and the work can be lifted onto either of these shelves by means of the hoist which is suspended from the swinging crane and trolley device on the head of the press. In this way the setting up of the heaviest work for which the press is adapted is quite a simple matter.



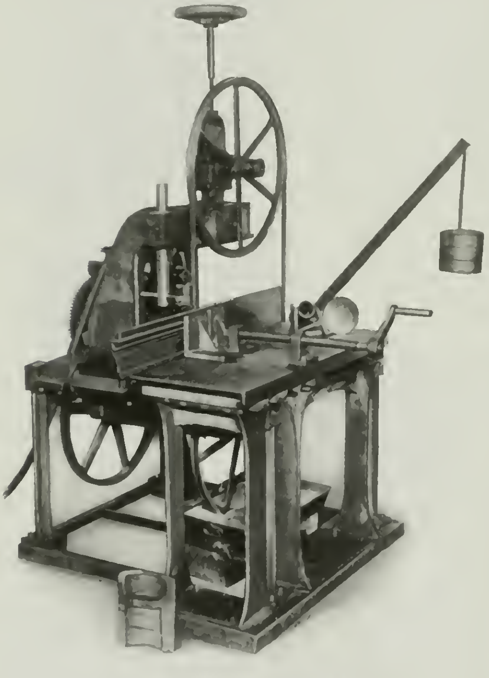
Hydraulic 60-ton Inverted Forcing Press

The press shown in the accompanying illustration is equipped with a two-plunger vertical hydraulic pump, the plungers of which are ⅝ inch in diameter and have a stroke of 3½ inches. This pump is driven through two eccentrics, operated by a three-horsepower motor mounted on the press. The gears of the motor power attachment are fully enclosed, and the pump is equipped with an automatic knock-out valve attachment, spring safety valve, tee-operating valve, and pressure gage. In order to provide ample strength, all parts of the press are made of steel, the strain rods being made of bright cold-rolled steel shafts. Cast steel is used for the pressure base, and the cylinder is made from a steel casting. The lower platen of the press has a working surface of 24 by 22 inches, and there is a 6-inch hole in the center of the platen to provide clearance for the end of a hub or shaft during the pressing operation. The movable platen is 24 by 22 inches in size and is guided by babbitted bearings on the strain rods. The ram is returned by a weight after the pressing operation has been completed. The capacity of the press is for pressures up to 60 tons.

WILLIAMSON METAL-CUTTING BAND SAW

In the latest type of metal-cutting band saw which has been placed on the market by H. C. Williamson, 1840 W. Lake St., Chicago, Ill., capacity is provided for cutting work ranging in size from ⅛ to 8 inches in diameter. An idea of the diversity of the material which can be cut on this machine will be gathered from the fact that it is being employed for cutting 8-inch I-beams, 8-inch square billets, and a great variety of sections of various sizes which come between these extremes. It is claimed for the machine that it will cut very accurate disks from tool steel bars, and that tubing and other light materials can be cut in an efficient manner. When handling certain classes of work, the back of the machine can be removed to give a flat table. The table is held stationary, and the feed is provided by moving the blade to the work rather than by feeding the heavy work up to the blade. This is the means of effecting a saving in the amount of power required to drive the machine. The frame that carries the wheels over which the saw runs and the driving mechanism, slides on ways on the machine; and provision is made for obtaining the feed either by hand or gravity. The saw guide is conveniently located and may be easily adjusted.

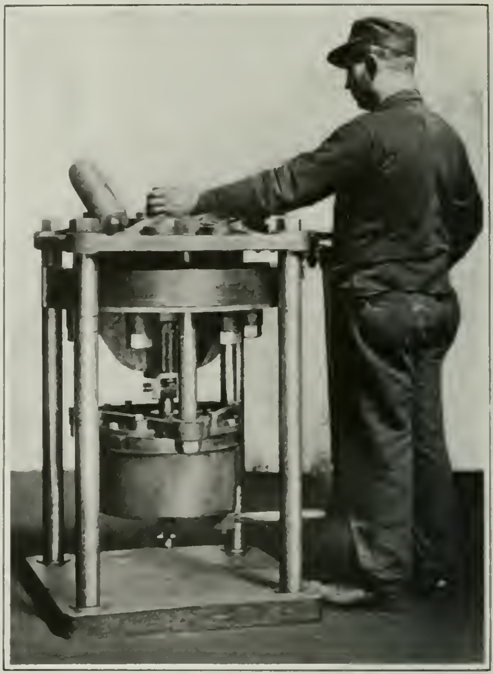
The pressure of the cut may be varied by changing the number of weights hung on the gravity feed lever. When the machine is equipped with individual motor drive, the motor may be mounted on the frame, as shown in the accompanying illustration. The tightening of the saw blade is accomplished by means of the handwheel shown at the top of the machine. It will be evident from the illustration that the design has been worked out along very simple lines, which, in turn, makes the machine very simple to operate. As a result, inexpensive labor can be employed and one operator can run several machines.



Williamson Metal-cutting Band Saw

MOTCH & MERRYWEATHER SHRAPNEL SHELL BANDING PRESS

The pneumatic banding press which forms the subject of this article has been developed for the purpose of compressing the copper bands onto shrapnel shells. The action of the press is such that the dies strike a sharp blow and then exert a heavy pressure which is sufficient to force the copper band into a dovetail groove in the shell. The rate of production which may be obtained with this machine is only limited by the ability of the operator to handle the work. The actual time required to set the band on an 18-pound shrapnel shell is from 7 to 8 seconds, so that it will be evident that the greater part of the time required for doing this work is taken by the operator in setting up the machine for the compressing operation and removing the banded shell from the press. Where one operator has entire charge of the machine, he should be able to turn out at least one shell per minute; and with two operations to a machine, the rate of production ought to be from three to four shells per minute.



Motch & Merryweather Shrapnel Shell Banding Press equipped with Nosing Attachment

The machine is self-contained, and in setting it up it is merely necessary to connect the air line in the shop to the control valve on the machine. A "nosing" attachment is provided, which consists of a thimble carried over the ram of the press. When this attachment is used, the shell is put in the same position as it would occupy when having the copper band put on, but for the "nosing" operation the shell is forced up by the air cylinder so that its end is compressed by entering the nosing thimble. The principal dimensions of the machine are as follows: Air pressure required, 100 pounds per square inch; floor space occupied, 30 by 30 inches; and weight of machine, 1750 pounds. The Motch & Merryweather Machinery Co., 707-715 Lakeside Ave., N. W., Cleveland, Ohio, has the exclusive sales agency for this press.

STORAGE BATTERY TRUCK

In the industrial truck which has been placed on the market by the Automatic Transportation Co., 258 Broadway, New York City, the feature of an elevating truck for use in connection with wooden loading platforms has been combined with motor drive. The truck is equipped with two three-horsepower motors, one of which does the driving while the other provides for raising the load by power. Both of these motors are connected to the same storage battery; and this battery has a sufficient capacity to drive the truck under maximum service conditions for a full working day.

The raising of the truck is done by means of four cams,

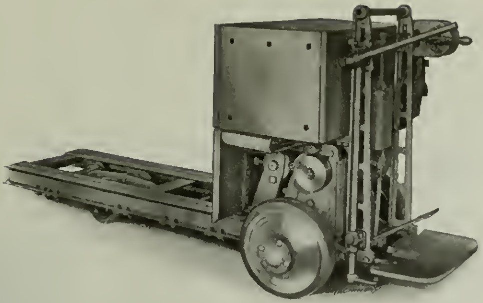


Fig. 1. Automatic Transportation Co.'s Storage Battery Truck

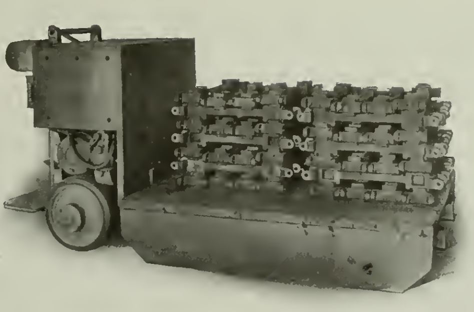


Fig. 2. Storage Battery Truck at Work

two of which are located at the front and two at the rear of the frame which goes under the loading platform. These cams are operated from the motor by means of a chain which can be seen in Fig. 1, and provide a lift of 3 inches. The motor is not used for lowering the load. For this purpose a band brake is provided on the motor shaft, and the lever which controls this brake provides for letting the load down slowly.

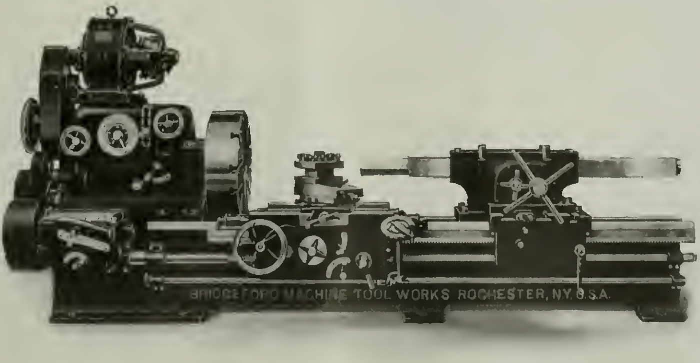
It will be noticed that a platform is provided on the truck, on which the operator stands while transporting a load from one department of the factory to another. The small wheels of the truck are 10 inches and the large wheels 15 inches in diameter. Rubber tires are provided on the wheels so that the truck runs quietly. The capacity is for loads up to 4000 pounds, and with such a load on the truck it can be driven at speeds up to 5 miles per hour.

BRIDGEFORD PROJECTILE LATHE

For use in turning and boring large explosive shells, the Bridgeford Machine Tool Works, Rochester, N. Y., has arranged the 32-inch heavy triple geared engine lathe of its manufacture with attachments which enable a high rate of production to be obtained on this class of work.

It will be seen that a power-fed tailstock is provided which adapts the lathe for boring large shells. The bar is 5½ inches in diameter and bored No. 7 Morse taper. It is arranged on a swivel so that either straight or tapered holes can be bored without using the taper attachment. Power for operating the bar is taken from the lead-screw and transmitted to the bar through gearing. In addition to the power feed, there is an arrangement by which the bar can be traversed by hand at either a low or high speed. For this purpose a large handwheel is employed, which drives direct for high speed or through back-gears for slow speed. The small handwheel provides for engaging or disengaging the power feed. The tailstock has a cross adjustment in addition to lateral adjustment along the bed.

A four-tool steel turret mounted on the compound rest is of great assistance in providing for the rapid and economical handling of the work. The lathe shown in the illustration is driven by an eighteen-horsepower Westinghouse variable-speed motor which is controlled from the carriage by the use of a Westinghouse drum type controller, placed on the rear of the frame. This enables the operator to control the motor from the carriage and change from slow to fast speed, or *vice versa*, without leaving the operating position. Without a motor, the headstock provides for fifteen mechanical speed changes, in geometrical progression; but when the lathe is equipped with variable-speed motor drive, these fifteen changes are multiplied by the number of points on the controller. The quick-change gear-box enables the operator to obtain any desired feed instantly. When equipped with side turning or full swing rests, this lathe is adapted for handling the machining operations on large shells advantageously.



Bridgeford 32-inch Engine Lathe equipped for the Rapid Production of Explosive Shells

NEW MACHINERY AND TOOLS NOTES

Staybolt Tap: Reinhold Betterman, Johnstown, Pa. A tapping device developed for rapidly tapping staybolt holes in internal fire-box boilers. Provision is made for overcoming the difficulty experienced in cutting the holes in proper alignment.

Duplex Milling Machine: C. F. Fulmer, Plainfield, N. J. A machine designed for slotting piston rings, which has a capacity for rings from 1½ to 14 inches in diameter. It is adjustable to 0.001 inch and is provided with a positive device for holding the work.

Quick-change Drill Chuck: Millholland Tool Co., Indianapolis, Ind. A quick-change chuck intended for use in machining work where drills, reamers, taps, etc., are required. The rapid manipulation of the chuck is the means of saving a considerable amount of time.

Heavy-duty Drill: Colburn Machine Tool Co., Franklin, Pa. A heavy-duty drill press equipped with a driving motor which has automatic starting control. A compound table is provided on the drill press, and the machine has a capacity for drilling holes up to 2 inches in diameter.

Fractiometer: Fractiometer Co., Rochester, N. Y. An instrument for use in adding and subtracting fractions, which is of simple construction, consisting of two celluloid disks, the outer one of which is held by hand while the inner is rotated to the desired position for the calculation to be made.

Welding and Cutting Torch: Imperial Brass Mfg. Co., Chicago, Ill. A torch in which the change from welding to cutting or *vice versa* can be conveniently made by removing the welding head and substituting the cutting attachment, or replacing the cutting attachment with the welding head, as may be required.

Emery Wheel Guard: William Plotz Iron Works, Cleveland, Ohio. A guard which may be easily clamped to any form of grinding wheel stand. In the event of the wheel bursting, the guard closes automatically to prevent the broken pieces from flying. This emery wheel guard is made in a number of different sizes.

Miter Cutting-off Machine: Grinden Art Metal Co., 427 Marcy Ave., Brooklyn, N. Y. A machine developed for use in making miter cuts on hollow steel molding. The cutting is done by an emery wheel 18 inches in diameter by ⅛ inch thick, and the machine is driven by an electric motor.

Cutting and Welding Torches: Modern Engineering Co., St. Louis, Mo. The important feature of these torches is the provision of an automatic spring closing or check valve, whereby the possibility of back-fire through the formation of an explosive mixture beyond the head is said to be entirely eliminated.

Automatic Grease Cup: Hunter Pressed Steel Co., Philadelphia, Pa. In this cup the grease is fed automatically by the use of compressed air, the action being supplemented by the force of a light compression spring. In this way a uniform action is provided which feeds the grease steadily down into the bearing.

Thread Limit Gage: C. L. Bailey, Glen Ridge, N. J. This gage has a frame of the C-type in which the hardened and ground measuring surfaces are clamped. On one side the measuring surface is continuous, while the "go" and "not go" surfaces on the opposite side are separate, with the required tolerance limit between them.

Cutting-off and Facing Machine: Williams Tool Co., Erie, Pa. This machine is particularly adapted for cutting off and facing shell forgings. The average speed of operation is estimated at 60 feet per minute, and running in this way a 4.5 shell forging can be faced in two minutes, and the open end cut off in slightly less than 30 seconds, when the wall is ⅜ inch thick.

Bench Die Grinder: Otto & Grayson Mfg. Co., Indianapolis, Ind. A bench machine for grinding dies, punches and similar work. The arbor is designed to carry small grinding wheels with a hole ½ inch in diameter. The bracket carrying the wheel has an overhang of 7 inches from the center of the spindle to the center of the column. The table of the machine is 12 by 12 inches in size.

Drinking Fountain: Allen Filter Co., Toledo, Ohio. A bubbling fountain and water cooler especially designed for shop use. The cooler box has double galvanized iron walls insulated with granulated cork. A coil tinned both inside and out carries the water through the cooler, the coil being submerged in the ice-cold water. The ice is inserted in one piece, and placed on top of the coil.

Portable Electric Drill: A. F. Carver & Co., Newtonville, Mass. A tool with a capacity for drilling holes up to ½ inch in diameter in steel. The motor is designed to run on alternating current, and is of the slow speed type. A push button control switch is located in the side handle, and the frame and spade handle are made of aluminum to reduce weight. The weight of the tool is 22 pounds.

Vertical Shrapnel Milling Machine: George Gorton Machine Co., Racine, Wis. A special high-speed vertical milling machine designed especially to meet the requirements of milling the powder groove in the timing disks used in shrapnel shells. The table is equipped with a special fixture for holding the work and locating it properly. The capacity is approximately 1200 disks in a ten-hour day.

Reproducing Machine: Commercial Camera Co., Rochester, New York. A machine which provides a rapid, accurate, and inexpensive method of reproducing all sorts of copy, such as photographs, letters, maps, drawings, blueprints, etc. It not only has the advantage of doing the work far more rapidly than it could be done by hand, but there is absolute assurance that a true facsimile of the copy will be obtained.

Storage Battery Truck: Elwell-Parker Electric Co., Cleveland, Ohio. A factory truck driven by a motor which takes power from an electric storage battery. The truck is used in connection with inexpensive wooden or metal platforms upon which the work is stacked, so that it is only necessary to provide the number of trucks that are actually required for transferring the work from department to department.

Hand Punch and Shear: Whitney Metal Tool Co., Rockford, Ill. A hand punch designed for punching sheet metal, angles, etc., with the minimum amount of effort. The tool has a capacity for punching a ⅜-inch hole through a ¼-inch metal plate. The hand-operated shear is suitable for all classes of sheet metal work, and is designed in such a way that the shear works equally well when cutting at the extreme point of the blades as it does at any other point.

Photograph Displaying Device: Corte-Scope Co., 5612 Carnegie Ave., Cleveland, Ohio. A device for use in exhibiting pictures of machinery or any other photographs. This device resembles a stereoscope, the particular advantage claimed for it being that the three dimensions of height, width, and depth can be shown quite clearly. This is obviously an advantage to the salesman who is showing a prospective customer the features of a machine which he is trying to sell

Metallographic Grinding and Polishing Machine: Eimer & Amend, New York City. This machine was built according to specifications drawn by Henry Wysor, Lafayette College, Easton, Pa. It is essentially a duplex machine, being provided with three carborundum wheels for the rough, medium and finish grinding operations, and a brass disk for the polishing operation. The grinding wheels are carried on a horizontal shaft and the polishing disk on a vertical shaft.

Emery-band Grinders: T. P. Walls Tool & Supply Co., 75 Walker St., New York City. An endless-band type of grinder which provides for obtaining a straight grained finish and sharp corners on the work. The work to be finished is held lightly against the emery band, which is held absolutely flat. When one band is worn out a new one can be substituted instantly by simply releasing the tension between the pulleys. Leather buffing bands for polishing can also be used on this machine.

Machine for Photographing on Both Sides of a Sheet: Cameragraph Co., Kansas City, Mo. This company has recently brought out a machine which is capable of taking two separate photographs at the same time and printing them on opposite sides of the same sheet. The machine also provides for developing and fixing the photographs by the manipulation of a crank, and delivers the completed prints cut ready for drying without requiring the operator to immerse his hands in chemical baths or water.

High-resistance Electric Pyrometers: Bristol Co., Waterbury, Conn. A line of high-resistance electric pyrometers for measuring temperatures up to 3000 degrees F. The millivoltmeter movement is of the pivot jewel bearing dead-beat type manufactured by the Weston Electrical Instrument Co. Bristol base metal couples may be used with these instruments for measuring temperatures up to 2000 degrees F., while platinum, platinum-rhodium couples are used for temperatures from 2000 to 3000 degrees F.

Air Compressor: Ingersoll-Rand Co., 11 Broadway, New York City. A small high-pressure air compressor of the horizontal type, which is driven by a steam engine. The air cylinder is equipped with Ingersoll-Rogler air valves which are independent of any external operating mechanism. These valves allow high speeds to be employed and give a high compression efficiency; in addition they are almost silent in operation. This type of valve is now used on all the air compressors of this company's manufacture.

Non-rusting Steel: Firth-Sterling Steel Co., McKeesport, Pa. A steel which will not rust or stain, so that it is particularly adapted for use in the manufacture of cutlery. This steel was originally made by Thomas Firth & Sons, Ltd., Sheffield, England, and was developed for use in making pump rods for colliery work. The breaking strength is from 50 to 55 tons per square inch with an elongation of 20 per cent and a reduction in area of almost 60 per cent. Hardening increases the tensile strength to about 100 tons per square inch.

Sand Blasting Machine: Mott Sand Blast Mfg. Co., New York City. This machine is for use in cleaning castings and is particularly adapted for intricate cored work, castings where the sand has been burned hard in the corners, thin malleable iron or steel castings, etc. The apparatus is so arranged that the nozzle or nozzles are moved across the face of the castings while they are being rolled in a tumbling barrel, so that the result is essentially the same as that obtained by an operator who turns the casting and moves the nozzle by hand.

Power Indicator: American Pulley Co., Philadelphia, Pa. A sensitive indicator for determining the horsepower required to run unloaded pulleys. This apparatus is interposed on the shaft between the driving pulley and the pulley to be tested. It consists of two disks, one of which is driven by the other by means of the free end of a flat spring attached to the driving disk, which presses against a pin on the driven disk. The relative position of the two disks when loaded is determined by the pressure on the spring, which is indicated by a pin moving over a scale that has been calibrated to indicate horsepower.

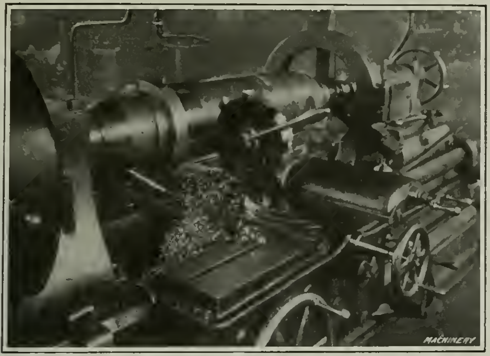
Lathe Chuck: Thomas Elevator Co., Chicago, Ill. A hand-operated lathe chuck which can be placed on a machine or removed as easily as a faceplate. A hand lever, cams and arms within the shell of the chuck are so arranged that a short initial movement of the lever moves the jaws from the fully opened position to a point where they are nearly in contact with the work; and the remaining movement of the lever moves the jaws slowly into contact with the work, giving a high holding pressure. Cams may be cut to give practically any distance of jaw movement within the range of the chuck without changing the gripping pressure of the jaws obtained by the final hand lever movement.

* * *

The chemists of the United States Bureau of Mines have discovered a process whereby radium can be produced at one-third its present cost; or at a price of $40,000 per gram instead of $120,000. Radium is much sought after because of its supposed curative qualities and its remarkable chemical activity. One grain of it evolves sufficient heat to raise its own weight of water from the freezing point to the boiling point every forty-five minutes.

SHEARER VERTICAL TURRET ATTACHMENT

When work is being machined on an engine lathe, which requires forming, grooving, beveling, beading, and similar operations to be conducted in sequence, the vertical turret attachment which has been patented by George T. Shearer of Augusta, Ga., will be found the means of saving a considerable amount of time. It will be seen that this attachment consists of a vertical head clamped to the carriage of the lathe, and that it has a capacity for eight tools. The tools are held in dovetailed grooves by beveled clamp-bolts, which method of fastening provides a very secure grip. When in operation, the cross-feed is brought up against a stop fastened to the lathe carriage and the graduation on the feed-screw is then turned to zero, the purpose of this adjustment being to insure having the same tension on all tools. The fine adjusting screw which is provided behind each tool enables the operator to set all the tools to cut at exactly the same distance from the center of the work. By releasing the handle, the turret may be turned toward the operator, and when the correct tool is brought to the working position the turret is clamped.



Shearer Vertical Turret Attachment for Engine Lathe

The accompanying illustration shows the turret attachment engaged in turning a copper band on a 10-inch projectile, this band being turned from the rough and finished to within 0.002 inch of the required size in less than nine minutes, without requiring the use of calipers. It is claimed for the attachment that it will do 60 per cent more work than can be obtained from a machine which is not equipped in this way. The attachment may be easily removed from the lathe by loosening two clamp-bolts.

* * *

TESTING HARDNESS AND ELASTICITY OF RUBBER

The physical properties of rubber used for automobile tires are so different from those of all substitutes which have been tried that a saying has arisen to the effect that "the only substitute for a rubber tire is another rubber tire." But the properties that make rubber so serviceable may vary to such an extent that tires made of unsuitable grades of rubber are little better than many tires made from inferior substitutes. The steadily increasing demands for uniformity in tires, which are made by automobile engineers, have created a demand for accurate instruments for testing the rubber in order to determine whether or not it is up to the required standards.

Hardness and elasticity are the two principal physical properties of rubber that are of importance as regards its application in tires. The Shore Instrument & Mfg. Co., 557 West 22nd St., New York City, took up the problem of developing instruments for determining these properties, with the result that the "durometer" and "elastometer" have recently been placed upon the market. These instruments are shown in Fig. 1, and they can be used free-hand, or in connection with a stand of the form shown in Fig. 2. The "durometer" is used for testing the hardness of rubber, while the "elastometer" measures the elasticity of the material.

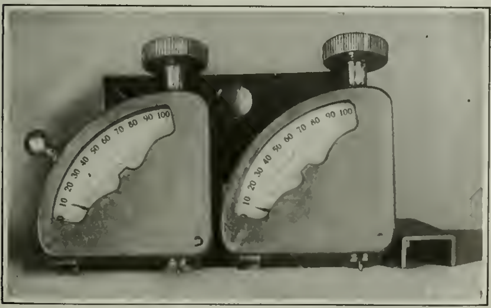


Fig. 1. "Elastometer" and "Durometer," and Standard Spring Plate for checking up "Durometer"

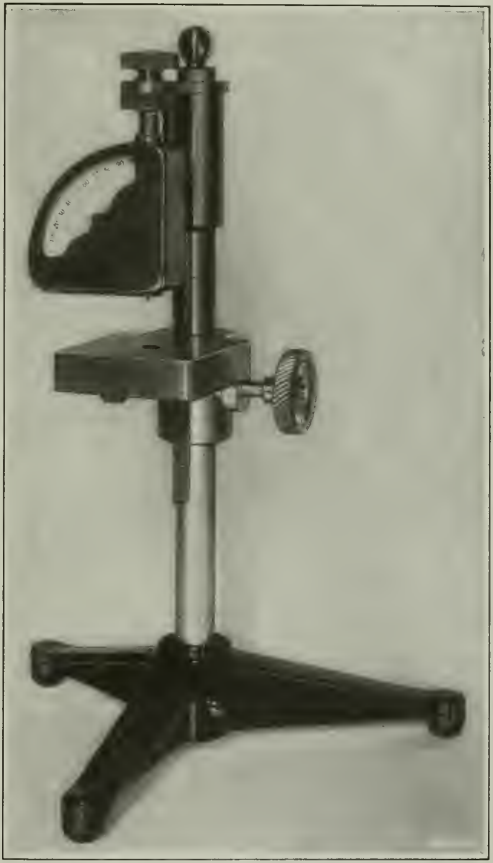


Fig. 2. "Durometer" mounted on Stand ready for Use

The hardness is measured in terms of the resistance offered by the rubber to the depression of a blunt pin into it by means of a standard spring. The surface of the rubber is not broken to any extent, so that the "durometer" is adapted for testing the quality of finished products without damaging them. The "elastometer" measures elasticity in terms of resistance to permanent depression or tearing. For this purpose, a moderately sharp point is caused to penetrate the rubber to a fixed depth. If the rubber is perfect, no tearing or permanent injury of the material will result, and consequently the point will be completely ejected when the pressure on the pin is released. The extent to which the rubber

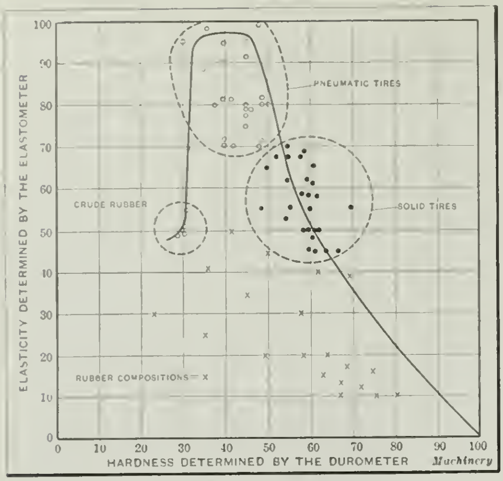


Fig. 3. Chart showing Relation of Hardness to Elasticity for Different Tires and Materials

recovers after imposing this test indicates the percentage of elasticity.

The importance of an accurate method of measuring the hardness and elasticity of rubber can be realized when it is known that if rubber is vulcanized in such a manner that the maximum elasticity is reached, while the hardness is too low for the conditions of service, each degree of hardness is obtained by sacrificing about 3 degrees of elasticity, as shown in the chart reproduced in Fig. 3. This loss of elasticity continues to such an extent that if solid tires are hardened sufficiently to carry the maximum load, so much of the elasticity of the rubber is sacrificed that the efficiency of the tires is very seriously impaired.

* * *

KRAUS INTERNAL COMBUSTION ENGINE FOR MARINE USE

A novel type of internal combustion engine has been invented by Otto Kraus of the Kraus Engine Co., 218 W. 26th St., New York City, which is believed to be particularly adapted for marine use, owing to its compactness and the fact that it utilizes crude oil or other low-grade oils. The interesting feature of the engine is that the combustion of the oil occurs in a separate chamber (corresponding to the steam chest of a steam engine) and not in the cylinders. In this combustion chamber the oil is injected and atomized and is mixed with a suitable quantity of water; a greater quantity of air than is actually required for combustion is also forced into the chamber by an air compressor driven from the crankshaft of the engine. The steam and gases of combustion are admitted to the cylinders by means of ordinary piston valves which are operated on the experimental motor by the Joy type of valve gear.

An electric spark ignites the atomized oil which is mixed with the compressed air; as soon as the engine is running, the current is turned off, since continuous combustion takes place without it. Only one spark plug is required regardless of the number of cylinders. In starting the engine, no previous heating is necessary and the starting may be done by the use of compressed air, which the engine itself provides by means of a tank attached to the engine. The speed is controlled by a throttle and it is reversed by a reversing lever the same as a steam engine. The power is exerted in both directions on each piston and the pressure in the cylinder is practically constant up to the point of cut-off. The engine uses kerosene, crude oil, or any fuel oil, and it is claimed that perfect combustion is obtained. No matter what fuel is used, it is said that there are no carbon deposits and the exhaust is odorless.

ANNUAL CONVENTIONS A. R. M. M. AND M. C. B. A.

The forty-eighth annual convention of the American Railway Master Mechanics' Association and the forty-ninth annual convention of the Master Car Builders' Association were held in Atlantic City, N. J., June 9-11, and June 14-16, respectively. The headquarters of the convention was Young's Pier, where the daily sessions of the conventions were held and the entertainments of the evenings were enjoyed. A large section of the pier, about 70,000 square feet, was given over to the exhibits of the members of the Railway Supply Manufacturers' Association. These exhibits represented the latest developments in railway supplies and devices including locomotive, car, track, and shop materials, as well as the tools and machines used in general railroad shop practice. The machine tool exhibit, while interesting, was not as large as in previous years, the reason being undoubtedly due to the fact that the machine tool builders in general are unusually busy and not as keen for railway business as in former years. While the delegates to the convention showed considerable interest in the machine tool exhibit, it was the consensus of opinion that buying by the railroads, at least of machine tool equipment, has not actively begun.

Among the reports and papers of the American Railway Master Mechanics' Association convention were the following:

June 9—Mechanical Stokers; Revision of Standards; Safety Appliances; Advantages of Compounding Superheated Locomotives; Side Bearings on Fenders; Smoke Prevention.

June 10—Locomotive Headlights; Design, Construction, and Inspection of Locomotive Boilers; Standardization of Tinware; Superheater Locomotives; Fuel Economy; Variable Exhausts, by J. Snowden Bell; Tender Derailments, Causes and Remedies, read by H. P. Bentley; Road Instructions for Engine Men and Firemen; Cross-head Design, discussion led by A. R. Ayers.

June 11—Discussion of reports on joint meetings with M. C. B. Association; Standardization of Tinware; Revision of Air Brake and Train Signal Instruction; Train Resistance and Tonnage Ratings; Locomotive Counterbalancing; Maintenance and Operation of Electrical Equipment; Forging Specifications; Boiler Washing; Dimensions of Flange and Screw Couplings for Injectors.

At this session the officers for the year were elected as follows: E. W. Pratt, president; William Schlafge, first vice-president; F. H. Clark, second vice-president; W. J. Tollerton, third vice-president; Angus Sinclair, treasurer; C. H. Hogan, J. F. De Voy and J. T. Wallis, executive committee.

The sessions of the Master Car Builders' Association convention were held June 14, 15 and 16, and the principal papers and discussions were as follows:

June 14—Revision of standards and recommended practice; train brake and signal equipments; brake shoe and brake beam equipment; car wheels; arbitration committee's report; revision of prices of labor and material; settlement prices for reinforced wooden cars; compensation for car repairs.

June 15—Discussion of reports on couplers; safety appliances; rules for loading material; overhead inspection; interline inspection; car construction; specifications and tests for materials; tank cars; paper by Paul Synnestvedt, "What is the Value of a Patent?"

June 16—Discussion of reports on train lighting and equipment; car trucks; draft gear; paper on "Impact between Freight Cars in Switching Service," by Prof. L. E. Endsley; topical discussion, "Air Brake Maintenance." At this session a joint meeting with the A. R. M. M. Association was held.

The following officers for the year were elected: President, D. R. MacBain, superintendent of motive power, New York Central Lines West of Buffalo; first vice-president, R. W. Burnett; second vice-president, C. E. Chambers, superintendent of motive power, Central Railroad of New Jersey; third vice-president, J. W. Demarest, superintendent of motive power, Pennsylvania Lines West of Pittsburg, Northwest System; treasurer, J. S. Lentz, Lehigh Valley Railroad.

Among the two hundred and twenty-seven concerns exhibiting or maintaining reception booths, the following exhibited machine tools, machine shop equipment or supplies:

Alston Saw & Steel Co., Folcroft, Pa. Alston hacksaw blades with demonstration of cutting qualities.

H. Boker & Co., Inc., New York City. High-speed and tool steel; steel specialties.

C. H. Besly & Co., Chicago, Ill. Patternmaker's disk grinder; motor-driven disk grinder for metal surfacing, etc.

C. & C. Electric & Mfg. Co., Garwood, N. J. Demonstration of electric arc welding outfit.

Duff Mfg. Co., Pittsburg, Pa. Duff ball bearing screw jack; car jacks; ratchet jacks; hydraulic jacks.

Greenfield Tap & Die Corp., Greenfield, Mass. Demonstration of self-opening dies, tapping chucks, etc. Samples of staybolt taps and illustrations of staybolt tapping operations.

Greene, Tweed & Co., New York City. "Favorite" reversible ratchet wrench; packings for piston rods, valves, pumps, etc.

Greenfield Machine Co., Greenfield, Mass. Cylindrical grinding machine; cutter grinding machine.

Ellsworth Haring, New York City. High-speed steel; tool steel; steel specialties.

Edwin Harrington, Son & Co., Inc., Philadelphia, Pa. Chain hoists.

Ingersoll-Rand Co., New York City. Pneumatic riveting and chipping hammers; "holder-ons"; sand rammers; motor hoists.

William Jessop & Sons, Inc., New York City. Jessop's steel.

H. W. Johns-Manville Co., New York City. Lagging, pipe coverings, packings, gaskets, etc.

Landis Machine Co., Waynesboro, Pa. Pipe threading and cutting-off machines; grinder for chasers and bolt cutters.

Lucas Machine Tool Co., Cleveland, Ohio. "Precision" horizontal boring, drilling and milling machine.

Manning, Maxwell & Moore, Inc., New York City. Putnam car wheel boring mill; geared head lathe; double axle lathe; journal turning lathe; etc..

National Machinery Co., Tiffin, Ohio. Forging machine; bolt cutter; automatic nut tapping machine.

Niles-Bement-Pond Co., New York City. Niles 44-inch vertical boring mill; Bement 60-inch horizontal milling machine.

A. O. Norton, Inc., Boston, Mass. High-speed jack.

R. D. Nuttall Co., Pittsburg, Pa. Heat-treated gears and pinions for railway use; pantograph trolley for electric railway use.

Nutter & Barnes Co., Hinsdale, N. H. Cutting-off saw; abrasive metal cutting machine; saw sharpener, etc.

Stockbridge Machine Co., Worcester, Mass. 20-inch motor-driven Stockbridge crank shaper.

U. S. Metal & Mfg. Co., New York City. "Cayuta" ball and cone bearing screw jack.

Warner & Swasey Co., Cleveland, Ohio. No. 2A universal hollow hexagon turret lathe; 3A universal hollow hexagon turret lathe.

Yale & Towne Mfg. Co., New York City. "Yale" triplex hoists, trolleys, etc.

* * *

CONVENTION OF N. A. C. S.

The third annual convention of the National Association of Corporation Schools was held in Worcester, Mass., June 8 to 11, with headquarters at the Bancroft Hotel. Practically the whole time was given over to business meetings, reports, and discussions. The Tuesday morning session began with an address of welcome by George I. Alden, president of the Norton Co., and by Hon. George M. Wright, mayor of Worcester. Charles P. Steinmetz, chief advisory engineer of the General Electric Co., and president of the National Association of Corporation Schools, then presented his annual address, after which the various annual reports were read. During subsequent meetings, reports of the committees on trade apprenticeship schools, special apprenticeship schools, public education, vocational guidance, office work schools, advertising, selling and distribution, employment plans, and safety, hygiene and cooperation, were presented. After each report, about two hours was allowed for discussion, so that each subject was very thoroughly dealt with. On June 8 an inspection was made of the Worcester Boy's Trade School in the afternoon, and on June 9 the plants of the Norton Co. and the Norton Grinding Co. were inspected by the delegates and visitors. A supper was served in the open, and after the supper the Norton Co. provided an entertainment that was highly appreciated. Later a session was held in the Norton Co.'s administration hall. Extensive exhibits of educational value and interest were arranged for on the mezzanine floor of the Bancroft Hotel. The convention undoubtedly proved of especial value to all the delegates interested in corporation and trade school work. Representatives of public schools were also present at many sessions.

SPRING MEETING OF A. S. M. E.

The spring meeting of the American Society of Mechanical Engineers was held in Buffalo, N. Y., June 22-25, the Hotel Statler being the headquarters. On Tuesday evening an address of welcome was made by Frank B. Baird, representing the industries of Buffalo, to which John A. Brashear, president of the society, responded. An informal reception and reunion followed. On Wednesday, June 23, the party went to Niagara Falls by special trolley cars, where a business meeting was held in the auditorium of the Shredded Wheat Co.'s factory. At this meeting, the following papers were presented:

"The Study of a Shaft and Its Improvement by Heat-treatment," by John Younger.

"A Comparison of the Properties of Nickel, Copper and Manganese Steel," by Robert R. Abbott.

"Use of Corrugated Furnaces for Vertical Fire-tube Boilers," by F. W. Dean.

"On Measuring Gas Weights," by Thomas E. Butterfield.

The afternoon was spent in an inspection of the attractions of Niagara Falls, the power plants on the Canadian and American side, etc. Wednesday evening Dr. F. H. Newell, formerly chief of the U. S. Reclamation Service, gave an illustrated lecture on "The Engineer as a Citizen" in the ball room of the Hotel Statler. Thursday forenoon was devoted to professional sessions at which the following papers were presented:

"Rational Design and Analysis of Heat Transfer Apparatus," by E. E. Wilson.

"Influence of Disk Friction on Turbine Pump Design," by F. zur Nedden.

"Surface Condensers," by C. F. Braun.

"Some Mechanical Features of the Hydration of Portland Cement and the Making of Concrete as Revealed by Micro-Harding.

"Design of Rectangular Concrete Beams," by Howard scopic Study," by Nathan C. Johnson.

"Model Experiments and the Forms of Empirical Equations," by Edgar Buckingham.

"The Effect of Relative Humidity on an Oak Tanned Leather Belt," by W. W. Bird and F. W. Roys.

Thursday afternoon was devoted to sight-seeing trips, etc. The reception and dance, the leading social function of the spring meeting, was held in the ball room of the Hotel Statler Thursday evening. Friday morning, at the professional session, the following papers were presented:

"Laws of Lubrication of Bearings," by M. D. Hersey.

"Relation between Production and Costs," by H. L. Gantt.

"Laps and Lapping," by W. A. Knight.

The regular nominating committee announced the following nominations of officers for election next fall: D. S. Jacobus for president; J. Sellers Bancroft, Julian Kennedy and W. B. Jackson for vice-presidents; H. de B. Parsons and John A. Stevens for managers.

* * *

In an address before the Patent Bar Association, at Chicago, Thomas Ewing, commissioner of patents, called attention to the great number of interferences that are a constant source of trouble to the examiners and applicants. There are forty-three primary examiners who declare interferences wherever it is thought necessary. Each examiner who declares an interference also hears the motions to dissolve it, so that an interference once started can only be dissolved by inducing the examiner to reverse himself. This has caused serious criticism of the patent system. Of late, one of the two law examiners that aid in the work of the patent commissioner has been devoting his entire time to going over all proposed interferences with the examiners before these interferences were declared. The result has been that twenty-five per cent of interferences proposed by the examiners have never been declared. In order to effect this reduction a practice has also been tried of not establishing interferences where the difference of dates of filing of the applications involved exceeds two years. It has been found that where the difference of filing dates exceeds one year, the party filing the application first has won in nearly all cases.

CHART RECORDING MECHANIC'S PROGRESS

The cause of progress in life might be summed up in one word—discontent. Be discontented with your present condition if you would change to a better one. Every ambitious person is discontented—for if he were not he would not strive so hard to change to a more agreeable environment. Contentment is a foe to progress, and ambition is commendable provided it is rightly directed. Many a mechanic has been contented to remain a journeyman because he was well satisfied. If he had been discontented he would have gone ahead, made a name for himself and perhaps died rich enough to endow a few libraries.

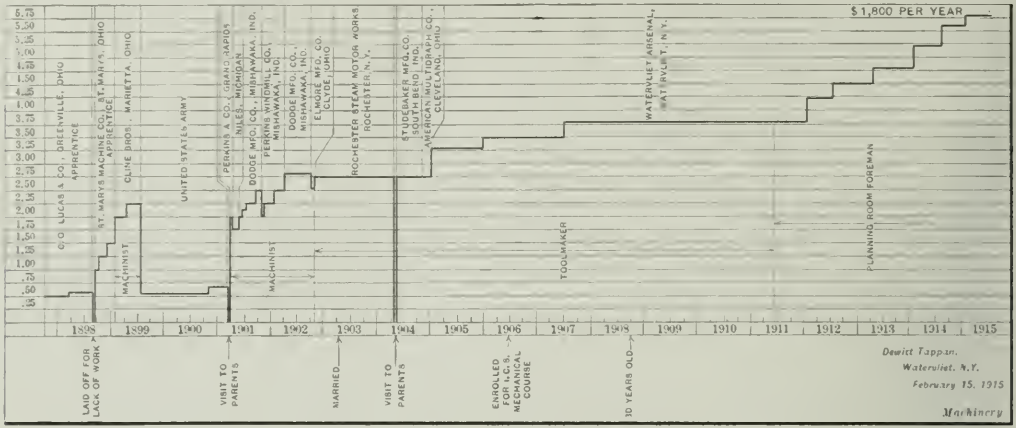


Chart of a Mechanic's Career from 1898 to 1915

It is the custom to take inventory of stock once a year, and it is a good plan for every individual to occasionally take stock of himself and his resources, and to record progress made. The simplest way of keeping a record of progress is to draw a chart, showing year by year, income, occupation, position and other data of interest. The accompanying chart, furnished by Dewitt Tappan, Watervliet, N. Y., is an excellent example of a personal record and is one showing satisfactory progress, but one not without ups and downs such as most mechanics experience—at least in their early years following apprenticeship. It will be noted that in 1906 he enrolled for a home study course in mechanical engineering and that substantial advancement in salary has been achieved since. Mr. Tappan has been a reader of and a contributor to MACHINERY for many years.

The executive of a great railway system has compiled a chart recording his personal career, and while it shows extraordinary and rapid advancement, a very significant feature is that the advancement was most notable at the time when he became a contributor to the railway technical journals. His contributions advertised his personality and writing stimulated his mental activities. Employers should take notice of this fact, especially the heads of the larger manufacturing concerns who have displayed in late years a tendency to stifle the ambitions of certain of their employes to contribute articles or papers for publication. This policy was adopted by employers for fear that certain "trade secrets" would be revealed and their business injured by giving advantages away to their competitors. This policy, like most other repressive measures, is likely to prove harmful to the concerns responsible. Ambition and mental activity are deadened, and employes who might have been leaders become unambitious and unfruitful except as they produce in the treadmill of daily work.

* * *

THE SHORT-PAID POSTAGE NUISANCE

The subject of short-paid postage on foreign mail has been reported upon by consular officers at such length and with such frequency that further discussion would seem needless. That the practice still continues and that possible purchasers of American goods are still annoyed by the receipt of underpaid letters from the United States is shown by a communication from F. St. Austell, editor of the *International Trade Developer*, who writes:

"Mr. Dunn, secretary of the Pan American States Association, recently received from William E. Jessup, a resident of Guatemala, a package containing 140 underpaid envelopes sent to him in one month by merchants of the United States who wish to sell their goods in Guatemala. Mr. Jessup states that his only reason for taking these 140 letters from the post office and paying the extra postage was that he might send the entire lot to Mr. Dunn as an object lesson to exporters."

* * *

PERSONALS

Clyde M. Carr, president of Joseph T. Ryerson & Son, Chicago, Ill., has returned to Chicago from Santa Barbara, Cal.

Prosper J. Hoeffler has taken a position with the Lumen Bearing Co., Buffalo, N. Y., as a salesman of babbitts and solders.

H. A. Flagg, formerly sales manager of the tubing department of the Standard Welding Co., Cleveland, Ohio, has been made general sales manager in charge of all sales, orders and branch offices.

S. W. Hartley, formerly sales manager of the Standard Welding Co., Cleveland, Ohio, has been made manager of production, in charge of all manufacturing orders, raw materials and finished parts.

Edward S. Wales-Smith, for many years traffic agent of the American Express Co., with an office in Paris, France, has been sent to Petrograd, Russia, for the purpose of developing Russian trade with the United States.

J. E. MacArthur, formerly connected with the Pierce-Arrow Motor Car Co., and more recently superintendent of the Keystone Mfg. Co., Buffalo, N. Y., resigned May 1 to become general superintendent of the Robinson Fire Apparatus Mfg. Co., St. Louis, Mo.

W. C. Tharp has been appointed district manager of the Hoskins Mfg. Co.'s Pittsburg office, succeeding I. J. Shults, resigned. Mr. Tharp has been associated with the Republic Iron & Steel Co., the Scientific Materials Co. and the Metallurgical Testing Laboratory of Pittsburg.

Holden A. Evans has been made general manager of the Baltimore Dry Dock & Shipbuilding Co., Baltimore, Md. This company recently acquired the two ship-building plants and other properties of the Skinner Shipbuilding & Dry Dock Co., of which Mr. Evans had charge for the past year.

A. B. Hazzard, for six years general manager of the J. Morton Poole Co., Wilmington, Del., and later one of the staff of managers of the Detroit Engine Works, Detroit, Mich., is now engineer of the Falcon Motor Truck Co. of Detroit. This company has recently put a light delivery motor truck of from 1000 to 1200 pounds capacity on the market.

H. T. Matthew has been appointed Pacific Coast representative of the Society for Electrical Development, 29 W. 39th St., New York City. Mr. Matthew was for six years business manager of the *Electrochemical Industry*, and later western manager of the *Electrical World*. For the past three years he has represented the McGraw publications on the Pacific Coast.

A. T. Spencer, export trade agent of the American Express Co., New York City, sailed for Europe in May with the intention of visiting the principal ports on the Baltic Sea, as well as Petrograd, Libau, Riga, Moscow, Archangel, and other Russian cities. Mr. Spencer will cooperate with Edward S. Wales-Smith in his work of placing Russian importers in touch with American manufacturers.

Herbert H. Rice, formerly vice-president of the Waverley Co., electric vehicle manufacturer of Indianapolis, Ind., has been made president of the company, following the retirement of William B. Cooley. Mr. Rice was graduated from Brown University in 1892, and received his training with Col. Albert A. Pope in the early days of the bicycle business. In 1904 he was sent to Indianapolis to take charge of the Waverley factory, then recently acquired by the Pope Motor Car Co. About the same time, Wilbur C. Johnson, also of the Pope Motor Car Co., joined the Waverley branch and he now becomes vice-president of the reorganized Waverley Co.

OBITUARIES

George M. Russell, advertising manager of J. H. Williams & Co., Brooklyn, N. Y., died at his home in Brooklyn, April 22, aged fifty-four years. Mr. Russell had been connected with J. H. Williams & Co. for twenty-four years, first as purchasing agent and then as advertising manager. He leaves a widow, a son and daughter.

Elmer Crawford, president and founder of the Crawford Publishing Co., Chicago, Ill., and editor of *Mill Supplies*, died in Chicago, June 15, from heart failure. Mr. Crawford was born in Michigan in 1862, graduated from the law school of the University of Michigan in 1886, and was later admitted to the bar of that state. In 1899 he became connected with the *Tradesman*. The following year he associated himself with *Domestic Engineering*, and in 1910 he established the Crawford Publishing Co. and became its president and editor of *Mill Supplies*. He is survived by his wife, a daughter, and son.

COMING EVENTS

August 17.—Annual meeting of the International Railroad Blacksmiths' Association, Philadelphia, Pa. A. L. Woodworth, secretary-treasurer, C. H. & D. Railway, Lima, Ohio.

September 7-10.—Twenty-third annual convention of the Traveling Engineers' Association, Hotel Sherman, Chicago, Ill. W. O. Thompson, secretary, East Buffalo, N. Y.

September 9-11.—Swedish engineering convention in the United States; meeting in Chicago. Secretary, Eastern organization committee, E. Oberg, 183 68th St., Brooklyn, N. Y.; secretary Western organization committee, C. G. Axell, 601 City Hall Square Bldg., Chicago, Ill.

September 25-October 2.—Annual exhibit of the Foundry & Machine Exhibition Co., Atlantic City, N. J., in conjunction with the American Foundrymen's Association convention. Foundry & Machine Exhibition Co., 1949 W. Madison St., Chicago, Ill.

September 27-October 1.—Annual convention of the American Foundrymen's Association, Atlantic City, N. J.

SOCIETIES, SCHOOLS AND COLLEGES

Beloit College, Beloit, Wis. Catalogue for 1914-15.

University of Vermont, Burlington, Vt. Catalogue for 1914-15.

Louisiana State University, Baton Rouge, La. Catalogue 1915-1916.

Montana State School of Mines, Butte, Montana. Catalogue for 1915-16.

Upper Iowa University, Fayette, Iowa. Bulletin containing catalogue for 1914-1915.

Lowell Textile School, Lowell, Mass. Quarterly bulletin containing catalogues for 1915-16.

Newberry College, Newberry, S. C. Catalogue for 1914-1915 and announcements for 1915-1916.

Princeton Summer School, Princeton, N. J. Announcement of the twenty-fourth annual session which opens July 12. Address C. R. Morey, Princeton, N. J.

National Founders' Association, M. W. Alexander, chairman, West Lynn, Mass. Bulletin 23: "Good Light—An Important Safety Factor." This bulletin was approved by the conference board on Safety and Sanitation, composed of the National Founders' Association, the National Association of Manufacturers, the National Metal Trades Association, and the National Electric Light Association. It is a short treatise on artificial lighting in foundries, dealing with the various forms of lighting that have been used successfully for foundry installations.

NEW BOOKS AND PAMPHLETS

The Pennsylvania Railroad—Its Policies Toward Its Employes. 60 pages, 6 by 9 inches. Published by the Pennsylvania Railroad, Philadelphia, Pa.

Standards for Gas Service. 197 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular of the Bureau of Standards 32, third edition.

Location of Ford Model T Engine Troubles Made Easy. Wall chart, 23 by 30 inches. Published by the Norman W. Henley Publishing Co., New York City. Price, 25 cents.

Proposed National Electrical Safety Code. 137 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular of the Bureau of Standards No. 54.

Safety Rules to be Observed in the Operation and Maintenance of Electrical Equipment and Lines. 50 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular of the Bureau of Standards No. 49.

The Effect of Boron Upon the Magnetic and Other Properties of Electrolytic Iron Melted in Vacuo. By Trygve D. Yensen. 19 pages, 6 by 9 inches. Illustrated. Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill., as Bulletin 77. Price, 10 cents.

Yearbook of the Department of Agriculture—1914. 715 pages, 6 by 9 inches. Illustrated. Published by the Department of Agriculture, Washington, D. C.

This government publication contains much useful information for the homes of all classes of citizens.

Steam-Boiler Explosions. By William H. Boehm. 24 pages, 6 by 9 inches. Illustrated. Published by the Fidelity & Casualty Co., New York City.

This short treatise on steam-boiler explosions, their causes and the destructive effects following explosions, should be in the hands of every steam engineer and fireman, and manager of plants having steam boilers.

South American Handbook. 75 pages, 6 by 9 inches. Published by the National Foreign Trade Council, 64 Stone St., New York City. Price, 25 cents.

This pamphlet is a compilation of information and statistics regarding the public investment, foreign and railway development of the South American republic. It was compiled for the benefit of business men who are turning to American markets for the extension of trade.

Road Models. 24 pages, 6 by 9 inches. Illustrated. Published by the United States Department of Agriculture, Washington, D. C., as Bulletin 220.

The contents of this interesting and public document comprise Roman roads, French roads, macadam method of construction, Telford method of road building, location and alignment, foundations, earth and earth-clay roads, gravel roads, macadam roads, cement concrete roads, bituminous concrete roads, paved roads other than cement, culverts and bridges, roadside treatment, and road machinery.

Flywheel Explosions. By William H. Boehm. 24 pages, 6 by 9 inches. Illustrated. Published by the Fidelity and Casualty Co., New York City.

This pamphlet is a companion to the short treatise on steam-boiler explosions. Flywheel explosions are nearly as disastrous as boiler explosions. The average man little suspects what tremendous potential energy is set free when a large flywheel bursts. The author points out the weaknesses of flywheels, gives rules for speeds and recommendations which if followed would reduce the danger of flywheel explosions to a minimum.

Acme Automatic Multiple-Spindle Screw Machines—Design, Construction, Operation, Tool Equipment and Attachments. By Douglas T. Hamilton. 63 pages, 7 by 8¾ inches. 104 illustrations. Published by the National-Acme Mfg. Co., Cleveland, Ohio.

This treatise on the "Acme" automatic multiple-spindle screw machines is a revision of the articles published in MACHINERY from December, 1912, to November, 1913, inclusive. These articles treated of the design, construction, operation, tool equipment, attachments, examples and methods of setting up, and dealt intimately with the details a successful operator must be thoroughly familiar with. The treatise is one that screw machine operators generally, and operators of the National-Acme machine in particular, should heartily welcome.

Organization of Workshops and Factories. By Robert Grimshaw. 104 pages, 3½ by 5¼ inches. Published by the author, 1330 St. Nicholas Ave., New York City. Price, 50 cents.

This little work is an addition to the already long list of books on factory management and efficiency methods. It treats of the "nine principles" of organization, choice of system, calculating manufacturing cost, calculating material, measuring and recording time, distribution of time, time records, shortening time of manufacture, inspection, sources of material, ordering material, storerooms, personnel, filling vacant positions, machines, correspondence, new designs, prevention of accidents, day's wages, piecework, contractor system, profit sharing, premium systems, stock-keeping, etc.

Location of Carburetion System Troubles Made Easy. Chart by Victor W. Page. Published by the Norman W. Henley Publishing Co., New York City. Price, 25 cents.

This chart in the form of a wall hanger, 26 by 28 inches, gives a concise statement of the common derangements likely to develop in the carburetion system of an automobile power plant. It is intended to supplement the chart entitled, "Systematic Location of Gas Engine Troubles," recently published by the same company. The illustration shows the parts nearly full size, all being named in large type. The information is divided into two heads, "Motor Will Not Start" and "Loss of Power and Misfiring." The cause of the trouble and the remedy is given under each head for all the troubles likely to develop. There are also notes on carbureter adjustment.

A Study of Boiler Losses. By A. P. Kratz. 72 pages, 6 by 9 inches. 31 illustrations. Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill., as Bulletin 78. Price, 35 cents.

The bulletin presents an analysis of the data obtained from a series of twenty-five trials made on a 500 H. P. Babcock & Wilcox boiler located in the heating plant of the University of Illinois. The boiler was operated under varying conditions of load and depth of fuel bed. Conclusions are drawn regarding the conditions necessary in order to secure the best continuous operation. Tests were also made using samples of coal which had been exposed to the weather for about six years. An interesting fact brought out was that no difficulty was experienced in burning weathered coal.

Short-Unit Courses for Wage Earners, and a Factory School Experiment. 93 pages, 6 by 9 inches. Published by the Department of Labor, Bureau of Labor Statistics, Washington. D. C., as Bulletin 159.

The bulletin contains a list of short-unit courses in various trades and occupations, and a discussion of their application to trade-extension work in part-time and evening schools. These short courses are intensified forms of instruction, intended to serve, in a limited number of lessons, the specific need of the particular group. Each unit deals with one part of the trade, and is complete in itself. The courses outlined include mechanical and electrical drawing, machine drawing, architectural drawing, drawing for sheet-metal workers, patternmaking, machine-shop mathematics, etc.

Banking and Credit in Argentina, Brazil, Chile, and Peru. By Edward N. Hurley. 77 pages, 6 by 9 inches. Published by the Department of Commerce, Bureau of Foreign and Domestic Commerce, Washington, D. C., as Special Agent's Series No. 90.

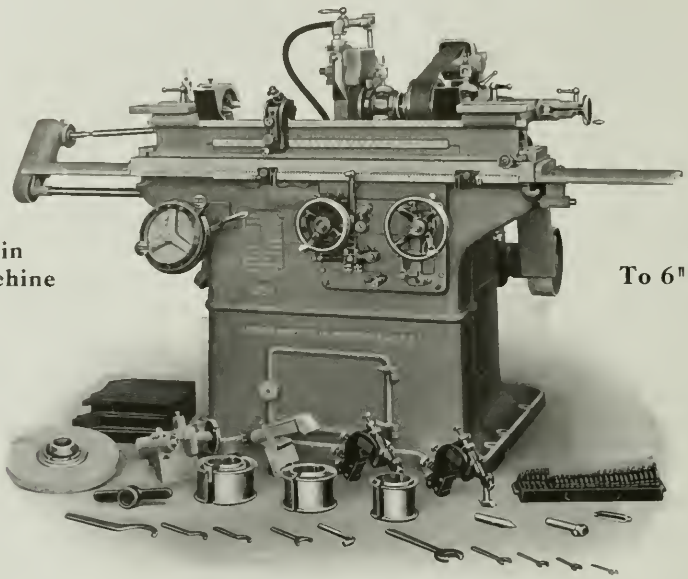
This government work should be of interest and value to many concerns now endeavoring to establish trade relations in South American countries. It is a report incorporating observations and conclusions from a manufacturer's point of view of the existing banking situation as related to present and future American trade in Argentina, Brazil, Chile and Peru. The functions of banks in South America are described, and the activities of the British, German and other European banks are dealt with; also banking and credit in Argentina, Brazil, Chile and Peru and methods of establishing American banks.

Elementary Drawing. By Charles W. Weick. 250 pages, 6 by 9 inches. 154 illustrations. Published by the McGraw-Hill Book Co., New York City. Price, $1.75.

The book under review aims to provide an elementary text-book for class use. The author, who is assistant professor of drawing and design at the Teachers College of Columbia University, has met the requirements for such a work in a very satisfactory manner. The object of the book is to cover both theory and practice. The treatment of the theory in the text is as brief as clearness permits, but is handled in such a manner and illustrated with engravings of such a character that the meaning is always fully expressed. The conventions of the drawing-room are duly explained. The book comprises ten chapters headed: Instruments and Materials; The Use of Instruments; Methods of Procedure in Drawing; Lettering; Drawing-room Practice and Conventions; Projection; Mechanical Drawing Practice; Geometrical Problems; Mensuration; Reproduction of Drawings.

The Model T Ford Car. By Victor W. Page. 288 pages, 5 by 7½ inches. 94 illustrations. Published by the Norman W. Henley Publishing Co., New York City. Price, $1.

This book is a tribute to the success of the Ford car, and it runs on all fours with the accessories manufactured exclusively for the Ford car by many concerns. With the close of the 1915 season's business, there will be probably 600,000 Ford cars of all types in use. This is the only



No. 11 Plain Grinding Machine

Capacity To 6" Dia. 32" Long

Our New Self-Contained Plain Grinding Machines

The new design of our Nos. 10 and 11 Plain Grinding Machines means a further increase in the already high operating efficiency of these machines. They are now entirely self-contained, having single pulley constant speed drives that do away with complicated overhead works. This adapts them particularly well to a motor drive.

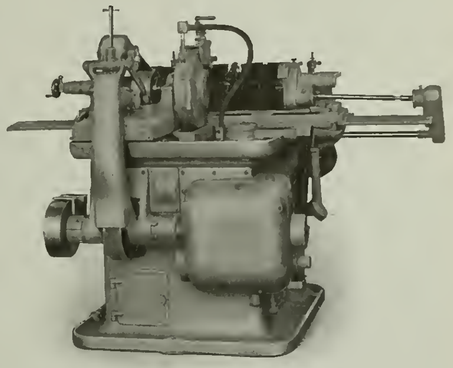
Efficient features of previous designs, such as the multiple friction disk variable speed mechanism and the automatic cross feed, are still retained. Thus in addition to a simplified and more efficient drive there is a wide range of speeds and feeds from which the most productive combination can be quickly selected. The automatic cross feed can be set to reduce pieces to a predetermined size and automatically disengage without attention from the operator, thus allowing him to prepare work or run other machines while a piece is being ground. If you are interested in the type of grinding efficiency that means saving time and money, the following features of these machines are worth your careful consideration:

BROWN & SHARPE MFG. CO.,

OFFICES 20 Vesey St., New York, N. Y., 654 The Bourse, Philadelphia, Pa., 626-630 Washington Blvd., Chicago, Ill., 305 Chamber of Commerce Bldg., Rochester, N. Y., Room 419, University Block, Syracuse, N. Y.

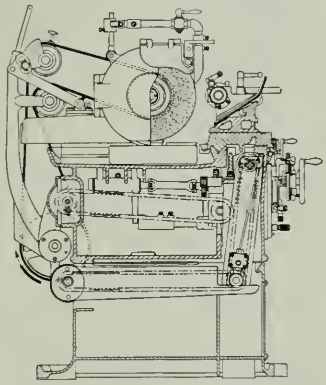
REPRESENTATIVES Baird Machinery Co., Pittsburgh, Pa., Erie, Pa.; Carey Machinery & Supply Co., Baltimore, Md.; E. A. Kinsey Co., Cincinnati, O., Indianapolis, Ind.; Pacific Tool & Supply Co., San Francisco, Cal.; Strong, Carlisle & Hammond Co., Cleveland, O., Detroit, Mich.; Colcord Wright Machinery & Supply Co., St. Louis, Mo.; Perine Machinery Co., Seattle, Wash.; Portland Machinery Co., Portland, Ore.

Main Drive



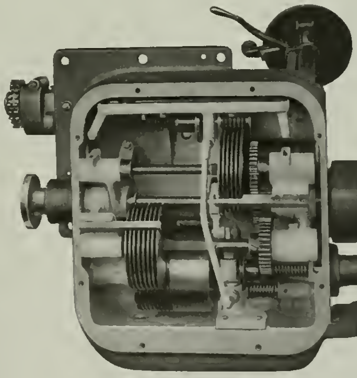
The rear view of one of these machines shows the main driving shaft. This shaft runs in ball bearings. The driving pulley at the left end carries a 3" belt and runs at 900 R. P. M., the high speed and large belt contact insuring ample power. The large pulley located near the center of the shaft drives the wheel spindle. The variable speed case is shown, this also being directly coupled to the main drive. Note the liberal size of the bearings of the driving shaft.

Wheel Drive



The accompanying line cut illustrates the general arrangement of the drive throughout these machines and shows the manner of driving the wheel. A 3" belt runs from the large pulley on the main shaft over a pair of idler pulleys to the wheel spindle. These idler pulleys are carried in a swinging arm so connected to the wheel stand that the cross travel of the wheel does not alter the belt tension nor interfere with the accurate feeding of the wheel. Varying wheel speeds are obtainable by means of split pulleys which can be quickly clamped on the wheel spindle. One of the idler pulleys can be adjusted to take care of the difference in belt tension when pulleys are changed. The location and arrangement of the silent chains which form a part of the

Head-stock and Table Drive



are also shown. These chains are driven by sprockets from the variable speed mechanism, the upper chain driving the table, the lower chain, in conjunction with the one running vertically, driving the head-stock through a splined shaft, a telescopic shaft and universal joints. This drive is shown at the right side of the machine in the top picture. The cut showing the interior of the variable speed case gives an excellent view of the arrangement of the multiple friction disks which give the smooth and powerful drive for the table and head-stock.

Write for descriptive literature.

PROVIDENCE, R. I., U. S. A.

CANADIAN: The Canadian-Fairbanks-Morse Co., Ltd., Montreal, Toronto, Winnipeg, Calgary, Vancouver, St. John, Saskatoon.

FOREIGN: Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow. F. G. Kretschmer & Co., Frankfurt, a/M., Germany; V. Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway; Schuchardt & Schutte, Petrograd, Russia; Fenwick Freres & Co., Paris, France; Liege, Belgium; Turin, Italy; Zurich, Switzerland; Barcelona, Spain; The F. W. Horne Co., Tokio, Japan; L. A. Vail, Melbourne, Australia; F. L. Strong, Manila, P. I.

READ PAGE 67

make of motor vehicle in the world that is sold in sufficient quantities to warrant the publication of a special treatise on its repair and maintenance. The work deals with the car, its parts, their functions, the engine and auxiliary groups, details of the chassis, driving and maintenance of Ford cars, and overhauling and repairing the mechanism. It was prepared especially for Ford drivers and owners, and was written by an owner who has driven and repaired a Ford car for a number of years. The illustrations were made especially for the work, and are not to be confused with the illustrations used by the manufacturer in his general literature.

Practical Applied Mathematics. By Joseph W. L. Hale. 206 pages, 4½ by 7 inches. 184 illustrations. Published by the McGraw-Hill Book Co., New York City. Price, $1.

This work is intended for public, private, trade, vocational schools, and corporation schools of manufacturing industries and railroads. It is based on the author's experience in the organization and development of schools for railway shop apprentices. He found no text-book suitable for these schools, and to meet the needs of his pupils, a series of instruction sheets were developed. The book deals with the simple mathematical fractions; decimals; percentage; ratio and proportion; measurement of angles; mensuration of rectangles and other four-sided figures; mensuration of triangles; the circle; mensuration of simple solids; use of rules and formulas; simple equations; the binomial; use of tables and curves; cube root; mensuration of prisms, pyramids and cones; mensuration of miscellaneous solids; miscellaneous rules for polygons; miscellaneous rules for length, area and volume; and the metric system of measurement. Each chapter contains a number of practical problems involving quantities of materials used by railways or manufacturers.

Lathes: Their Construction and Operation. By George W. Burley. 231 pages, 4½ by 7¼ inches. 200 illustrations. Published by Scott, Greenwood & Son, London, and D. Van Nostrand Co., New York City. Price, $1.25, net.

This work by a well-known British contributor to MACHINERY was written with the object of presenting a survey of the whole field of lathe construction and operation from the descriptive point of view. Necessarily, therefore, the treatment is elementary, because of the extensiveness of the subject and the limitation of space. It deals with the evolution of the lathe, the classification of modern lathes, hand turning lathes, engine lathes, turret lathes, vertical lathes, special lathes, lathe accessories, lathe cutting tools, lathe work, cutting speeds and feeds, and contains an appendix of tables as follows: List of screw threads that can be cut on Hendey-Norton lathe; list of change gear wheels for cutting English threads; and list of change gear wheels for cutting metric threads. The book should be useful to those wanting a general survey of lathes used for metal turning, students and others interested in metal-working machinery. The machinist will find useful information on lathe construction and descriptions of accessories, some of which are not in common use in America.

Experiences in Efficiency. By Benjamin A. Franklin. 167 pages, 5 by 7½ inches. Published by the Engineering Magazine Co., New York City. Price, $1.

This book by Mr. Franklin gives specific examples of efficiency methods and the saving resulting from the adoption of the same, as noted in his experience. A few weeks' study of the workmen's tendencies in a certain factory effected a saving of about $30,000 yearly. Nothing was spent for new equipment, nor was any change made in the organization and personnel. The saving was effected by correcting wrong conditions—in other words, by reorganizing the methods. The author begins with that which is generally uppermost in the manufacturer's mind—the handling of labor. Four chapters are given over to methods of increasing both output and quality of direct production. The fifth chapter extends the same principle to the treatment of clerical or non-productive labor, and the sixth enlarges the same ideas applied to include the entire force. Then follow chapters on increase in production by a simple reorganization, reducing the factory expenses, building a cost system, and the necessity of efficiency will. This work forms a unit of the Engineering Magazine Co.'s works management library.

Modern Toolmaking Methods. Compiled and edited by Franklin D. Jones. 309 pages, 6 by 9 inches. 176 illustrations. Published by the Industrial Press, New York City. Price, $2.50.

Considering the fact that the work of the toolmaker requires an unusual degree of skill and refinement and that it is of great importance in interchangeable manufacture, it is surprising to note how little has been published on toolmaking practice. This volume of "Modern Toolmaking Methods" is, therefore, believed to meet a real need as it deals with a great variety of tool-room problems and explains many important toolmaking operations. Some of the methods described represent standard practice, whereas a great many are of special operations that have been developed in different shops. The treatise covers quite completely the methods and operations which are fundamental and essential to the production of small tools and precision work. It also contains many valuable rules, simple formulas and typical calculations that will aid in the solution of the practical problems met with in the tool-room. As accuracy is essential to all toolmaking operations, the various methods for locating, spacing and dividing precision work have been made a special feature in this book. The book is divided into eight chapters headed as follows: Precision Locating and Dividing Methods, Laps and Lapping, Straight and Circular Forming Tools; Precision Threading; Threading Chaser Troubles and Remedies; General Toolmaking Operations; Precision Bench Lathe Practice; Gages and Measuring Instruments.

Combined Power and Heating Plants. By Charles L. Hubbard. 408 pages, 6 by 9 inches. 220 illustrations. 98 tables. Published by McGraw-Hill Book Co., New York City. Price, $3.

This work is Part III of a series of three volumes on "Power, Heating, and Ventilation," the first of which deals with "Steam Power Plants" and the second with "Heating and Ventilating Plants." This third part on "Combined Power and Heating Plants" relates especially to power and heating equipment for large buildings, such as office buildings, department stores, hotels, machine shops, foundries, and factory buildings in general. The various problems have been treated broadly and with special reference to the steam requirements. The equipment relating to the generation and use of steam has been considered in detail. It is assumed that the user of this book is already familiar with the common details of heating and ventilation, and, hence, attention has been given only to such special requirements as may be met with in the buildings under consideration. The various steps in the design of power and heating plants for the service referred to have been taken up in logical order, and computations worked out in detail to show their application to special requirements. The twelve chapters of the book are headed as follows: Heating and Ventilating Requirements for Different Types of Buildings; Working Data for Steam and Hot-water Heating; Working Data for Hot-blast Heating and Ventilation; Central Plants; Power and Steam Requirements for Different Types of Buildings; The Boiler Plant; Steam Engines and Turbines; Auxiliary Equipment; Piping for Power Plants; Combined Power and Heating; Equipment and Operating Costs; Practical Examples in Design and Cost of Operation.

Valves and Valve Gears. By Franklin De Ronde Furman. 253 pages, 6 by 9 inches. 300 illustrations. Published by John Wiley & Sons, Inc., New York City. Price, $2.50.

This is the first volume of a work in two volumes on valves and valve gears, the first volume pertaining to steam engine and steam turbine valves. The author, who is professor of mechanism and machine design at Stevens Institute of Technology, first published a set of mimeographed notes in 1903 on this subject, and the present work has developed on the basis of these notes. A feature of the work is that all types of practical valves for steam engines and turbines have been segregated into seven fundamental forms, and the valve gear constructions have been grouped into six fundamental types. This gives the whole subject a logical arrangement. The book is divided into eight specific sections, headed as follows: Elementary Reciprocating Steam Engines, Valve Diagrams for Steam Engines, Fundamental Valve Forms, Fundamental Valve-gear Mechanisms, Practical Types of Valves for Reciprocating Steam Engines, Eccentrics and Shaft Governors for Steam Engines, Practical Steam Engine Valve Gears, and Steam Turbine Valve Gears. Much of the material in this work is based on visits to works and construction offices, in which the work in valve gears is carried on in a practical and commercial way, and it is therefore believed that the methods presented in this book will be found to agree closely with general practice. It has been made a rule to have the manufacturer of the valve gear or engine described pass upon the accuracy of the description and the illustrations that appear in this work. This gives the book an unusual stamp of authority, and it should prove useful both to students and designers of engine and turbine valves and gears.

Tools, Chucks and Fixtures. By Albert A. Dowd. 304 pages, 6 by 9 inches. 186 illustrations. Published by the Industrial Press, New York City. Price, $2.50.

This book comprises a comprehensive and detailed treatise covering the design and use of cutting tools and holding devices employed in turning and boring operations in modern manufacturing plants, for obtaining accuracy and increasing production. The book comprises mainly the articles on tools and holding devices for engine and turret lathes, and horizontal and vertical boring machines, which have been published in MACHINERY during the past year by the author. These articles have been recognized as constituting the most fundamental and complete descriptions of tools and devices for machining operations ever published, and have, therefore, been collected and are now published in this volume. In addition to the chapters applying specifically to boring and turning operations, considerable attention has been paid to the design of tools and holding devices relative to the cost of keeping them in repair—considerations which are of prime importance in economical shop management. Perhaps the most valuable feature of this book is that the arbors, chucks, fixtures, and other holding devices shown are illustrated complete with their working details, and not merely in diagrammatic form, and also that these devices are examples of designs actually employed in practice and successfully applied to productive work in a great number of manufacturing establishments. The descriptions of the tools are in plain matter-of-fact statements and will appeal with especial force to the great body of men of practical training who are seeking specific and up-to-date information. It is the belief of the author and the publishers that the work fills a well-defined gap in existing mechanical literature and that the direct and definite method by which the information is conveyed to the reader will meet with the approval of the trade for which this book has been prepared. The contents are divided into a number of chapters, each covering one particular phase of the subject. The headings of the chapters are as follows: Adjustable and Multi-cutting Turning Tools; Design of Boring Tools; Recessing Tools; Floating Reamer Holders; Arbors for Turning, Boring and Grinding; Holding Devices for Lathe and Boring Mill Work; Methods of Machining Thin and Irregular Work; Taper Boring and Turning Attachments; Machining Convex and Concave Surfaces; Methods for Machining Eccentric Work; Counterbalanced and Indexing Fixtures; Influence of Chips on the Design of Tools and Fixtures; Providing for Upkeep in the Design of Cutting Tools.

Text-book of Advanced Machine Work. By Robert H. Smith. 520 pages, 5 by 8 inches. 609 illustrations. Published by the Industrial Education Book Co., Boston, Mass. Price, $3.

This text-book has been prepared by the author, who has charge of the machine shops of the Massachusetts Institute of Technology, with a view to meeting the demand for a text-book in machine work for students in technical, manual training and trade schools, and for apprentices in machine shops. In his preface, the author calls attention to the fact that text-books have been prepared for the study of languages and all the sciences, whereas teachers and students of machine shop work, apprentices and machine operators, have been handicapped by the lack of text-books comparable with those that aid the student and teacher in other subjects, and for this reason he has prepared two text-books—one on "Principles of Machine Work" and one on "Advanced Machine Work"—the book under review being the latter of the two. In his book on advanced machine work, the author treats of engine lathe work, cutting tools, measuring, turning, fitting, threading, chucking, reaming, mandrels or arbors, curve turning and forming, inside calipers and inside micrometers, boring and inside threading, brass finishing, broaching, drilling jigs, boring, boring-bars and boring machines, eccentric turning, knurling, cylindrical, internal, surface and cutter grinding, planing, milling, spur, bevel, worm and spiral gear cutting, toolmaking, spiral milling, the plug and button methods of locating holes of precision in jigs and fixtures, and sine bars.

The book differs from the ordinary descriptive work on machine tool operation in that it is arranged strictly as a text-book, giving specific "problems" of work to be turned out by the student. The whole subject has been analyzed and arranged so as to afford a gradual step-by-step training in machine work, much the same as the student would be taught mathematics or mechanics by a simple orderly method. Machines, mechanisms and tools are illustrated mainly by perspective drawings so that the student who is not familiar with mechanical drawing may be able to get a comprehensive idea of the object represented. The drawings are, in many cases, so clearly marked with explanatory words and letters that many of them show the operations and processes involved more clearly than would an explanation in words. In addition, the book contains a great number of valuable tables and compilations of data that make it suitable for a reference book. In order to make reference to any particular part convenient, a very complete index is attached. The book is divided into twelve sections, each of which has the page number of the section preceded by the section number, this being a new idea in the arrangement of a book of this character. The instructor who is organizing a course will find a text-book of this character very valuable, because no lectures could possibly be as complete as is this book, and the data and illustrations will prove very useful to the student for study between the lectures. The whole arrangement of the book is founded on the author's thirty years' experience and study of the subject. The increased efficiency obtained at the Massachusetts Institute of Technology, by the use of these text-books, justifies high praise for them.

NEW CATALOGUES AND CIRCULARS

Bemis & Call Hardware & Tool Co., Springfield, Mass. Leaflet listing the line of wrenches manufactured by this company.

Dover Boiler Works, 50 Church St., New York City. Pamphlet of Dover rust-proof enameled tanks, guaranteed against rust.

Hanna Engineering Works, Chicago, Ill. Catalogue 3, describing and illustrating pneumatic riveters made by this company.

Allen-Bradley Co., Milwaukee, Wis. Bulletin 1154 on type H resistance starting switch for alternating current induction motors.

Hisey-Wolf Machine Co., Cincinnati, Ohio. Bulletin 1402-A on heavy-duty portable surface electric grinders, direct current only.

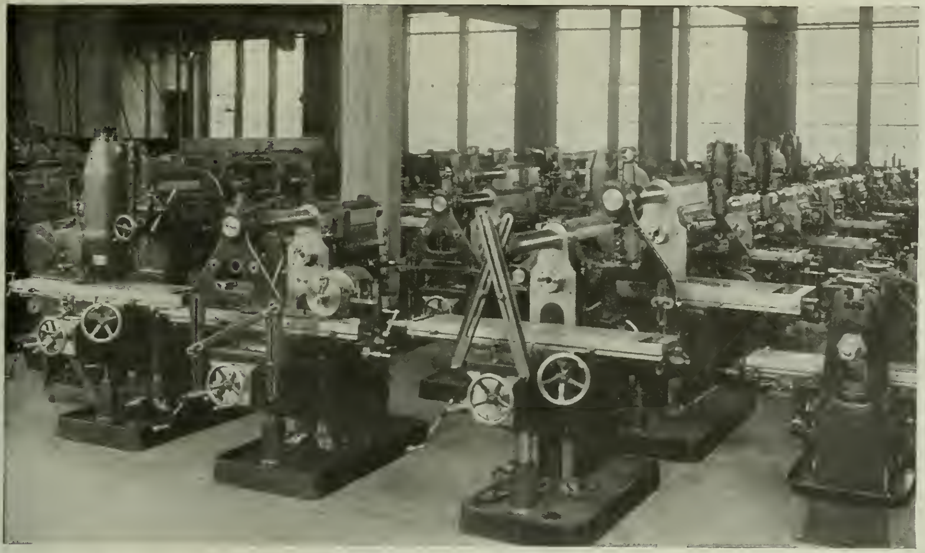
Harvey Hubbell, Inc., Bridgeport, Conn. General catalogue 15, containing 175 pages, 5 by 6 inches, devoted to electrical specialties of all kinds.

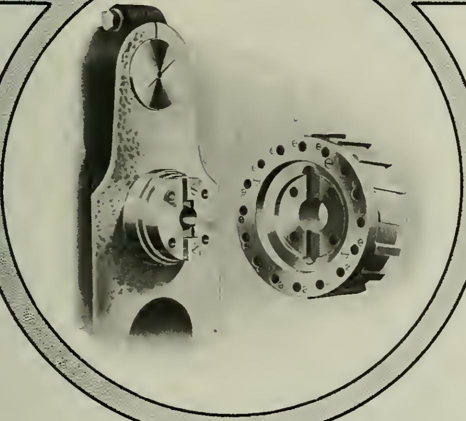
National Machinery Co., Tiffin, Ohio. Tapper Talk No. 3, illustrating the National automatic bent tap nut tapper that will tap nuts from 3/16 to ¾ inch.

Charles H. Besly & Co., 120 N. North Clinton St., Chicago, Ill. Pamphlet on the Besly disk grinder, illustrating the wide variety of work for which this machine is adapted.

Lucas Machine Tool Co., Cleveland, Ohio. Booklet "Saving Set-Ups in Railroad Shops," showing how the Lucas precision boring, drilling and milling machine is adapted for railroad work.

Lamson Co., 161 Devonshire St., Boston, Mass. Folder illustrating systems of the Lamson carrier or conveyor for effecting rapid transportation and quick communication inside factories, offices, etc.





Complete Interchangeability of Face Mills

Another Big Cincinnati Milling Improvement

We designed these flanged spindle ends, with hardened keys, for our large size High Power Millers and then adopted them for all Cincinnati Millers of High Power Design, Plain, Universal and Vertical, also 28″ Semi-Automatics. These spindle ends are all of the same size. Hence any one face mill will fit all of the 22 different sizes of Cincinnati Milling Machines shown above.

Now for further advantages:

Understand, first, the cutter is slightly counterbored to fit closely over the spindle end for centering it and is held in place by bolts. There is no centering plug required.

The drive is entirely through the hardened keys which are fitted to and form part of the spindle end.

The drive is powerful, durable and positive. And the face mills are easily put on and, even after heavy service, easily taken off.

Cutter arbors for these machines have a similar flange with a corresponding keyway. They are driven direct by the same keys in the flanged spindle end that are used for driving face mills. There is no intermediate driving collar.

The Bulletin which describes this latest Cincinnati Milling improvement is just off the press. Where shall we address your copy?

**The
Cincinnati
Milling Machine
Company**

CINCINNATI, OHIO, U. S. A.

Shore Instrument & Mfg. Co., 555-557 West 22nd St., New York City. Circular of the Shore "durometer" and "elastometer" for measuring the hardness and elasticity of rubber and other pliable materials.

Chicago Flexible Shaft Co., 149 W. La Salle St., Chicago, Ill. Catalogue 56 of Stewart gas and oil gas furnaces for the heat-treatment of metals, and positive pressure blowers and pyrometers.

Abrasive Material Co., Philadelphia, Pa. Booklet on "Boro-carbone," a new abrasive composed of oxide of alumina in crystalline formation, produced by fusing bauxite in an electric furnace by the arc process.

National Machinery Co., Tiffin, Ohio. "Tapper Talk No. 2" deals with the "National" automatic (bent tap) nut tapper, for which the advantages of bigger output, longer tap life and less tap breakage are claimed.

National Machinery Co., Tiffin, Ohio. Tapper Talk No. 4 "Why the Bent Tap Principle Makes the Ideal Automatic Nut Tapper." The bent tap principle enables the machine to run continuously in one direction.

Ingersoll Milling Machine Co., Rockford, Ill. Bulletin 32A containing a number of layouts illustrating methods employed by motor manufacturers in milling gas engine cylinders and crank cases on Ingersoll milling machines.

Bristol Co., Waterbury, Conn. Booklet of Bristol recording instruments distributed at the Panama-Pacific Exposition as a souvenir of the twenty-fifth anniversary of the manufacture of Bristol recording instruments.

Gem Mfg. Co., Pittsburg, Pa. Catalogue 8 of the products manufactured by this company, which include brazed seam oilers and torches, foundry chaplets, flue scrapers, flexible shafting, special dies, metal stampings and specialties.

Peerless Machinery Co., 45 Binford St., Boston, Mass. Leaflet advertising the "safety" toolholder. This tool will hold drills or reamers from ¼ to 1¼ inch, and will drill a perfectly true and parallel hole because of its floating feature.

Ingersoll-Rand Co., 11 Broadway, New York City. Bulletins 3031 and 4034 on the new Ingersoll-Rogler, class FR-1 steam-driven single-stage staight-line air compressor, and the type 26 Leyner-Ingersoll water drill, respectively.

Lucas Machine Tool Co., Cleveland, Ohio. Booklet entitled "Saving Set-Ups." This booklet describes the work for which the Lucas precision boring, drilling and milling machine is adapted, and illustrates this machine in operation on a wide variety of work.

Neil & Smith Electric Tool Co., Cincinnati, Ohio. Catalogue of portable electric tools, comprising variable and constant speed grinders, buffers, drilling machines, screw-drivers, portable flexible shaft screw-drivers, and portable direct-connected circular saws.

H. D. Smith & Co., Plantsville, Conn. Leaflet on the "enchased" joint slot-cutting pliers, which are provided with a new type of joint that has a bearing around its entire circumference except where there is an opening for a cutter. These pliers are made in 6-and 8-inch sizes.

The Bourse, Philadelphia, Pa. Circular illustrating the machinery exhibition hall and salesroom. The Bourse which is the machinery center of Philadelphia contains, besides the machinery exhibition and salesroom, about 450 offices, affording manufacturers office facilities convenient to the exhibition hall and salesroom.

Mesta Machine Co., Pittsburg, Pa. Horsepower chart for power transmission machinery, including gears, pulleys, rope wheels, etc. The chart is printed in small scale on a 9- by 12-inch page, but a large blueprint of it can be obtained from the company by engineers and others concerned with transmission problems.

Turbo-Gear Co., Industrial Bldg., Baltimore, Md. Circular of the "Turbo gear" speed transformer, consisting of a planetary herringbone gear combination for reducing the speed of high speed shafts. These gear transformers are made for various speeds from 500 to 6000 R. P. M., and various ratios from 1 to 16, to 1 to 85.

Cooper Hewitt Electric Co., Hoboken, N. J., has begun the publication of a house organ entitled, "The Output." The magazine is devoted to increasing production in manufacturing and other industries by the use of better lighting facilities. The leading article in the May number is "Lighting of a Punch Press Room," by Theodore D. Pratt.

Reynolds Pattern & Machine Co., 101-103 Third Ave., Moline, Ill. Catalogue of the Reynolds automatic screw driving machine for wood or machine screws. These are made in a variety of styles including machines with magazine feed and boring attachments, magnetic chucks, extension heads, etc.

National Machinery Co., Tiffin, Ohio. "National Forging Machine Talk No. 7" discusses the subject of protecting forging machines from damage from the gripping mechanism, and describes the automatic relief device provided on the gripping dies of "National" forging machines. The halftone and line illustrations make the construction very clear.

Ready Tool Co., 654 Main St., Bridgeport, Conn. Leaflet descriptive of the "Red E" belt-shifting pole which has been designed to eliminate the accidents that happen when an operator is obliged to climb a ladder and put on or take off a belt by hand. This belt-shifting pole complies with the requirements of the various state compensation acts.

Eck Dynamo & Motor Co., Belleville, N. J. Bulletin 1000 illustrating and describing a new line of direct current motors known as type D. These motors have several new features incorporated in their design, among which might be mentioned the use of commutating poles, positive ventilation by internal fans, and the employment of self-aligning ball bearings.

Chicago Pneumatic Tool Co., Chicago, Ill. Circular of the Chicago pneumatic banding press for compressing the copper bands on shrapnel shells. This press sets the bands on an 18-pound shrapnel shell in from seven to eight seconds, and its production with one operator is about one shell per minute, and with two operators from three to four shells per minute.

Keuffel & Esser Co., Hoboken, N. J. General catalogue, 566 pages, 5½ by 8½ inches (thirty-fifth edition), listing the complete line of drawing materials, surveying instruments and measuring instruments made by the company. The draftsman should find this book of considerable value, as it lists all the instruments and other paraphernalia that he might need in connection with his work.

National Tube Co., Pittsburg, Pa. Catalogue J of pipe fittings, valves and specialties manufactured at the Kewanee works of the company. The catalogue contains 450 pages, 5 by 7½ inches, and the index embraces approximately 1800 entries. The edition of this catalogue is strictly limited and it will be sent only to officials, purchasing agents and others responsible for the ordering of supplies.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, and 52 Vanderbilt St., New York City, has issued Bulletin 34-X on class A-G "Giant" gas and gasoline engines. The bulletin illustrates these engines in six sizes, ranging from 16 to 130 H. P. The engines are similar in general design to the "Giant" fuel oil driven engines manufactured by the same company, except that they are designed for operating with manufactured and natural gas.

New Departure Mfg. Co., Bristol, Conn. Bulletins 8 and 9, constituting loose-leaf catalogue data sheets of "New Departure" ball bearings and their applications to machinery. Bulletin 8 illustrates ball bearing mountings for multi stage turbine pumps, and Bulletin 9, ball bearing installations for light mine car wheels. A loose sheet table of contents, frequently revised, is also furnished for the convenience of users of data on these ball bearings.

Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa. Catalogue 49 illustrating the complete line of Newton standard and special slotters. The smaller sizes are crank driven, while the larger sizes are driven by screw or by rack and pinion. These machines are built to be driven by belt, pneumatic clutch or reversible motor. A few of the different designs of milling, boring, drilling and cold-saw cutting-off machines are also shown.

Detroit Twist Drill Co., 600-612 Fort St. West, Detroit, Mich. Booklet on the new "Detroit" quick-twist drill, including miscellaneous tables and general information for users of twist drills. The "Detroit" quick-twist drill is a departure from the common form in which the angles of the flutes are 25 degrees at the point and 20 degrees at the shank. The angles of the flutes of quick-twist drills are 27 and 32 degrees, respectively. The claim is made that a more acute cutting edge, larger chip space and freer action are secured by this change.

Willy Lamot, Shardhighs, Halstead, Essex, England, is forming an organization of Belgian business men, having for its object the introduction in Belgium when the war is over of American products, machines, etc., and the employment as agents, representatives, etc., of Belgian manufacturers and business men who were partly ruined but still possess sufficient capital and can give the necessary guarantees. American manufacturers interested in this prospective outlet for their products are invited to correspond with Mr. Lamot.

Blanchard Machine Co., 64 State St., Cambridge, Mass. Bulletin of the direct motor drive type of Blanchard high-power vertical surface grinder. A standard motor is incorporated in the wheel head of the machine, thus giving a compact and efficient drive. Simple means of forced ventilation are provided in the motor, which tends to prevent dirt from entering and keeps the motor temperature low, even when operated at heavy overloads. Details of the motor construction are shown, and an example of work for which this type of vertical machine is adapted.

Globe Machine & Stamping Co., Cleveland, Ohio, has issued an interesting booklet entitled "A Trip through the Globe Shop," which is illustrated with views of the offices and various shops included in the plant. A glance through the book will give an idea of the diversity of work done by this company. The product includes stampings of all kinds, sheet metal work, metal boxes for automobiles, steel reels and beams, tumbling barrels, etc. A cordial invitation is extended to all interested to visit the Globe shops and see for themselves the character of the work done.

General Electric Co., Schenectady, N. Y. Bulletin 41013 on direct current commutating pole motors, type RC. These motors have cast steel frames of medium weight and symmetrical section. They may be used with a sliding base which maintains a correct driving alignment and which, with the adjustable shields, permits the installation of the motor on the floor, wall or ceiling. They may be equipped with covers, rendering them semi-enclosed, totally enclosed or self ventilated. They are wound for 115, 230 and 550 volts direct current circuits, with permissible voltage range of from 110 to 125, 220 to 250, and 500 to 600 volts.

Charles Stecher Co., Chicago, Ill. Catalogue of automatic can-making machinery and machine tools, comprising lock-seam can-body making machines, wire bail forming machines, can earing machines, ear assembling machines, ear crimping machines, handle riveting machines, horning and wiring presses, beading and flanging machines, false wiring chucks, double seaming and false wiring machines, double seamers, crimping machines, folding and edging machines, heading and squeezing machines, square can machines, handle soldering machines, testing machines, ear sweating machines, ear coating machines, rivet spinners, screw presses, bench drilling machines, etc.

American Express Co., 65 Broadway, New York City. Booklet entitled, "What the American Express Co. meant to Americans in Europe During the War." The foreign organization of the American Express Co. embraces Great Britain, France, Germany, Italy, Scandinavia, Holland and Belgium. The intention is to establish branches in Buenos Aires, Manila, Hong Kong and other important cities in the Far East also. The company will cooperate with the sales department of American manufacturing concerns on ways and means of entering the foreign countries in which it operates. These and other services are offered for the promotion of American foreign trade.

TRADE NOTES

Buissono Bros. Mfg. Co., 3351 Parnell Ave., Chicago, Ill., has removed to its new plant located at this address.

John MacNab Machinery Co. has removed its office from 154 Chestnut Ave., Jersey City, N. J., to 90 West St. (West St. Bldg.), New York City.

L. W. Randolph, Inc., 9-15 Clinton St., Newark, N. J., has been licensed to manufacture the Tygard reversible and non-reversible rotary steam engine.

Max Ams Machine Co., builder of sanitary can machinery, presses, dies, special machinery, etc., has moved its works from Mount Vernon, N. Y., to Bridgeport, Conn.

Independent Pneumatic Tool Co., Chicago, Ill., has appointed George C. Wilson manager of the company's Atlanta, Ga., branch in place of F. H. Charbono, who has been transferred to Boston.

Lumen Bearing Co., Buffalo, N. Y., announces that Prosper J. Hoeffler has been employed to sell the full line of babbitts and solders which the company has developed during the past fifteen years.

J. N. Lapointe Co., New London, Conn., has begun the erection of an addition 40 by 80 feet, two stories high, constructed of concrete and brick. The upper floor will be used for a hardening room.

Standard Drafting Service, 142 Market St., Newark, N. J., announces that it is prepared to make drawings, tracings, charts, forms, specifications, etc., for all engineering, contracting and mercantile work.

Fafnir Bearing Co., New Britain, Conn., manufacturer of ball bearings, has opened an office in the David Whitney Bldg., Detroit, Mich., to take care of Ohio, Indiana, and Michigan business. M. Howard Cox is the manager.

Pullman Automatic Ventilator Mfg. Co., York, Pa., has placed on the market a small ready-to-run exhaust ventilator, electrically driven. A descriptive booklet has been issued illustrating the device, giving capacity, etc.

Powers-House Co., 724-725 Illuminating Bldg., Cleveland, Ohio, succeeds the M. K. Powers Advertising Co. The business of the company is technical advertising, preparing house organs, booklets, catalogues, folders, etc.

Hoskins Mfg. Co., 459 Lawton Ave., Detroit, Mich., maker of electric furnaces, pyrometers and heating appliances, has appointed W. C. Tharp district manager in charge of its Pittsburg office, to succeed I. J. Shults, resigned.

Nasel Engineering Works, 4043 N. Fifth St., Philadelphia, Pa., has purchased the electric riveter business of the Eveland Engineering & Mfg. Co., Philadelphia, Pa. The Eveland riveter softens the rivet head by electric heat and then upsets by pressure.

Burd High Compression Ring Co., Rockford, Ill., has increased its capital stock from $50,000 to $200,000. The additional capital was voted for the purpose of adding to the equipment and enlarging the business to take care of the large contracts recently made for piston rings.

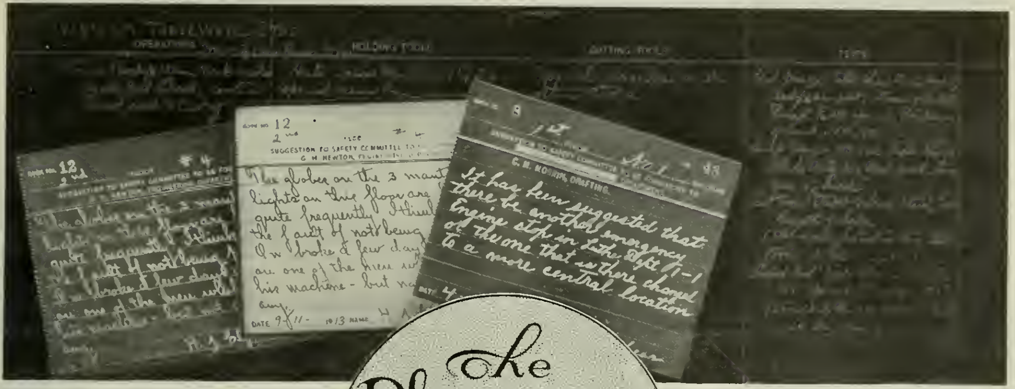
Tropenas Converter Co., 50 Church St., New York City, has begun the erection of a new office and laboratory building in Brooklyn, N. Y. Sufficient ground has been purchased to provide room for a small experimental plant also. In this experimental plant a new steel-producing method will be developed which will be put on the market at an early date.

Nordberg Mfg. Co., Milwaukee, Wis., announces that E. W. Swartwout, formerly of the Chicago office, will be associated after June 1 with Mr. MacLaren in the New York office of the company. Larger offices have recently been taken in the new Equitable Bldg., 120 Broadway, New York City. The Chicago office of the company will be in charge of John E. Lord.

Prest-O-Lite Co., Inc., Indianapolis, Ind., maker of acetylene lighting systems, oxy-acetylene welding and cutting equipment, etc., has entered the electric lighting field, having placed the "Prest-O-Lite" storage battery on the market. The plant of the Pumpelly Battery Co. in Indianapolis has been purchased, and for the present the storage battery will be produced by the Pumpelly plant.

Harvey Co., Inc., 113 South St., Baltimore, Md., has been incorporated under the laws of Maryland to sell supplies and equipment to railroads, con

AUGUST MACHINERY 1915



12
2
SUGGESTION TO SAFETY COMMITTEE
G H NEWTON
The globes on the 3 mant
lights on this floor are
quite frequently I think
the fault of not being
I w broke a few day
are one of the new
his machine - but
any.
DATE 9/11 - 1913 NAME

C. H. NORRIS, DRAFTING.
It has been suggested that
there be another emergency
Engine stop in Lathe Dept 1-1
or the one that is there changed
to a more central location

The Photostat and its use

by Luther D. Burlingame*

THE fact that a demand has existed for a quick, cheap and accurate method of copying, which is capable of universal application, is indicated by the long-continued attempts that have been made to meet this need, resulting in the development of many ingenious methods. The usual photographic process is much too slow and expensive for the large proportion of such work. A reproducing method was described by Joseph C. Riley in an article entitled "A Process for Copying Printed Pictures," which was published in MACHINERY, September, 1904, showing how copies from printed pages could be transferred by rubbing on "metallic" paper of the kind used for steam engine indicator cards. Following its publication, this method was used to some extent at the Brown & Sharpe Works, one use being in making copies from catalogues, books and other publications for records in connection with patent matters. It was found, however, to be quite limited in its application, and had the further objection that the copies were reversed, and sometimes not at all distinct.

It was not until the advent of the "photostat" that a generally applicable method of copying became available, making it possible to produce rapidly accurate and inexpensive copies of articles and printed matter of almost every description and of any required size. One of these photostats has now been installed at the Brown & Sharpe Works for several years and has developed some interesting and important uses. One of these is in making copies from pages of books. The value of old files of technical literature is greatly enhanced when it is possible to quickly and cheaply make facsimile reproductions whenever wanted.

This article describes a quick and low-cost method of making reproductions of drawings, blueprints, illustrations, correspondence, catalogue pages, orders, maps, textiles, medals, and in fact any flat copy that can be photographed. There are many evident advantages of a process for quickly reproducing blueprints, letters, orders, etc., in the office, drafting-room and manufacturing plant. The process may be used for making copies of instruction sheets for distribution among employes, and other data which are not required in sufficient numbers to warrant the cost of setting in type and printing in the regular way. The reproductions generally used are negatives, but positives may be made by a second photographing.

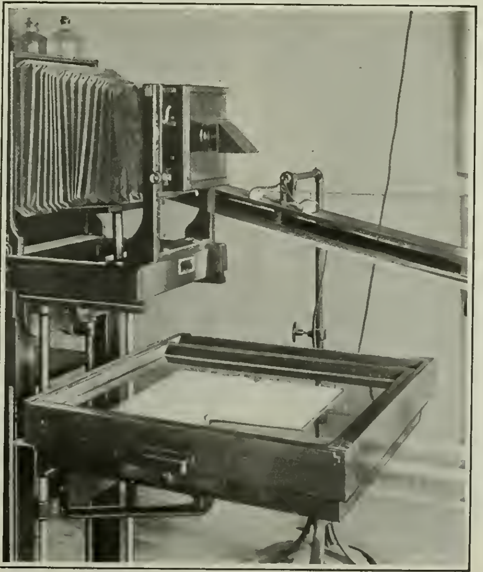


Fig. 1. Photostat set up ready for Use

Fig. 1 shows the photostat set up for copying from a bound volume of MACHINERY; and Fig. 2 shows a part of the copies thus made from an article in the September, 1894, number. In connection with this view, an index card is shown, such as is used at the Brown & Sharpe Works in connection with the filing of mechanical literature, that illustrates how different subjects can be included in one copy. One of the uses of the photostat that has proved a great saver over former methods is in copying blueprints when the original drawing is not available, this being a common need when prints are received from customers or when old record prints of early lots of machines are to be used for making repairs. Obviously copies must be made.

The old method was to have a draftsman make a copy or tracing from the blueprint (which is not always an easy matter) and then make the required number of blueprints from the new tracing, after it had been carefully checked. Now all that is necessary is to send the blueprint, with any changes and additions that may be needed, to the young man operating the photostat, with an order for as many copies as may be wanted, and they can be obtained as quickly as blueprints could be made from a tracing. The fact that the copies are reversed in color, *i. e.*, where the original is dark

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* Industrial Superintendent, Brown & Sharpe Mfg. Co., Providence, R. I.

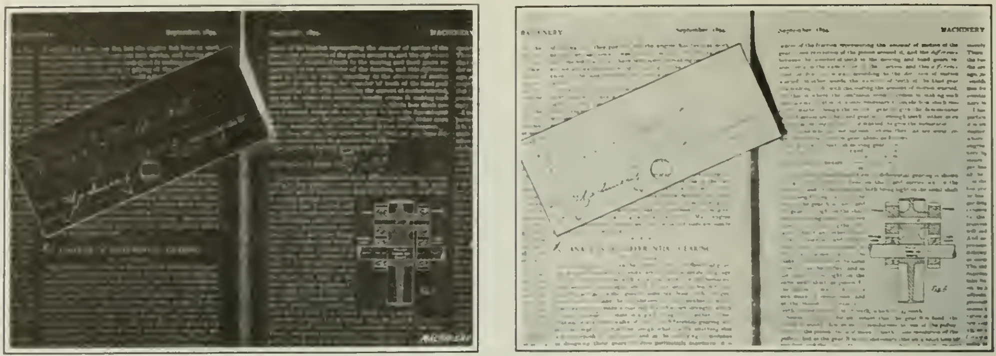


Fig. 2. Negative and Positive Photostat Copies of a Page in the September, 1894, Number of MACHINERY

the copy becomes light and *vice versa*, produces copies from a blueprint having dark lines on a light background, thus giving the effect of the original drawing. The article "photostated," however, is not reversed on the copy, owing to the use of a prism in the machine. Because this prism makes the light "turn a corner," another advantage results, as it is possible to lay the drawing or work that is being copied on a horizontal support, thus making it much easier to manipulate than if it were required to be placed vertically, as for ordinary photography. Changes can be made on the blueprint with Chinese white before it is copied. Sometimes, in changing blueprints or drawings, or in adding notes on the copy, it is desired to keep the original without change. In such cases, pieces of paper can be placed over the original to "stop out" parts that are not wanted, or for the purpose of making additional notes which are required for a particular job and which can be changed at will for any future job. A photostat copy from a blueprint, where such notes have been added, is shown in Fig. 3.

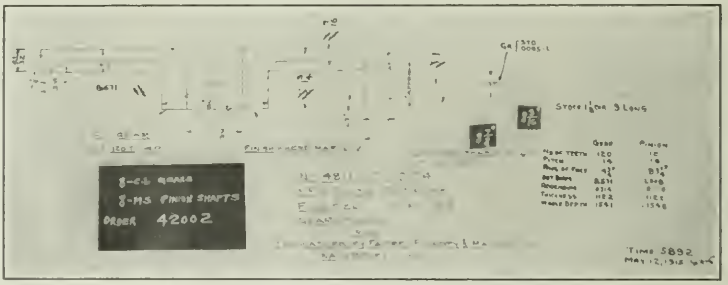


Fig. 3. Copy from Blueprint, on which Additional Notes and Dimensions have been made on Separate Slips of Paper

Photostat copies can be made of any desired size, which is of value when making a book of prints, where it is desired to bring all material to fit the size of the pages of the book. This is illustrated in Fig. 4, which shows a book used by agents in ordering parts of machines wanted by customers, the system of numbering being such that parts can be ordered without doubt as to what is wanted. In this case, a set of negatives is first made from the working drawings to the required size, and the parts are then numbered in Chinese white on the negatives, parts not wanted being "stopped out," after which any number of copies to make the required number of books can be made from each sheet without change of scale or focus.

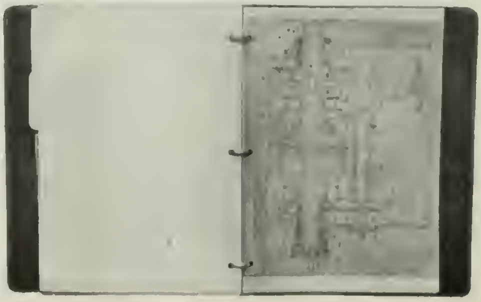
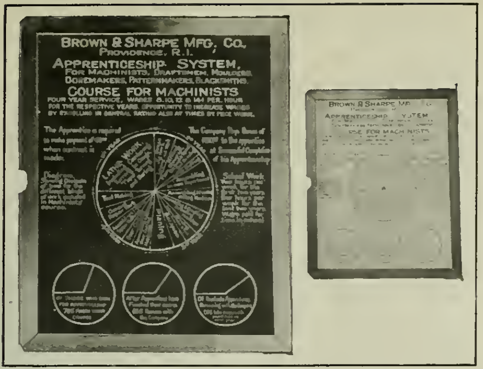


Fig. 4. Book of Photostat Copies, where a Uniform Size is Desirable

It is not alone in making copies from printed matter that this machine is useful. It can also be employed to show the texture of cloth and the kind of stitches used; and if desired, these copies can be made on an enlarged scale. Copies can also be made from metallic articles, such as medals. It will be readily seen that this method can be made use of when making copies of small parts of machines, which might be required for repairs, such copies being sent with the order, so as to be sure that the desired part is furnished.

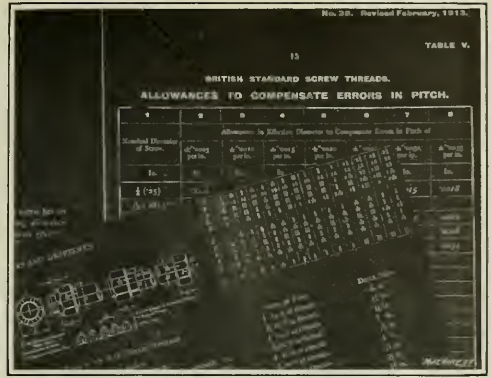
By the use of a color screen it is possible to make copies from colored articles which could not be brought out satisfactorily under ordinary conditions of photography, this being one of the secrets of obtaining satisfactory copies from blueprints, as already shown in Fig. 3 An important use of the photostat is in connection with correspondence, orders, telegrams, etc., where it is desired to have copies go to several departments at the same time, so that the work may have prompt attention. Fig. 9 shows copies of this kind. Here, again, the photostat copy has a value beyond any hand-made copy, because it is a facsimile of the original, and mistakes of copying, or misunderstanding on account of the complete data not being given, are not possible. In making copies from pencil originals, an advantage is gained, not only by securing a copy, but because the copy becomes a better and more permanent record than the original.

It has often been the case that when matters were submitted to us for consideration, and the original drawings or documents could not be left with us, copies have been made during the conference, the originals being returned within a few moments. While the photostat cannot compete with regular photography in making high-grade photographs, useful results for many kinds of work can be obtained by this process. Both negative and positive can be made from a halftone illustration, the positive or second copy being reduced to a smaller size than the negative. As an example of enlarging from a small photograph, Fig. 5 illustrates what can be done. Even though only a small copy of the original is available, if the photograph is sharp, clear copies as large as a full page of MACHINERY can be made from it. Another use is found for this machine in preserving his-



BROWN & SHARPE MFG. CO.
PROVIDENCE, R.I.
APPRENTICESHIP SYSTEM,
FOR MACHINISTS, DRAFTSMEN, MOULDERS,
COREMAKERS, PATTERNMAKERS, BLACKSMITHS.
COURSE FOR MACHINISTS

Fig. 5. Enlargement made from Photographic Copy of Chart



No. 38. Revised February, 1913.
TABLE V.
15
BRITISH STANDARD SCREW THREADS.
ALLOWANCES TO COMPENSATE ERRORS IN PITCH.

Fig. 6. Data prepared for Distribution among Committee Members

torical data, it being possible to make permanent and durable copies from old papers or documents.

In one case, a rare book that was out of print was copied complete, and from these prints other copies can be made at any time. In this case, the value of the photostatic process was especially noticeable, as the book was full of illustrations. This method of making copies has also proved useful in connection with the work of technical committees, such as those for the American Society of Mechanical Engineers, where a number of members are to be kept informed as to suggestions and progress made. By making photostatic copies of sketches, manuscript, and other data, such information can be furnished with the minimum of trouble and expense. Fig. 6 will illustrate this point. The advertising department of a factory also finds frequent use for the copies made in this machine, a minor feature of advantage being that an opportunity is given to consider a choice between the effect of a light or a dark background (Fig. 8) and also to vary the size so as to secure the most effective copy. In indexing electrotypes, copies of proofs of large electrotypes can be made by this process that will be small enough to go in the index file. If the drawing to be copied is too large to be held in the frame of the photostat, it can be mounted on the wall or on a board, at such a distance as to give the required reduction. Fig. 7 shows the machine set up for copying a blueprint which is six feet long. The photostat is so designed that it can be operated without the services of an experienced photographer, and it does not require the use of plates, or any other form of negatives. No dark room is required for development, and the object to be copied is mechanically focussed for any desired scale.

The equipment consists of a camera, having, in addition to the lens, a prism which has already been mentioned. A "light-tight" magazine holds the roll of sensitized paper, and a mechanical device is provided for unrolling and cutting it off to the required length, which can be either a half or full-

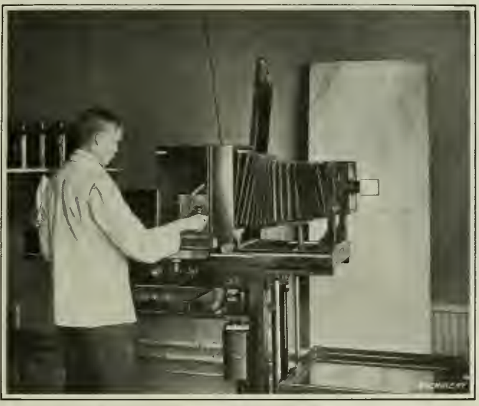


Fig. 7. Making Copy of Blueprint that is too Large for Photostat Frame

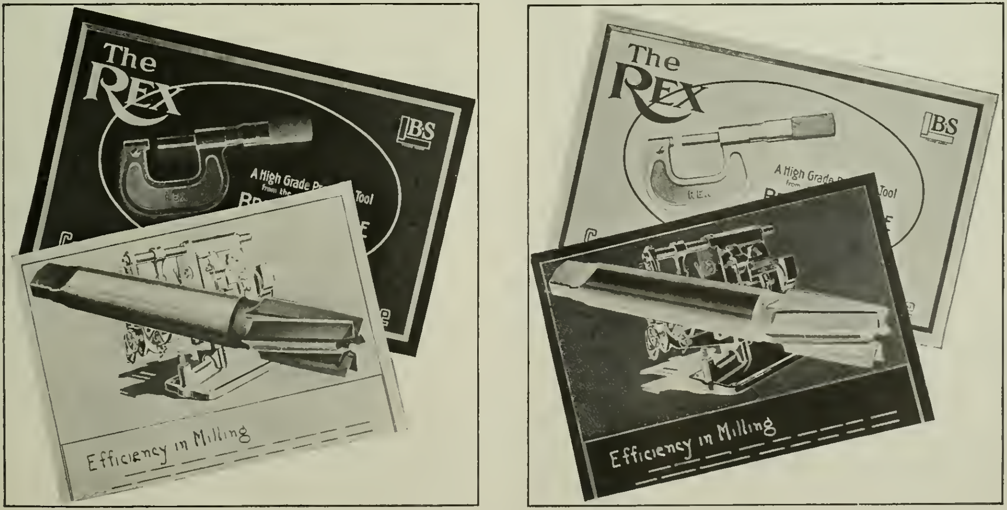
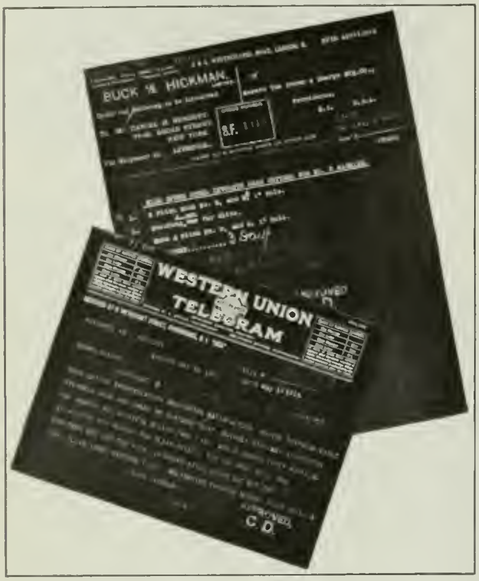


Fig. 8. Comparing Relative Effectiveness of Light and Dark Backgrounds on Advertising Copy by making Photostatic Prints

sized sheet. If only a half-sized sheet is required, a dark slide covers half of the field; and by setting an indicator to the scale on the side of the frame, the correct position and focus are obtained. Either daylight or artificial light can be used for making the exposures, but a greater degree of uniformity is secured by using the latter, mercury vapor lamps being suitable for this purpose. A special clock can be used to give the time for exposure and development. After the print is cut off, it is mechanically carried into the developing bath, where it is left for the required length of time, after which it is transferred to the fixing bath. It is then rinsed in clear water for a few minutes, and either hung up to dry or, if wanted in a special hurry, dried between blotters. Most of the water can be quickly removed by laying the print on a flat surface and running a roller over it.


BUCK & HICKMAN

WESTERN UNION TELEGRAM

C.D.

Fig. 9. Photostat Copies of Telegrams and Orders, made in Duplicate for Distribution to Several Departments to avoid Possibility of Mistakes

If a positive copy is wanted, the first print can be laid on the glass, even when wet, and the positive copy made from it without delay. While prints made by this process are more expensive than blueprints, on account of the greater cost of the paper and chemicals used, the field of usefulness of the process is wide; and it proves not only a great convenience, but also a great financial saving over other methods of reproduction required when such a machine is not available. The value of this machine and the dependence placed upon it are shown when, for any reason, the machine is out of commission for a short time and other methods must be resorted to as substitutes. The photostat has added another to the many conveniences and short-cuts in conducting business, and it is believed that it will become more and more of a factor in efficiently carrying on the work of modern industry.

WAGES AND HOURS OF LABOR IN THE IRON AND STEEL INDUSTRY

The United States Bureau of Labor Statistics recently issued Bulletin 168 on wages and hours of labor in the principal productive occupations in nine departments of the iron and steel industry of the United States for the year 1913. This is in continuation of Bulletin 151, data from which are incorporated in the present report for the sake of comparison, thus presenting a complete statement as to rates of wages per hour, hours of labor per week, and full-time weekly earnings from 1907 to 1913 for three departments, and from 1910 to 1913 for six departments. The report is based on data for May in each year, obtained from the pay rolls of representative establishments in the various centers of the industry. There was a marked decrease in seven-day work between 1907 and 1913, many establishments having put into effect a plan whereby relief gangs were provided to take the place of regular employes and thus give each employe in seven-day occupations one day of rest in each week. The wide range of full-time weekly earnings is shown by the accompanying table, including a few of the unskilled, semi-skilled, and skilled occupations for 1913 selected from the various departments.

A similarity in earnings by no means indicates a similarity in full-time weekly hours. For example, it will be noticed that blast furnace keepers and sheet mill doublers have almost identical full-time weekly earnings, but the working time for these earnings differs greatly in the two occupations, the average full-time hours per week of keepers being 81.9, while that of doublers is only 42.7. The rate of wages paid common laborers is to a large extent a basic rate from which are determined the rates for other occupations requiring little skill, hence the rate for common labor is of importance beyond the limits of the occupation proper. The rate per hour is practically the same in all departments of a plant, but the earnings per day or week, of course, are determined by the number of hours worked. The average rate per hour of laborers in 1913 in the nine departments covered by this report was $0.183, while the average full-time hours per week ranged from 61.1 to 76.2, and the average full-time weekly earnings from $11.51 to $14.38.

* * *

TRUING FILES WITH ACID

BY J. P. DOWNS[*]

I saw in the May number of MACHINERY a request for a description of the process of truing files with acid, and will say that at present in the Sedalia shops of the Missouri Pacific Railway Co. we are doing this work on files for truing triple valves in the following manner:

A circular block of brass, about 8 inches diameter and 3 inches thick, is faced off on one side as a faceplate. The file to be trued is rubbed over the block very lightly, so that the high points of the teeth pick up small quantities of brass from the surface of the faceplate. Then the operator takes a small pointed stick and dips it in a vial of nitric acid, and applies the acid to the points of the teeth covered with brass. After this he takes a dampened sponge and wipes the acid off and again rubs the file over the brass surface plate, making the same application of acid to the tooth points as before. This process is repeated until the high points are reduced.

[*] Superintendent, Missouri Pacific Railway Shops, Sedalia, Mo.

FULL-TIME WEEKLY EARNINGS IN THE IRON AND STEEL INDUSTRY

BLAST FURNACES		BLOOMING MILLS		BAR MILLS	
Laborers	$12.43	Bottom makers' helpers	$19.33	Bundlers	$14.05
Keepers	19.13	Manipulators	27.60	Roughers	26.00
Blowers	26.84	Heaters	44.18	Rollers	60.71
BESSEMER CONVERTERS		**PLATE MILLS**		**SHEET MILLS**	
Mold cappers	$20.28	Shearmen's helpers	$17.47	Openers	$12.56
Steel pourers	33.94	Tablemen, sheared	21.35	Doublers	19.21
Vesselmen	41.09	Screwmen, sheared	33.36	Sheet heaters	42.60
OPEN HEARTH FURNACES		**STANDARD RAIL MILLS**		**TIN PLATE MILLS**	
Stokers	$15.30	Hot bed men	$15.01	Screw boys	$15.91
Stopper Setters	27.78	Table levermen	27.51	Catchers	18.23
Melters' helpers, first	33.89	Rollers	50.18	Shearmen	30.66

Machinery

TURNING TOOL-HOLDERS[*]—1

A STUDY OF LATHE TOOL-HOLDERS USED FOR TURNING, CUTTING-OFF AND SCREW-CUTTING

BY JOSEPH HORNER[†]

THE wide extent to which the employment of tool-holders has spread during the past fifteen or twenty years is one of the striking features of machine shop practice. Although Babbage devised a tool-holder—or "cutter-bar" as it was called—early in the nineteenth century, the idea was regarded as rather a curiosity for a long time, and the employment of this and other designs was restricted chiefly to amateur workers using small lathes. The early types of holders were not regarded seriously by men in machine shops because of their inherent weakness, which prevented the cutters from standing up to the work as well as tools forged from a single piece of steel. The era of their practical introduction really began about 1866, when W. Ford Smith, of Manchester, England, in a paper read before the Institution of Mechanical Engineers, described a system of tool-holders for cutting metals, some utilizing round cutters made from ordinary bar steel, and others a deep vee-section with the bottom edge rounded. The principle of these holders, it is interesting to note, is still preserved in holders manufactured in large numbers by Smith & Coventry, of Manchester, where they originated.

Solid tools possess certain advantages over cutters inserted in holders, and they have not therefore been entirely displaced, though their province has been seriously invaded. The fact that the metal is continuous in a solid tool is favorable to the dissipation of heat from the cutting point, which is a feature of more vital importance in carbon steel tools than in those made of high-speed steel. In the heavier classes of cutting, a solid tool is undoubtedly stiffer and better able to withstand severe duty, so that in some kinds of heavy work tool-holders are practically never used. A third point in favor of a solid tool is that it is more compact, *i. e.*, the nose takes up less width than the nose of the average tool-holder of equal capacity; and this is of advantage when working in confined situations, or where the tool must be presented at an awkward angle. But there are some types of holders which are well adapted to work in confined places, provided the cutting is not too severe, so that the feature just mentioned applies more forcibly to the heavy work than to light jobs.

The advantages of tool-holders may be summed up as follows: The most serious item of cost of tool steel is immensely reduced in a shop where an outfit of holders is installed, particularly now that high-speed steel has so generally replaced carbon steel. The time spent by the blacksmith in forging and reforging tools is rendered unnecessary. The area of the surface to be ground is reduced to a minimum, and as the shapes are uniform, the operation of grinding can be done by unskilled labor. As the cutter is always held at a definite and constant angle, either of front rake (clearance) or top rake, there is no need of grinding in one or the other of these directions. Cutters are always presented correctly to the work, and no gaging is required. The height of the cutting point can be altered to bring it level with, above or below the lathe axis, according to requirements; and the packing which is employed to adjust the height of solid tools is not required.

Tool-holders are divisible into three primary types: (1) Those which hold the cutter with its longitudinal axis horizontal, thus embodying no top rake in the principle of the holder. (2) Those which hold the cutter with its axis at a slope corresponding to the most desirable angle of top (or cutting) rake. (3) Those which hold the cutter with its axis coincident with the most desirable angle of front rake or clearance. In the first case, the front of the cutter is ground to an angle which gives the proper front rake or clearance; in the second case, this is also done; while in the third case, only the top face is ground. Actually, of course, the whole surface of the end or top of the cutter need not be ground at each sharpening, because very often the face is ground with two facets, leaving a narrow portion for touching up. It is one of the main principles of tool-holder design that one or the other of the cardinal angles, *i. e.*, the clearance or rake, shall be provided in the holder, and for this reason it is neither good nor economical practice to design a holder which carries the cutter in the same position as that of an ordinary solid tool, and thus involves grinding on the top as well as on the front to produce the necessary rake and clearance. The rake ought to be embodied in the holder and not dependent on grinding for each separate cutter. The case is different with holders for brass and similar materials, and for cutting-off or screw-cutting, in some of which operations no top rake need be provided.

The three basic positions of the cutters just mentioned are represented in diagrammatic form by Fig. 1. The second and third positions both claim a host of adherents and points may be adduced in favor of each. The chief advantage of the second type is that the cutter is not quite so likely to slip backward under the pressure of cutting as the more vertically set cutter, and also that it can be thrust out to project advantageously into recesses or positions where the width of the nose of the holder would interfere with the sides of the work. The third type is stiffer under heavy cutting, because there is less tendency to bend, and because more metal is massed nearly under the line of pressure; but this latter advantage only holds good by comparison with a cutter of similar cross-section set in the second position, and by employing steel of a special deep section instead of round or square, this objection is largely overcome. The objection of bending in the first straight-set design also disappears in many holders which utilize deep-section cutters. The proper relation of its width to depth depends largely on the duty which the cutter has to perform; if only of a straightforward nature, as for grooving, cutting off, or light facing, a narrow deep section is satisfactory; but if there is severe lateral pressure, as when traversing, or heavy facing, or screw-cutting, the relative width of the cutter must be increased to enable it to withstand the pressure.

The primary types of tool-holders that have been mentioned are sub-divisible into three other groups, represented diagrammatically in Fig. 2, and comprising the straightforward setting *A*, setting the cutter to the left or right *B*, and rolling or swiveling as shown at *C*. Position *A* shows the location of the point for straightforward feeding or light traversing; *B* for heavier traversing or side cutting; and *C* throws the section more or less out of the vertical for cutting screw-threads, in order to avoid the fouling of the point against the sides of the thread. Positions *B* and *C* may be embodied in a fixed manner in the holder, or a range of adjustability may be afforded by the swiveling action. There is one other difference in the design of holders, a sort of sub-variation on position *A*, Fig. 2, *i. e.*, whether the cutter stands in the center of the width of the holder or is located at one side, the latter position being adopted for side cutting, or cutting off close up to a shoulder.

All of the other numerous variations in tool-holders are developed from these elementary types, and concern only diverse methods of clamping the cutters in place, and in some designs, devices for adjusting the height of the cutter by means of a screw. An immense number of tool-holders have been put on the market during the last decade, and it is curious to note how the same ideas recur again and again. Some of the holders produced quite recently have their ante-types dating back perhaps twenty, thirty, or forty years, and those who are conversant with inventions during this period will find little to surprise them in the latest productions. But many tool-holders invented years ago failed to find a market for the reasons stated at the commencement of this article, *i. e.*, because they were too weakly constructed to be practical tools. Even during recent years a distinct tendency has been noticeable in the direction of strengthening tool-holders by increasing the cross-section of the bar, and enlarging the dimensions of the head so as to make it stiffer or afford space for a larger size of cutter.

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[*] For additional information on the subject of tool-holders published in MACHINERY, see "Tool-holder Design," February, 1910.

[†] Address: 45 Sydney Bldgs., Bath, England.

Much diversity in practice exists in regard to the cross-sectional shape of the cutters used in tool-holders. At one time it was held as an axiom that a holder should be fitted to use the plainest shapes of steel commonly available, that is either round or square, with a thin rectangular section for cutting-off operations. These sections are still utilized in an immense number of holders, but other special cross-sections are also employed. The demand for these special sections is now so great that it is easy to obtain them, which was not the case several years ago when the market was extremely limited, and steel makers had little inducement to produce them. Certain sections of steel can be employed in a good many designs of standard tool-holders, while others are a special feature of one manufacturer's holders. None of these sections require anything but grinding to fit them for work. Again, a few designs of holders for screw-cutting, or backing-off, employ a special section produced by milling, which is the only way to get an accurate profile for the purpose, so that neither rolling nor forging to shape play any part. Sharpening is done on the top of the steel, and the profile is preserved until the cutter is worn to a useless length.

With regard to the methods of holding cutters in place, although these present a seemingly bewildering variety, they are easily separable into those in which pressure is produced by a screw or by a wedge; and they may be further classified by making a distinction between clamping actions effected either directly by a screw or wedge, indirectly by a combination of these two, or through the closing in of a split or divided holder. The numerous changes of these devices present an interesting study, and will be readily understood with the help of the accompanying illustrations. It must be understood that to show all of the forms of holders in use would require some hundreds of illustrations, and we must therefore content ourselves with a selection only, showing as far as possible the main types, some of which exist in numerous modifications—as many as a dozen in some instances—which are the result of designers' ideas, or differences in sizes or functions.

Fixed-front-rake Holders

It is proposed to illustrate the types of holders classified according to the position in which they present the cutter, irrespective of methods of clamping, and for this purpose we shall take first the designs with a fixed front rake or clearance. A large proportion of these holders employ either round- or square-section cutters, the round-section being a greater favorite in England than it is in America. Both shapes have their particular advantages. The elliptical form of the top of a round cutter when ground with top rake is excellent for roughing purposes, corresponding to a simple round-nose solid tool; and it also has the advantage that by twisting it in the holder, more or less side rake can be imparted, which gives better results when feeding to right and left or facing down a side. Using a square-section cutter, side rake must either be provided by grinding or by setting the holder itself to an angle, and the latter is not always feasible. The square-section provides an excellent diamond point for roughing or finishing, according to the manner in which it is applied. A round-section cutter may be converted into a diamond point by grinding its face; and conversely, a diamond point may have its point rounded to approximate the round nose, but either device is in the nature of a makeshift and entails extra labor, as well as weakening the area of the cutting end

The usual practice in holding a round-section cutter is to drill a hole in the holder at the most suitable angle of front clearance, and bind the cutter by jamming it laterally through the medium of a screw or wedge, or by a combination of screw and wedge. One of the earliest practical holders (the Smith & Coventry shown in Fig. 3) which still has a prominent place in English shop practice employs the direct pressure of one or two set-screws, depending on the size of holders, and the cutter is set in the best way to afford front and side clearance or rake, the holders being made right- and left-hand. The objection to a set-screw at the side is that it is apt to come in the way of the work, hence the reason for partly sinking the heads, as shown in Fig. 3; and it is also awkward to get at for altering the height of the cutters, or twisting them while the holder is in the working position. For this reason some designs of direct screw pressure holders have the head of the screw brought to either the top or the end, where they are easily accessible under any circumstances. Fig. 4 shows a type of tool-holder which has a plunger running through the center to bind the cutter when the screw is tightened. In the Günther holder made by W. Günther & Sons, Oldham, England, which is shown in Fig. 5, the screw forces a block *A* against the cutter and binds it in the head of the holder, the screw being prevented from withdrawing by a groove and pin as shown. Round cutters are utilized for roughing or square ones for finishing according to requirements.

A draw-bolt action is utilized in some kinds of holders, by which the tightening is also done at the rear, an example being shown by Fig. 6. The screwing up of the nut *A* pulls the head *B* backward and presses the cutter against the two pins *C*, thereby clamping the cutter. The adjusting nuts *D* are provided to form an adjustable bearing for the nut *A*, to compensate when necessary for compression, stretching, and wear of the parts of the holder. It is not practicable to grip a cutter which has a fixed front rake or clearance with a set-screw pressing vertically downward, so a wedge must either be included or the screw must stand at approximately a right angle to the axis of the cutter. The first device is illustrated in Fig. 7, which shows a diamond-point holder made by the Ready Tool Co., Bridgeport, Conn., that has the hole made to enable the cutter to be set to cut right- or left-hand. The second device is seen in another type of holder made by this firm, which is shown in Fig. 8. Here the cutter slot is inclined toward the work so as to provide the necessary clearance for facing, in addition to the front clearance, and the screw is perpendicular to the cutter.

A form of holder which is much favored in England for handling light work is the split design shown at *A* in Fig. 9. A cutter of round section is nearly always preferred to a square one. It will be seen that the cutter is held by the elasticity of the metal, sprung inward by the tightening of the screw. Sometimes the saw-kerf is carried only as far as the hole which receives the cutter; sometimes it passes to the front, in which case the cut need not extend so far into the shank. The objection of splitting the holder, and forming a possible source of weakness and vibration, is avoided in another type of tool-holder in which the metal is left solid and clamping is performed by a binder bolt of the same kind that is sometimes employed to hold the shanks of turret tools. The appearance of this device in plan section is as shown at *B* in Fig. 9. Two such bolts are employed in heavy holders, one above the other. They have the advantage over the practice of tapping a screw into the body of the holder that replacement is easy, whereas when a threaded hole in a holder wears, it can only be made good by retapping to a larger size, a practice which is not often feasible. Yet another mode of securing a cutter is seen in Fig. 10. In this instance, an eccentric bolt is given a partial turn to cause the groove on its body to jam against the cutter. The objection to this form of binder lies in its liability to shift the cutter slightly while tightening. Provision for endlong adjustment of a cutter is made in a few types of tool-holders. Fig. 11 shows a design made by J. Squire, London, England, with a screw which is convenient for rapidly adjusting the cutter for height.

Wedge action, without the employment of a screw, is not such a convenient method of fastening, and consequently its employment is restricted. Messrs. Smith & Coventry, Manchester, England, manufacture such a holder, which is shown in Fig. 12. The back of the cutter is serrated to match serrations on the wedge so that slipping is impossible. In

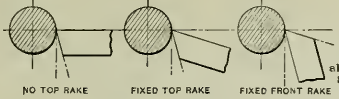


Fig. 1. The Three Basic Positions of Cutters held in Tool-holders.

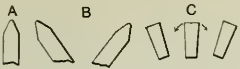


Fig. 2. The Three Basic Settings of Cutters; A shows the Straight Forward Position, B the Angular Setting to the Left or Right, and C End Views of Cutters provided with Means of Swiveling.

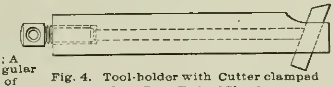


Fig. 4. Tool-holder with Cutter clamped from Rear End of Shank.

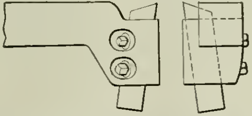


Fig. 3. Smith & Coventry Tool-holder with Cutter clamped by Set-screws.

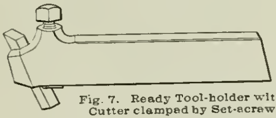


Fig. 7. Ready Tool-holder with Cutter clamped by Set-screw and Wedge Method.

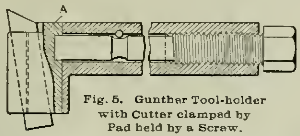


Fig. 5. Gunther Tool-holder with Cutter clamped by Pad held by a Screw.

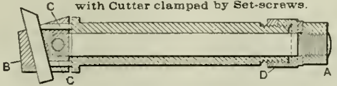


Fig. 6. Tool-holder with Cutter clamped by Pressure against Pins C.

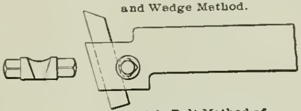


Fig. 10. Eccentric Bolt Method of clamping the Cutter.

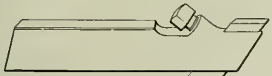


Fig. 8. Method of clamping the Cutter with an Inclined Set-screw.

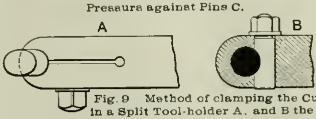


Fig. 9 Method of clamping the Cutter in a Split Tool-holder A, and B the Use of a Pad Bolt for clamping the Cutter.

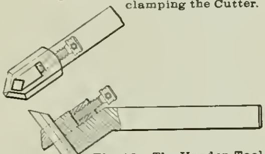


Fig. 13. The Haydon Tool-holder with an Angular clamping Set-screw.

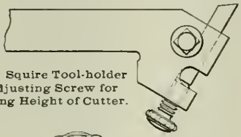


Fig. 11. Squire Tool-holder with Adjusting Screw for Regulating Height of Cutter.

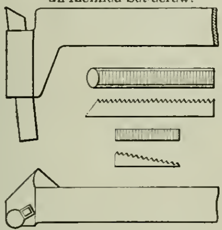
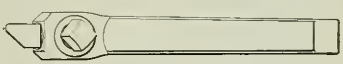
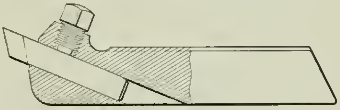
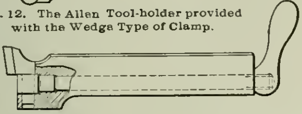


Fig. 12. The Allen Tool-holder provided with the Wedge Type of Clamp.







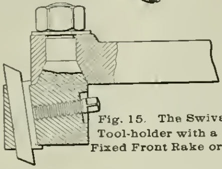


Fig. 15. The Swivel Type of Tool-holder with a Cutter of Fixed Front Rake or Clearance.

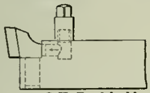


Fig. 14. O.K. Tool-holder provided with Drop Forged Cutter.

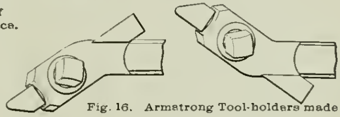


Fig. 16. Armstrong Tool-holders made Straight and also Right and Left-hand.

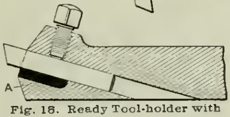


Fig. 18. Ready Tool-holder with Tool Steel Insert under the Cutter.

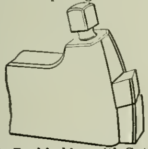


Fig. 17. Tool-holder with Cutters supported on the Under Side.

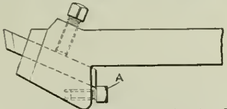


Fig. 19. Tool-holder with Adjusting Screw which regulates and supports the Cutter.

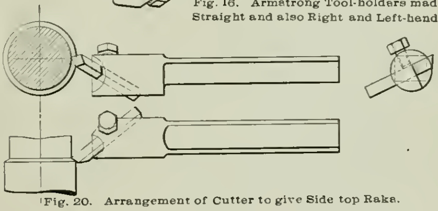
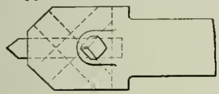


Fig. 20. Arrangement of Cutter to give Side top Rake.



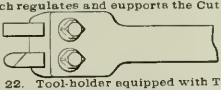


Fig. 22. Tool-holder equipped with Two Cutters for Simultaneous Roughing and Finishing Operations.

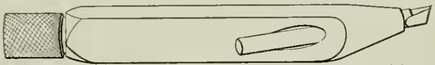
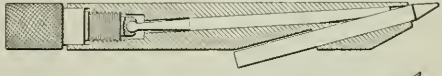


Fig. 24. Provision for Tightening the Cutter without requiring the Use of a Wrench.



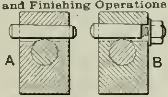


Fig. 23. Clamping of Cutter by Taper Pin A and by Wedge Bolt B.

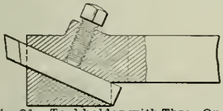


Fig. 21. Tool-holder with Three Openings for Straight Forward, Right and Left-hand Settings of the Cutter.

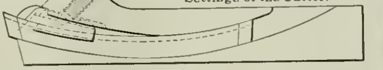
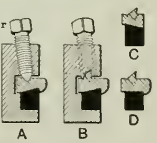


Fig. 26. Tool-holder using Curved Cutter and provided with Means of making Straight Forward, Right and Left-hand Settings of the Cutter.



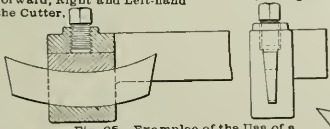


Fig. 25. Examples of the Use of a Curved Cutter in a Tool-holder.

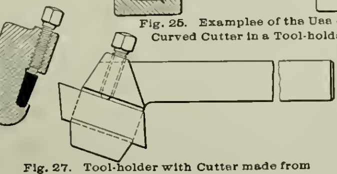


Fig. 27. Tool-holder with Cutter made from Steel of Deep Cross-section.

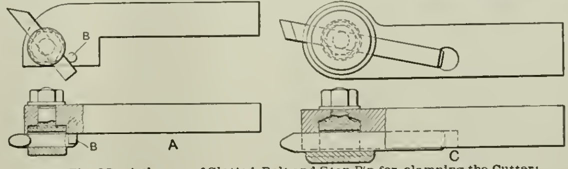


Fig. 28. A the use of Slotted Bolt and Stop Pin for clamping the Cutter; C Cutter clamped by Slotted Bolt and Groove in Holder.

Machinery

another kind of serrated grip holder, the wedge is pulled laterally by a bolt so as to tighten the cutter, the back of which is serrated to match the wedge; here there is no need of hammering to tighten or loosen the cutter. A method of gripping which is defective in principle, and therefore finds little favor, is the yoke or "bridle" type of clamp. This is faulty because the cutter is not contained within the body of the holder, but sustained by a yoke, which is liable to spring and stretch, and which may not obtain a perfect bearing against the cutter to prevent it from rocking under the pressure of the cut.

The Haydon tool-holder, another early English design shown in Fig. 13, was at one time used for light cutting, but has been superseded by more effective designs. In an American design working on this principle, a little advantage has been gained in making the yoke deeper to obtain contact with a greater length of the cutter; this is possible because the American type of holder, suitable for American slide-rests, does not have to be dropped to bring the tool point to the center height, as is necessary in English practice. This feature will be noticed by comparing several of the holders illustrating the practice of the two countries; and some American holders have to be made in two patterns, one straight for home consumption, the other with a dropped head for the European market. Most holders utilize standard sections of steel, which do not require any preparation beyond grinding on the top. There is, however, one exception, i. e., the tool-holder shown in Fig. 14, which is made by the O. K. Tool-holder Co., Shelton, Conn. In these holders the tools are hydraulic or drop-forged to a special shape suited to the particular service demanded of them, and each one has a shank which fits in the holder. Binding is effected either by a pull-up bolt which forces a plug against the cutter, or by a draw-bolt which draws the cutter backward.

There are numerous holders of the fixed-top-rake type that will be considered next, which are provided with a swivel action to point the cutter to the right or left, but it is rather difficult and clumsy to attempt this swiveling with a holder where the front rake or clearance is fixed. The reason is apparent on comparing the relative position of the axis of the cutters. One attempt is illustrated by Fig. 15, but it is obviously a clumsy and cumbersome fitting and never found much favor. A set-screw and packing slip bind the cutter, which is contained within a bolt that can be swung around and tightened in the shank with the nut, the coned shoulder increasing the firmness of the hold. Except for this and one or two other somewhat similar ideas, nothing has been done in the direction of swiveling this kind of cutter, preference being given to cranking the nose of the holder around to give a permanent right-hand or left-hand tool if a straightforward one is not suitable for the work.

Fixed-top-rake Holders

Considering now the tool-holders having cutters set with a fixed top rake, the first point which affects the design is the degree of inclination with the base, which is usually from 15 to 20 degrees. This position of the cutter makes it convenient to employ the direct vertical clamping action of a screw point, the screw being set at right angles to the cutter. A simple screw pressure is therefore found in a great number of holders, and the screw-head or the nut nearly always comes at the top, the position which is most convenient to get at, and which moreover permits the width of the holder to be kept down, and avoids interference at the sides. The well known Armstrong holders, made by Armstrong Bros. Tool Co., Chicago, Ill., and shown in Fig. 16, are typical of this class; they are made straightforward, and also right- and left-hand as illustrated, and are also supplied in the drop-head form for European rests. Holders of this general design do not offer much variety in shape because the essential idea is simplicity; they have been made stronger of recent years, with enlarged heads to take bigger cutters, and with larger set-screws; and the nose is usually pushed out underneath the cutter to support it under the cutting pressure.

In two or three cases an extension support is forged on the nose of the holder, Fig. 17, slightly narrower than the cutter width, which takes the strain; and this reduction of the overhang of the cutter is a considerable advantage in preventing spring and the compression of the metal at the mouth of the hole on account of the leverage exercised by an overhanging cutter. A device for preventing wear at this location is incorporated in one of the holders made by the Ready Tool Co., Fig. 18; a half-round piece of tool steel *A* is electrically welded in the shank to take the wear and prevent "mashing," with consequent risk of cutter breakage. The low angle of the cutter and the direct pressure of the screw are sufficient to guarantee freedom from risk of backward slip. It is not usual to provide any supplementary resistance, although one attempt at this is illustrated in Fig. 19. The backing screw *A* also serves to adjust the height of the cutting edge. The cutter must not be much longer nor shorter than the standard length; otherwise the head of the screw will come in the way, or it will fail to reach the end of the cutter.

When the tool has to be traversed to the right or left, the shank can be pointed in the direction of feed, holes can be made in the holder to direct the cutter to the required angle, or a swivel motion may be incorporated for all angles. The last-named arrangement will be considered shortly. Fig. 20 shows a holder with the opening slotted so as to give the cutter the required angular setting, and also the necessary side top-rake. A rather clumsy method is to cut three holes in an enlarged head, Fig. 21, to afford a choice of three settings; but the size of the head thus formed militates against its general usefulness hence the common preference for a swivel head or separate bars for the three settings. Another instance of the use of an enlarged head is shown in Fig. 22, the purpose of which is to set two cutters in the proper relative positions for roughing and finishing, or to use them for turning two diameters at one traverse. Three cutters are also arranged thus in a still wider head; the three slots can be merged into one long opening, and the cutters adjusted for width by the fitting in of packing slips of appropriate thickness, to bring the points to exact longitudinal positions. Very massive holders of the double cutter type usually have two set-screws for clamping each cutter, the screws standing one behind the other.

Cutters of round section are not used to any important extent in the fixed-top-rake holders, because the cutter has to be ground on the top and sides just sufficiently to form flats, and this consumes time and labor and weakens the point; a square cutter, on the other hand, needs no preparation in this respect, and only requires the end to be sharpened, which is legitimate grinding in accordance with the principle of this design of holder. The only points that can be advanced in favor of the round-section cutter are that it enables side top-rake to be given by twisting the cutter in the hole, and also that it possesses a slight advantage when a very pointed shape of end is wanted. A method of binding round section cutters which is used instead of the other devices already shown, is to employ a slightly flattened hardened steel tapered pin, fitted into a transverse hole merging into the cutter hole, as shown at *A* in Fig. 23; or to use a flattened tapered bolt *B*, a method that is also utilized for square or rectangular cutters. The head of the holder is then enlarged to receive the pin. A neat device for securing a cutter for light work, which has the advantage that no spanner is required, is illustrated in Fig. 24. A slanting hole takes the cutter, and it is locked by the pressure of a wedge-ended steel rod. The latter is thrust forward or withdrawn by turning the knurled-head screw, which is coupled to the ball end of the thrust rod by spinning over the metal, so that the two may be free to rotate, but not to move longitudinally.

The employment of a cutter of triangular section is an old practice, dating from the early days of tool-holders; the section is weaker than a square one, and offers no particular advantage, but it is used to a very limited degree for light work, an ordinary set-screw binding action from above being employed. An idea which has been followed to a small extent is that of using a curved piece of steel for the cutter, gripped in the holder so that a constant top rake is afforded. Fig. 25 shows one design of such a holder, with a curved packing-piece interposed between the screw and the cutter. By substituting a parallel packing, a parallel cutter can be secured, for use in cutting-off or screw-cutting, etc. In another type of tool-holder a long piece of steel can be placed in a groove in the holder, see Fig. 26, and clamped by the pressure of the screw against a clamping piece. The section at *A* is taken to show the action of the screw on this clamping piece; that at *B* shows how the little feather or "nib" standing up from it engages in a groove in the holder and prevents the clamping piece from falling out. The top of the cutter may have a slope to the left or right, as shown at *A* and *B* in the first case, and *C* in the second, to provide the rake for feeding in one or the other direction. Or a strictly square section *D* can be utilized for threading, round-nose roughing, or other purposes where top side-rake is not wanted. Double holders are manufactured on the same principle, the grooves lying on each side of the shank, and the cutters being adjusted relatively for depth, to rough and finish, or to turn two diameters.

The utilization of a special deep section of steel is more common in some of the swivel-bolt types of fixed-top-rake holders to be considered later, and in cutting-off holders, but there are examples to be met with in simple holders with a set-screw fastening, as shown in Fig. 27, for example, which shows a tool-holder made by Charles Taylor, Ltd., Birmingham, England. One type of holder has the cutter brought out to the side so that it can lie beside the rest and avoid any overhang at the front, such as is necessary when the cutter lies in line with the shank. This holder may also be used close up to a large shoulder, and the cutter can be put in or removed from the side.

Although a lateral clamping action is used in a good many holders for cutting-off, which will be considered later, it is not a method that is employed to any considerable degree for round or square-section cutters of the fixed-top-rake style. A few examples, however, are made, such as that shown at *A* in Fig. 28, where the transverse bolt has a hole in its head to receive the cutter, which is held at the proper angle by a stop-pin *B* driven into the shank. At *C* the head of the bolt is also slotted, but the cutter fits flush into a groove in the shank and so is supported in a better fashion than the type of clamp illustrated at *A;* and this holder is not so liable to chatter. A holder manufactured by Clarke, Cluley & Co., Coventry, England, embodies a special feature in the way of two vertical adjusting screws, see Fig. 29, tapped into lugs. A screw comes underneath the tool, regardless of which side of the shank it stands on, and the height of the cutting edge can be thus modified with ease. The cutter (of round section) is gripped between the head of the bolt and a sleeve, and by taking off the nut and reversing the bolt and sleeve to point in the other direction, the cutter may lie on the other side of the shank, so that work can be done close up to a shoulder in either direction. The cutters are double-ended, being ground similarly at each end, or differently, according to requirements.

There are a few examples of fixed-top-rake holders which have no clamping action for the cutter apart from the pressure of the toolpost or clamps of the slide-rest. The holder assumes the form of a rectangular bar with a sloping groove, and is sawed at one side to give sufficient spring. The clamp used in conjunction with the Carr combination holder (made by Henry G. Thompson & Son Co., New Haven, Conn.) shown in Fig. 30 is representative of this kind of holder, but differs in being tightened by the screws of the special holder. Sometimes when the slide-rest clamp screws are employed for binding the cutter, the holder is made in halves, tongued with transverse tongues to prevent slipping, such as are shown at *A* in Fig. 31, or with a top fitted over the base and attached loosely with a rivet, as shown at *B* in the same illustration.

This idea is excellent from the point of view of completely surrounding the cutter with the metal of the holder, thus supporting it and preventing chatter or vibration. Several types of holders are built on this principle, and other things being equal, they should be superior to open-sided holders where only the local pressure of a bolt head or heads, or a narrow clamp is adopted. On the other hand, the open-side holder possesses the advantage that the blade may be brought close up to a shoulder.

Certain holders which bind the blade by a vertical action are assisted in this mode of gripping by the pressure of the toolpost screw, and sometimes the small screws in the holder are merely utilized to bind the blade lightly when the holder is not in use, or while grinding is being done. Fig. 52 shows a spring type of holder with screws near the ends, the cutter having a bevel on the lower edge to draw it toward the holder.

Fixed-top-rake Holders with Swivel Action

We now have to consider that class of fixed-top-rake tool-holders which has a swivel movement. This constitutes a numerous group and includes the employment of round, square, and special sections of steel. A swivel bolt is the essential element in most cases, and it is either slotted to take the cutter direct, or subsidiary fittings are incorporated. Sometimes the cutter stands centrally with the axis of the bolt and sometimes it is to one side, the former being the case in the majority of designs. The swivel-bolt holders are used in American shops to a very limited extent, as compared with their popularity in Europe, and this fact is probably explained by the difference in height of the slide-rests. The European rest permits of a good deal of drop to the cutter in relation to the height of the shank, and this gives room in the vertical direction for the employment of a swivel bolt fitting of generous proportions, still bringing the cutter clear of the shank. With the American rest, the available depth is more restricted, and it is necessary to cut into the body of the holder to let the cutters pass. This is illustrated in Fig. 32; the holder head has three apertures, a wide one at the front and lesser ones at each side, corresponding to the straightforward, and the right- and left-hand positions, and the bolt through which the cutter passes is swiveled accordingly. Either round or square cutters are utilized.

The tool-holder which was invented by Babbage contained the essential principle of a great many swivel holders that have since been evolved. A vast number of these have been patented during the past fifty or sixty years but have never found favor, either because of the weakness of their construction or because the parts are too elaborate and so cost too much to make and fit, while as good results are obtained with cheaper, simpler and more durable types. One special fault in many tool-holders was dependence upon a weak bolt, yoke or overhanging member which would spring under the pressure of a fair cut. Another fact is that certain holders which are highly convenient, because of their adaptability to varied conditions of turning, answer very well for light work, but fail when applied to heavier turning. Discretion must therefore be observed in the selection of a holder, and it is not fair to condemn the principle of a holder because it does not give good results on heavy work. The early Babbage holder, just alluded to, is shown in Fig. 33. It had a drop shape of shank, which by the way, was a gunmetal casting. This shape is the reverse of the forms commonly used today, *i. e.*, with an overhanging head into which the swivel bolt fits, and from which it is suspended. The central bolt was slotted to receive the cutter, which was gripped between two circular washers, having inclined faces standing at an angle of 27 degrees, and matched together by dowel pins. The action of tightening the nut after setting the cutter to the angle desired drew the washers together firmly. Fig. 34 shows another rather early design of holder, but this one has the overhanging head and a slotted bolt which draws the cutter up against two locations on the shank. This kind of contact does not give such a powerful grip as is desirable, and the cutter may slip. A firmer grip, without the necessity for screwing the nut up excessively tight, may be obtained by the employment of a circular collar which is slotted out to partly embrace the tool. The prototype of this design is illustrated by Fig. 35, and has been made by Smith & Coventry for many years. This is a holder which is in extensive use. A V-section of steel is used, and the points are ground to various shapes, a few examples being shown at *A*. The

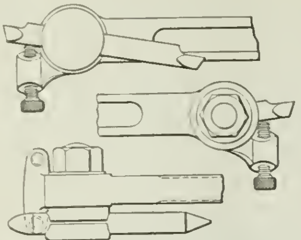


Fig 29. The Use of Adjusting Screws to support Cutter on Either Side of Shank

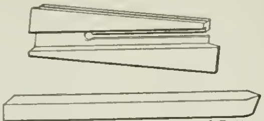


Fig. 30. The Form of Clamp and Cutter used on the Carr Tool-holder.

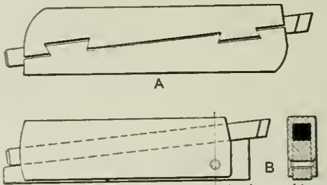


Fig. 31. Tool-holder in which Cutter is clamped by Pressure of Toolpost—A Interlocked Holder, B Holder with Pivoted Cap Piece.

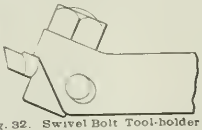


Fig. 32. Swivel Bolt Tool-holder with Three Available Settings of Cutter

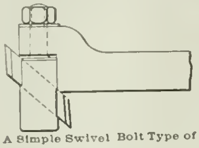


Fig. 34. A Simple Swivel Bolt Type of Tool-holder.

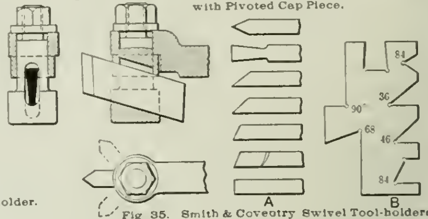


Fig. 35. Smith & Coventry Swivel Tool-holders—Different Forms of Cutters A which may be used, and Cutter Gage B.

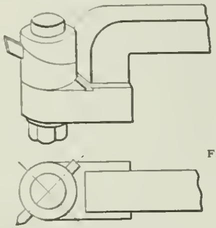


Fig 33. The Babbage Tool-holder.

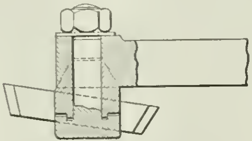


Fig. 37. Swivel Tool-holder with Cutter held to the Side of the Bolt.

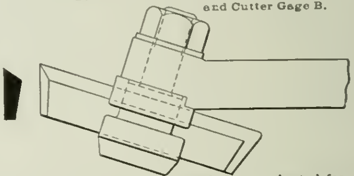


Fig. 38. Swivel Tool-holder with Cutter adapted for working Right or Left-hand.

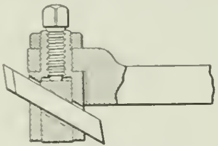


Fig 36. Swivel Tool-holder provided with Separate Screw for clamping the Cutter.

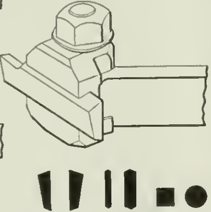


Fig. 40. T.R. Almond Tool-holder with Swivel Bolt for making various Settings, and Different Cross-sections of Steel from which Cutters are made.

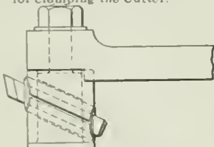


Fig. 39. Swivel Tool-holder with Revolvable Bushing to clamp Cutter.

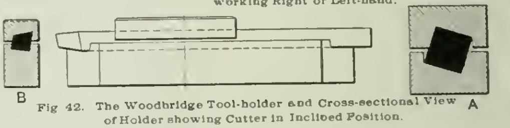


Fig 42. The Woodbridge Tool-holder and Cross-sectional View of Holder showing Cutter in Inclined Position.

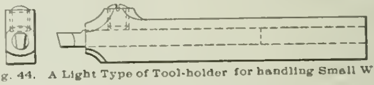


Fig. 44. A Light Type of Tool-holder for handling Small Work.

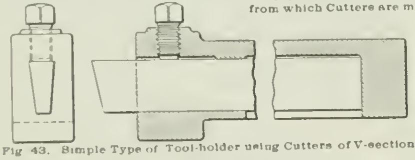


Fig 43. Simple Type of Tool-holder using Cutters of V-section.

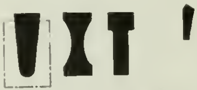


Fig. 41. Sections of Cutter steel used with or without Cap Clamps.

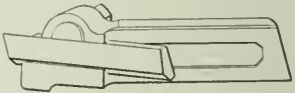


Fig. 45. Armstrong Off-set Tool-holder of the Side Tool Type.

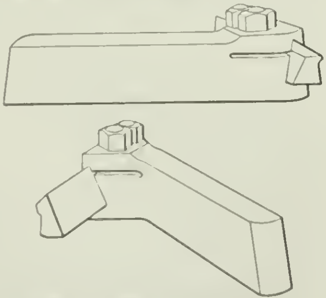


Fig 46. Hill Left-hand Off-set Tool-holder made by the Union Caliper Co.

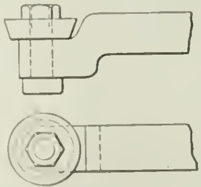


Fig 47. Tool-holder for Radius Cutter

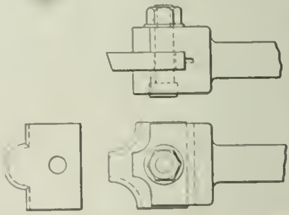


Fig 48. Another Tool-holder for Radius Cutter

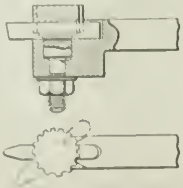


Fig 50. Tool-holder with Head of Clamping Bolt notched to Clamp Cutter at Various Angles

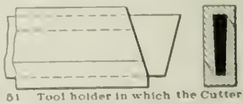


Fig 51. Tool-holder in which the Cutter is clamped by the Toolpost Screw.

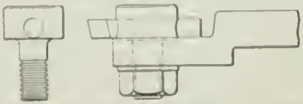


Fig 49. Simple Form of Swivel Bolt Tool-holder

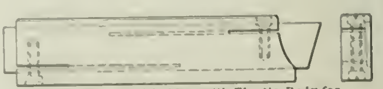


Fig 52. Tool-holder with Elastic Body for carrying a Cutting-off Tool

Machinery

second cutter from the bottom has side top-rake ground on its surface. The angle-gage employed when grinding various standard shapes is shown at *B*. A special swiveling design of this holder is used for screw-cutting, and will be illustrated later.

Fig. 36 represents a holder having a supplementary device, the object of which is to retain the bolt in the angular position to which it has been set, irrespective of whether the cutter is in place or not. This permits the cutter to be withdrawn for sharpening or changed without changing the angle at which it stands in relation to the work. The nut which tightens the hollow bolt has a left-hand thread, and the cutter is secured by the set-screw forcing down the slotted plug. Another variation of design is illustrated by Fig. 37; here the bolt is not slotted, but is of smaller diameter, and the cutter is clamped between a groove in its head, and a groove in a collar above. The collar fits into a tapered socket in the holder, to obtain a tighter hold without excessive screwing down of the nut. There is no particular advantage in this method, and it is not employed to nearly the extent of the central grip devices hitherto shown. Rogers-McGown, of Manchester, England, make a rather interesting type of holder, differing from common practice in regard to the section of cutter and the arrangement of the clamping bolt. Instead of setting the bolt vertically, it is inclined at a right angle to the axis of the cutter, Fig. 38, so that by swiveling the bolt around, the other end of the cutter is presented properly for turning. The side top-rake, imparted to the section in rolling, then points correctly for feeding to the right or left, according to which end is turned to the front.

When a cutter of round section is gripped by a suitable form of clamp, side top-rake can be produced by twisting it, as previously mentioned; but if a cutter of square or rectangular section is used, this adjustment cannot be made. A device which produces the same result is that of enclosing the rectangular cutter in a bushing, split on one side to enable the pressure of the collars, see Fig. 39, to tighten it upon the cutter. This arrangement is also of use when screw-cutting has to be done and the nose of the cutter must be tilted to fit in the groove of the thread. Two or three types of holders are made for American toolposts, with the cutter usually of rectangular section and clamped between a pair of washers that are drawn together by the bolt. The cutter stands out to one side and is capable of being swiveled through a sufficient portion of the circle to meet the demands of right- and left-hand applications to the work. The side of the cutter is open to the work, *i.e.*, it is not covered by any part of the clamping arrangement, and is well suited for working up against shoulders and into corners. The design is, however, apt to be weak unless means are provided to increase the rigidity of the holder, and to resist the chances of springing downward or sideways. The holder shown in Fig. 40 is made by the T. R. Almond Mfg. Co., of Ashburnham, Mass., and its design combines certain interesting features. The head is not simply rounded, but has an octagonal formation, and the cutter is drawn against one or the other of the five faces by screwing up the nut, the head of the bolt, and the clamp being beveled to draw in the cutter, which is of rectangular section with beveled edges. Five different radial settings are possible, including right- and left-hand offset, right- and left-hand side, and straight across the front. Bushings are required to grip square and round cutters.

Holders without Top Rake

The third group of tool-holders, *i.e.*, those with no top rake, constitute a numerous class, but are not used so much for ordinary turning as for operations where top rake is either unnecessary or undesirable. They are employed for turning brass and similar materials, but the greater number are found among the side tools, the cutting-off tools, and the forming tools. As with the previous holders, the cutters may be set permanently straightforward, or to the right or left also permanently; or a swivel action may be provided. It is neither good practice nor economical to grind the nose of a cutter held horizontally to give it more or less slope for top rake, because the correct idea is to have this rake embodied in the construction of the holder. A sort of compromise is made in some cases when a special section of steel is used for turning, and a long piece of it is laid in a supporting block and clamped down by the toolpost. A smaller size of cross-section of steel can be used for the cutter under such conditions. Three examples are shown in Fig. 41. An old idea in connection with the use of a long piece of steel was to hold it at an angle, as shown in the section *A*, Fig. 42, thus imitating the manner in which the hand-turner holds a common graver. The Woodbridge holder, made by the Pratt & Whitney Co., employs a similar principle, illustrated at *B* in Fig. 42, but the top of the cutter is rolled with a bevel to give a side top-rake which is about right for cast iron and steel.

A set-screw fastening for a cutter is shown in Fig. 43; and a light holder is shown in Fig. 44 that is employed on the Hardinge bench lathes. The round section of the cutter is convenient, particularly for screw-cutting where it is convenient to be able to twist the cutter in the holder. Side tools without top rake are preferably made with the cutter exposed at one side, to act close up to a shoulder; and the cutter is generally of rectangular section with beveled edges, but it is sometimes widened at the base for greater strength, as in the Armstrong tool-holders. Binding is effected by a bolt which comes against the top and jams the cutter into the recess in the holder, which in the case of the straight-shank tools extends the whole length, but in the off-set side tools only for the distance of the head portion, as shown by Fig. 45. Side top-rake is imparted to the top of the cutter for a short distance by grinding. In some designs a different method of clamping is followed. Instead of the lateral bolt, as in the last example, the top edge of the cutter is beveled and it is drawn into place by a lip on the clamp, so that the downward pressure given by the bolt or set-screw produces a good locking action. Yet another device is that of splitting the holder and squeezing it in upon the cutter with a set-screw, or one or two bolts. Such a method is employed in the Hill holder, made in straight and off-set types by the Union Caliper Co., Orange, Mass., two views of an off-set holder being shown in Fig. 46. Profile or forming tools are a class without top rake, and are simple to hold, either by a bolt, by one or two set-screws or by the grip of the split end of the holder. These methods may be noted in Figs. 47 and 48, the latter showing different forms of radius tools. Swivel-head holders are not used very much for tools without top rake. Two examples are shown, however, in Figs. 49 and 50, the first of which uses round-section cutters, tightened by the hole in the bolt-head. The tool shown in Fig. 50 is for more strenuous duty, and is provided with means of locking the bolt at various angles. Two prongs are prolonged from the shank, which engage with the teeth on the head; and the bolt is lifted sufficiently to clear these horns and again dropped into position. The tail of the cutter fits into a slot in the shank when set straightforward, and is held with great rigidity. This holder is made by the Selson Engineering Co., Ltd., of London, England.

Cutting-off Holders

Cutting-off tool-holders as a class are nearly always made without top rake or with a very slight amount; and this group stands somewhat apart from those already considered. This is because the cutter has to be made of a special section on account of its thinness. A deep section is generally used, that is rolled or ground tapered from top to bottom and often ground tapering from front to back. The comparative weakness of the blade and the nature of the operation demand as much support as is practicable, in order to avoid risk of breakages; and no more of the cutter than is necessary should be allowed to project. An additional precaution may be observed in some holders which extend underneath the blade for a short distance, this thrusting forward of the shank being carried as far as possible without interfering with the work. Screws or bolts are utilized for binding the blade, but there is one exception (see Fig. 51) in which the two parts of the holder are so arranged and fitted together that the pressure of the toolpost screw compresses them tightly around the blade so that no other clamping device is required.

THREE ADAPTABLE MILLING FIXTURES

DESIGNS EMBODYING FEATURES WHICH ARE APPLICABLE IN A VARIETY OF CASES

BY CHRISTIAN F. MEYER*

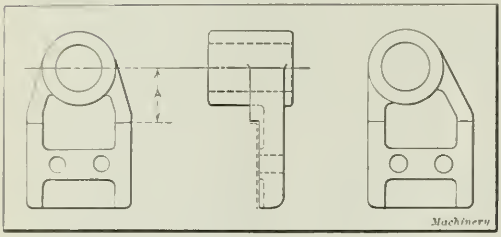


Fig. 1. Type of Bearing Brackets milled in Fixture shown in Figs. 2 and 3

THE milling fixtures described in this article are used in the manufacture of textile machinery, and work with exceptional rapidity and accuracy. This description is presented with the idea that the same principles may be useful to the tool designer or toolmaker in designing fixtures for the production of similar work to that for which the present tools were made. The first fixture is employed in milling a number of bearing brackets similar to those which are shown in Fig. 1. The shape and size of these brackets may, however, be entirely different from each other, but all of them rest on a shoulder which is marked by dotted lines. It is the milling of these shoulders that is to be performed by the aid of the fixture. The distance *A* from the shoulder to the center of the bore must be absolutely the same for each set of brackets, as they are fastened on the same machine member and are employed to support a long shaft. The bearings are in an exposed position and their bore, therefore, should be exactly in the center of the hub for the sake of appearance. As the milling of the shoulder is the first operation, the brackets being entirely unfinished—with their bores roughly cored and sometimes far out of center—it will be readily seen that it is difficult to obtain the preceding requirements and still handle the work rapidly and accurately. The fixture, however, gives entire satisfaction in machining these or similar bearings, regardless of their size or shape.

This fixture consists of a baseplate *C* in which is milled a long finished slot extending nearly the entire length of the base. A number of screws *F* slide in this slot, being prevented from turning by means of flats filed on their heads and fitting in an enlargement of the slot provided for that purpose. A round steel plate *G*, the shape of which is clearly shown by the longitudinal section of Fig. 2, is slipped over each screw and slides along with it. Each screw is also provided with a steel cover plate *E* shaped almost like the bottom plate *G*. In loading the fixture, the first bracket is laid with its hub in the bottom plate and squared by adjusting the set-screw provided in the extension *D* for that purpose. The cover plate *E* is then put on and drawn down by a nut and washer. The shape of the steel plates *G* and *E* is such that they force the bracket into a position that brings the center of its hub into coincidence with the center of the plates, and also with the center line of screw *F* and the slot. The next bracket is now placed on the following screw, and so on until the fixture is filled. The set-screw in the extension *D*, opposite the one used to square the first bracket, is then screwed against the last bracket, thus squaring all others against the first one and holding them at the same time. Suitable adjusting screws *H* are set to suit the height of the brackets, as shown. The cutter is then adjusted and the brackets are cut absolutely alike. It is clear, however, that this fixture will suit any similar bracket, no matter what its shape or size. Since the screws *F* slide with the brackets, they may be set to suit any one within the limits of the size of this particular fixture. Fig. 3 shows the fixture in operation on a vertical milling machine.

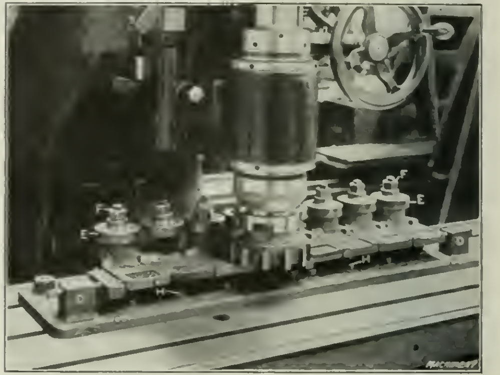


Fig. 3. The Milling Fixture shown in Detail in Fig. 2

The second fixture was constructed to mill the brackets shown in Fig. 6. Four of these brackets—two right-hand and two left-hand—go on one machine together, and it is of the greatest importance that the dimension *I* as well as the dimension *J* be absolutely alike for each bracket. Since these brackets have to be replaced very frequently, they must be milled in such a way that any one of them will always take the place of a similar one in any machine, without filing or fitting. It is also very essential that the shoulder which is to be milled by the aid of this fixture (marked by dotted

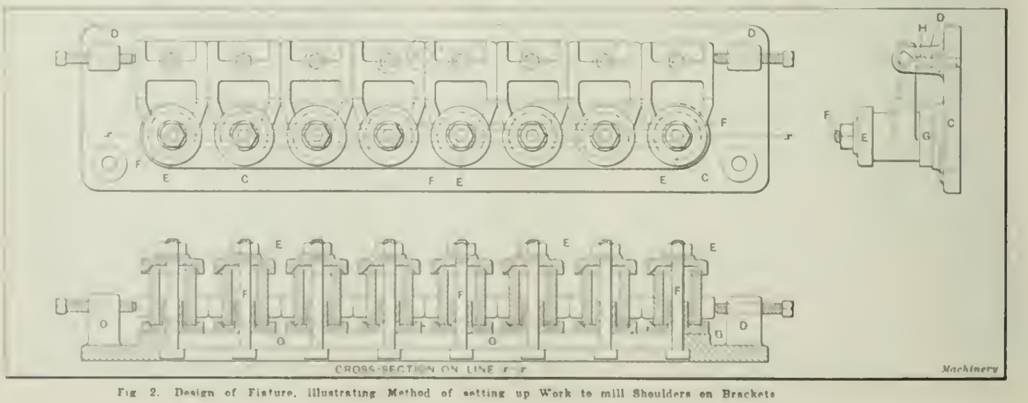


Fig. 2. Design of Fixture, Illustrating Method of setting up Work to mill Shoulders on Brackets

lines) should be absolutely square with the center line of the bracket. Finally, the fixture should turn out the work as quickly as possible, as these brackets are used in very large quantities. The fixture, Fig. 5, consists of a baseplate *K*, guided and located on the milling machine table by a suitable key *L*. Studs *M* and *N* fit into the corresponding holes in the brackets to be milled, thus not only bringing the latter at right angles to the cutting line of the miller, but also holding these holes in an absolutely vertical position. The setting of the cutter to finish the shoulder, in such a way that its distance from the center of both holes is correct, is achieved by means of a hardened steel gage *O*. A "feeler blade" 0.002 inch in thickness, may just be inserted between the side of the cutter and the gage to bring the brackets in the proper position for the correct cut. The same "feeler blade" inserted between the teeth at the circumference of the cutter and the top of the shoulder provided in the gage *O* for that purpose, will also determine the exact depth of cut in a vertical direction. As a result, the cut must always be exactly the same in all respects. The gage *O* may be swung out of the way of the cutter during the time that the operation is in progress. The work can be set up in and taken out of the fixture very rapidly by means of the slotted clamps *P* which are provided with handles to facilitate operating them. Pins which are filed flat to fit clamp *P*, prevent the latter from turning while the nut is being tightened down. Fig. 5 shows clearly how these pins are arranged. This fixture works very quickly and accurately and gives satisfaction in all respects.

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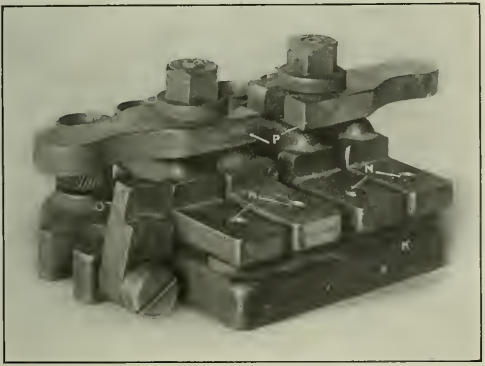


Fig. 4. Milling Fixture shown in Fig. 5

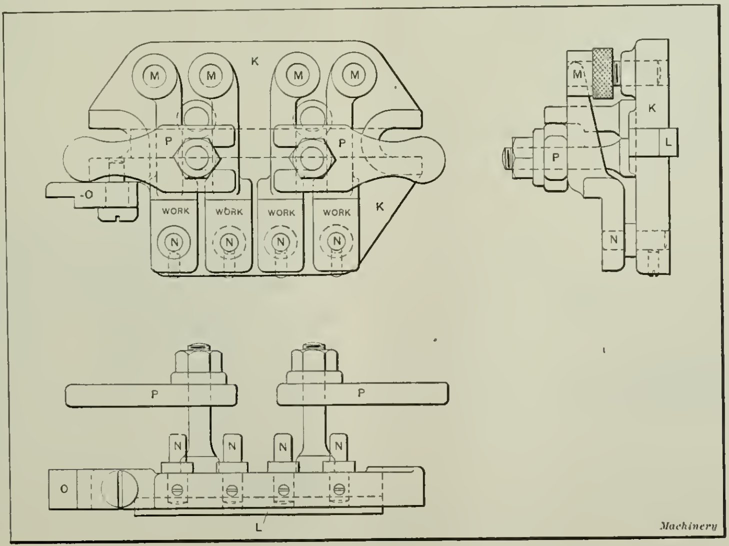


Fig. 5. Design of the Fixture for milling Work shown in Fig. 6

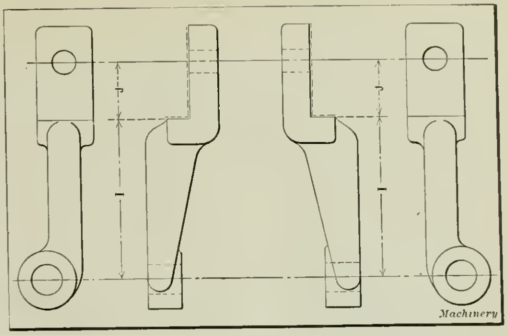


Fig. 6. Type of Brackets for which Fixture shown in Figs. 4 and 5 was designed

The third fixture, which is illustrated in Figs. 7 to 10, inclusive, was designed to mill the narrow surfaces (marked by dotted lines) of cams similar to those shown in Fig. 7. These cams are made in halves, the two halves being fastened together by a single flange. It is very important that the surfaces milled in this fixture be exactly square with the sides of the cams which are fastened against the flange. Since the halves are laid against each other to make a complete cam, any deviation from the right angle would produce an imperfect joint. For the same reason, these narrow surfaces must be milled in such a way that they are the same distance *Q* from the center of the small holes by means of which the cam halves are fastened to the connecting flange. The bolts holding the two halves of the cam have a good fit in the holes and any difference in the dimension *Q* would, therefore, make it impossible to put one half of the cam on the flange with its mate. This is absolutely necessary, however, as some of these cam halves are worn out quickly and it must be possible to replace them without unnecessary work or delay. The surfaces must also be properly milled in relation to two fixed points on the outline of the cam, which is not yet finished while these surfaces are milled. This is necessary in order to achieve a uniform finishing cut for the outline of all cams of the same shape, which will greatly assist in getting the outlines of these cams as nearly alike as possible. Finally, the fixture should be applicable for use in machining all shapes and sizes of cams within its range.

The fixture constructed to secure these results consists of a baseplate *R* with two projections *S* and *T* cast integral with it. The projection *S* is provided with two rib-like extensions, as shown. Two hardened steel bars *U* are securely held to the projection *T*, extending over the entire length of this projection; and two similar but stronger bars *V* are fitted into suitable slots in the projection *S*, in such a way that they are exactly opposite the bars *U*. The bars *V*, however, are loose and may be drawn in or pushed out of their slots by means of four hardened steel screws *W* which are screwed into the bars through holes provided in projection *S* for that purpose. Two other pins *X* fastened to each bar *V*, are equipped with suitable springs which tend to draw the bars into the slots. The screws *W* are operated by four hardened steel cams *Y*, these cams being fastened to two shafts *Z* which are supported by the two rib-like extensions

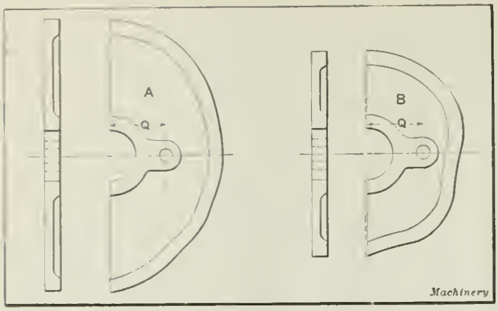


Fig. 7. Cams which are milled in the Fixture shown in Figs. 8 to 10

of the projection *S*. The motion is given to these shafts by two steel gears *a*, one of which is provided with a steel rod *g* serving as a handle. The upper shaft *Z* has a ratchet *b* fastened to it, into which a suitable pawl c works. The latter is operated by a spring, which presses a small pin against a flat portion of the stud about which pawl c revolves. A screw holder *d* is held to each side of the jig in such a way that it may be easily and quickly exchanged. Each of these holders is provided with five hardened set-screws, the center distance of which is equal to the thickness of the cams to be milled. A pin *e* which fits into a suitable hole drilled through projection *T* and partly into *S* as shown, may be easily removed and replaced by means of a knurled knob *f*.

To use the jig, five cams of the same kind are set up in it so that pin *c* goes through the holes in the cams which, of course, are the same size for all cams. The cams are now adjusted properly as regards their outline by means of the set-screws in the members *d*. This, however, has only to be done for the first set of cams to be milled. Any other set of the same shape will, thereafter, be automatically located in the correct position. It may be well to mention at this point, that it is advisable to provide a special screw holder *d* for each different shape of cam to be milled. Fig. 8 shows cam *B* in the fixture, with an extra screw holder *d* suitable for its size and shape. By providing suitable screw holders, the fixture may be changed ready for milling another kind of cam in a few seconds. After the cams are located, the lever *g* is moved over. Thus, the four cams *Y* are revolved, pushing in the screws *W* and, consequently, moving the bars *V* against the cams. The latter are pressed against the fixed bars *U* at the opposite side. Since the bars *U* are exactly at right angles to the center line of pin *e* as well as to the milling machine table, and since the cams *Y* may be adjusted in such a way as to insure a sufficient and equal pressure at four points of the cam surface, it is clear that the narrow "jointing" surfaces must be absolutely square with the sides of the cams. The depth of the cut is adjusted by inserting a 0.002 inch "feeler blade" between the cutter and the gage *h*

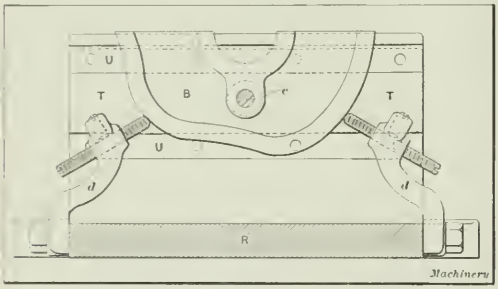


Fig. 8. Detail of another Type of Work-holding Device for Cam Milling Fixture

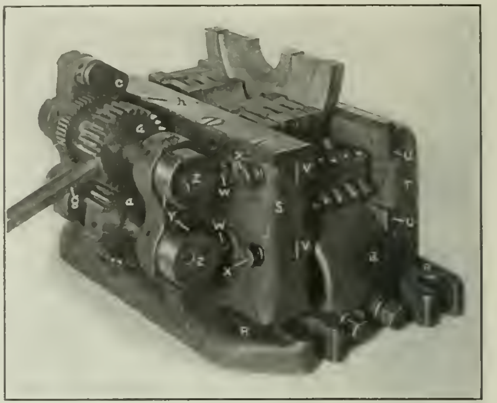
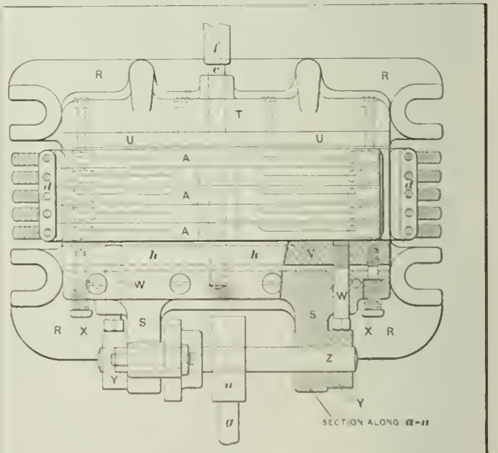


Fig. 10. Cam Milling Fixture shown in Fig. 9



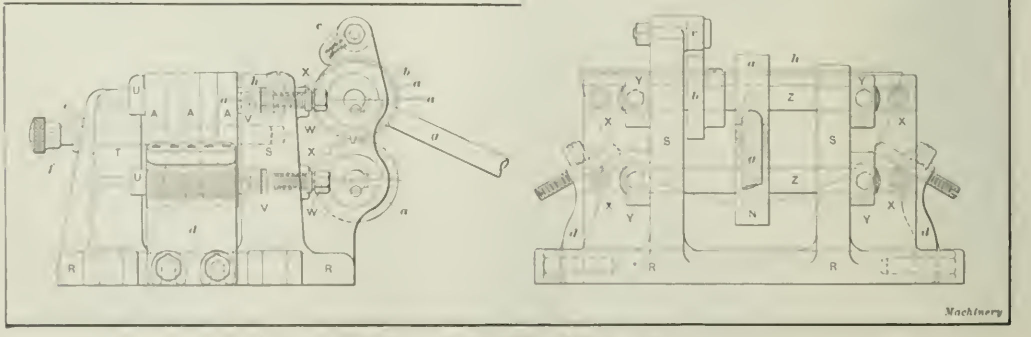


Fig. 9. Design of Fixture for milling Connecting Surfaces of Cams shown in Fig. 7

which is located above the steel bar *V*. Thus the distance *Q* between the center line of pin *e* (or the hole in the cam) and the surface to be milled will always be accurate and exactly the same for all cams, thus making it feasible to exchange any cam-half with any other one without the slightest trouble.

The ratchet and pawl are provided to prevent the gears and cams *Y* from losing their firm grasp of the bars and cams due to vibration during the process of milling. In the illustration of the fixture Fig. 10, the pin *e* has been removed and one of the cams is drawn out to show its construction more clearly. The quick action of the cams *Y* in connection with the action of the springs on the studs *X* enables the work to be clamped or released by a single movement, and the pressure exerted to hold the work may be adjusted at will by means of cams *Y*. This fixture has been found to give excellent results and can be recommended for any work of a similar nature.

* * *

DOUBLE-HEAD AUTOMATIC FOR FINISHING ROLLER BEARING ROLLERS

The special double-head model B automatic screw machine illustrated in Fig. 1 was developed by the Cleveland Automatic Machine Co., Cleveland, Ohio, for use in finishing roller bearing rollers and similar parts of the form shown in Fig. 2. The machine has a capacity for work up to 1 1/16 inch in diameter by 7½ inches long and is used for crowning, beveling or facing the ends of work, finishing both ends to exactly the required length at a single operation. To do this, it means that the end *K* must be finished without leaving a burr since it is held in the spindle *L* after being separated from the bar. The piece *M* is also finished in this manner. Referring to the illustration of the machine, it will be seen that the spindle *A* is driven by shaft *B*, the power being transmitted from the main spindle *C* by gears. The spindle head *D* slides on the elevating block *E*, and the shaft *B* is provided with splines to allow the driving gear to slide with the head *D*.

The operation of the machine is as follows: The stock is fed through the main spindle *C* until it strikes the adjustable stop *F*, which passes through the spindle *A*. The spindle head *D* is then moved forward by means of a cam on the drum *G* until the spindle *A* is close to the spindle *C*, allowing the necessary clearance for the forming and cutting-off tools. After the spindle head has moved forward, the chuck in the spindle *C* closes, through the action of the regular cams on the drum *H*, after which the chuck in the spindle *A* is closed by means of a cam on the drum *G*. The cut-off tool, which is carried on the rear slide, then advances to the work at the same time that the front slide advances to bring the forming tool into operation to bevel or crown the ends of the work. After the work has been separated from the bar, the chuck in the spindle *A* is opened through the action of a cam on the drum *G*, and the spindle head *D* is moved back by a cam on the drum *G*. The work is ejected from the clutch by means of the adjustable stop *F* which also acts as an ejector.

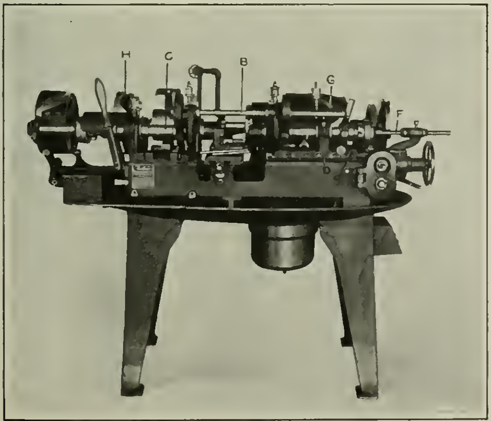


Fig. 1. Cleveland Double-head Model B Automatic for finishing Roller Bearing Rollers

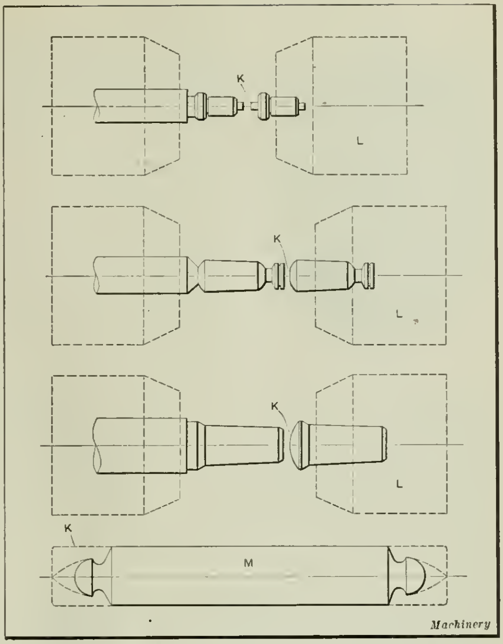


Fig. 2. Examples of Work done on Machine shown in Fig. 1

* * *

COMPOSITIONS OF ALLOYS

On account of that peculiar property possessed by metal alloys, as compared with chemical compounds, which permits one to vary the percentages of the constituent metals within certain limits without appreciably changing the characteristics of the alloy, there are a great many different specifications for alloys known by the same name. Hence, if one compares the composition of alloys having the same name as given in a number of different handbooks, one will find wide variations, yet each of these compositions undoubtedly gives practically as good results as another. There is no standard for the composition of many alloys known by distinctive names. The proportions of the ingredients have been varied by some manufacturers to suit certain requirements, although the original name has been retained. Hence, when two authorities differ as to the composition of a common alloy, both compositions may be satisfactory. German silver, for example, is probably made to almost as many different formulas as there are manufacturers, yet all obtain good results from the alloy.

* * *

HIGHER SPEEDS FOR THE LINESHAFT

In many factories, the lineshafts run too slowly, and consequently most of the machines provided with cone drives are so speeded that the slowest speeds obtainable on the machine are seldom or never used. A Connecticut manufacturer of machine products has set a good example by speeding his lineshafts so that the slowest speeds that can be obtained on any machine are the slowest that ever will be required. Whenever he belts up a new machine, he considers what is the slowest speed that will ever be required for that machine, and then fixes the sizes of the pulleys on the countershaft so that this pre-determined speed is the slowest that can be obtained. The natural tendency for the workmen, then, will be to use higher cone speeds than are common and more use is made of the back gears. The general effect has been to use higher speeds on all work from the lowest turning speed to the highest filing speed.

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AUGUST, 1915

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STANDARD TWIST DRILL DESIGN

The lead of the flute, the lip angle and the angle of the point of twist drills have remained practically unchanged for the last forty or fifty years. But a new development has recently been made by a twist drill maker in changing the angle of lead of the flute. Several advantages are claimed for the new type of drill, but the fact that the present form has been accepted for so many years prompts some conservative users to ask the reason for the change.

Is there any assurance, based upon practical tests, carried out with scientific precision, that twist drills are made of a form most advantageous for the rapid removal of metal? Why should the point angle be 59 degrees? Why is a lead angle of 20 or 25 or 35 degrees superior or inferior to some other angle? What thickness of web is most advantageous to strike a favorable balance between cutting quality and strength? What increase in the thickness of web toward the shank is justifiable in order to insure reasonable strength?

Because twist drills have been made in a certain way for the past few decades, is no reason why this way is the right way. Where is the investigator who can answer the questions propounded for the benefit of the practical efficiency expert? Do we now use 25 per cent or any per cent more power than would be necessary to remove the same amount of metal by a drill if it were differently designed?

There is an awakening to the fact that established methods are not necessarily the best or the right methods, simply because they are established. The methods in all walks of human activity were never so severely questioned as today, and not the least in engineering and machine shop practice.

* * *

MECHANICAL EFFICIENCY

A machine is a device for utilizing power in doing useful work, and is efficient to the degree that the power is made useful. Power is lost by the frictional resistance of shafts, bearings, gears, belts, chains and other means of power transmission. If every shaft and other moving part were made frictionless, the efficiency of the mechanism would be practically one hundred per cent; that is, all the power put into the machine would be utilized in doing the work desired. Of course this is impossible of realization, but more and more is being done to eliminate frictional losses by using ball and roller bearings and, what is fully as important, by perfecting plain bearings. A "perfect" plain bearing is one in which the oil film is never broken down under load, and in which there is no metallic contact of the shaft and bearing shell. Such a bearing will run indefinitely without wear.

The efficiency of an unbroken oil film is strikingly demonstrated in high-grade worm-gearing. Common worm-gears, as ordinarily designed and cut, are notoriously inefficient, but a worm-gear of the Hindley type may be made to develop efficiency as high as 97 per cent, or more, when there is an unbroken oil film between the worm and worm-wheel teeth. Rubbing action then meets no resistance due to interlocking of metallic surfaces in contact. High-grade machine work, ground teeth and perfect alignment, are conditions necessary to insure an unbroken film, high efficiency and long wear; but they are well worth the cost.

* * *

MACHINE DESIGN TO SUIT OPERATORS

When a machine designer or machine builder complains of the stupidity or ignorance of machine operators who do not appreciate the delicate nature of his machine, and hence do not obtain satisfactory results, he is really pronouncing a severe criticism of his own work. The tendency today is to do away with highly skilled machine operators, and replace them by men of comparatively little training. The manufacturer must meet this condition, difficult as it sometimes may be, and instead of complaining about the impossibility of success with a certain type of machine, because it is so intricate or delicate that it cannot be handled by cheap help, he should devote all his energy toward being able to claim, as many a maker of special automatic machinery justly may, that a man of average intelligence, who has never seen the machine before, can be taught to operate it in an hour or two.

There is no use complaining about the lack of skill in operators. The designer and maker of machine tools must recognize lack of skill as a condition to be met. The more successfully his machine fulfills the requirement of being "foolproof," the more secure is its commercial success. The tendency is to avoid intricate and delicate machinery under present manufacturing conditions. Adjustments must be simply obtained and positive. The troubles in operation must be reduced to a minimum, and the method of overcoming unavoidable difficulties must be made as easily understood as possible. The time to consider the ignorance of the operator is when the design is on the drafting-board; don't complain about it after the machine is on the market, and won't sell.

* * *

CHEMISTRY IN ENGINEERING

Mechanical engineering has made great strides in a few decades. The engineer points with pride to the automobile, the flying machine, the gas producer, the modern locomotive, and numerous other developments that are the result of his inventive ability and skill; and because the mechanical engineer generally is directly engaged in the production of the final and visible result—the machine or the device—he is often considered as the man wholly responsible for the great advance made. The engineer, however, has created these new developments out of materials superior to those available in the past; and these materials have been made possible by the chemist rather than by the mechanic. The remarkable qualities of alloy steels, for example, have been of greater value in the development of the automobile than any other factor, the gasoline engine excepted. The development of the aeroplane is largely due to the high tensile strength, light-weight aluminum alloys of recent years; but these alloys have been perfected by the chemist in his laboratory. High-speed steel was accidentally discovered by a mechanical engineer; but the final development of this product was the work of the metallurgical chemist. In many industries we find the chemical research laboratory an indispensable adjunct in the solution of what to many seems to be a purely mechanical problem. In the manufacture of grinding wheels, for example, chemistry is the science that stands behind the best practice. The chemist has done more valuable service in the development of mechanical engineering than is generally acknowledged.

ENGINEERING SOCIETY DISCONTENT

It is not improbable that some of the questions agitating the American Society of Mechanical Engineers at the present time are based upon an underlying cause which affects voluntary associations generally, and which is sometimes not as fully recognized as it should be.

When a new professional society is organized, all its members are thereby enjoying a new experience. Those who have attained mature age are likely still to be youthful in feelings and in ambitions, else they would not take part in the new society. They are forming new acquaintances and are having experiences pleasing to them. The more youthful members have in addition the enthusiasm of youth. The affairs of the society under such conditions are bound to go well, and practically everybody who participates in it will approve of what is being done and the way in which it is being done. But if this society is successful the very fact of its success introduces some elements which may tend toward discord. A growth to larger membership usually requires a different manner of handling the business of the society. The methods that would do for a small membership will often not do at all for a larger membership. The "one-man control" which will often do admirably for the small society is usually impossible for the larger, and things in general must undergo the changes incident to growth.

After a while when the apparently necessary changes have been made, no matter how prosperous the society may be as shown by its increase of membership and the increased prestige it may have attained, there will be those who will be dissatisfied. Everything that is different from what it was in the old days will be unsatisfactory to them; the secretary is not as glad to see them as the old secretary was; when they go to the office they are met by strange faces; they do not find the old tables and the old chairs in the accustomed places, and do not feel at home; the papers presented to the society seem to them less meritorious than in the old days; the social functions do not suit them as well, and in short pretty much everything is wrong. They imagine that if they could be put back to the earlier days they would enjoy things as they were in the old way. But in this they are almost certainly mistaken, for they forget the chief element of enjoyment in such matters, and that is youth and enthusiasm. A large part of the halo that hangs around the older days comes from the same cause as the high regard in which "mother's pies" are held; in both it is a case of youthful appetite and enthusiasm.

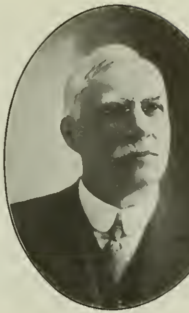
Every organization which is successful enough to hold its members throughout their active lives is bound, as it grows older, to have a certain proportion of its membership who will be dissatisfied with the way things are going, thinking that the dissatisfaction is due to wrong methods, whereas, as a matter of fact, it is due to the hardening of arteries, and to the same influences which generally cause those who are advanced in years to lose their interest in contemporary things and to imagine that all the older things were better. As societies grow older the number of old men in them increases, and comparatively few of the aged are able to recognize that the present-day ideas and methods may possibly be better than the older.

* * *

In a recent report of the industrial commission of Wisconsin, it is shown that over 70 per cent of all the injuries to workmen caused by chips, nails and other small flying objects affect the eyes. Out of a total of 346 cases reported, thirty-two men lost the sight of one of their eyes entirely, 217 had their eyes injured, seventy-five suffered from lacerations, seven from impaired sight and fifteen from bruises. The causes of these injuries were as follows: hit by chips, 283; by nails, fourteen; by stone from blasts, three; by other small objects, forty-two. The report further states that of the 70 per cent of eye accidents, it is safe to say that fully three-quarters of the eye injuries could have been avoided by the wearing of goggles. Within the past year, many Wisconsin plants have adopted the use of goggles, and as a result eye injuries have been almost entirely eliminated.

INTERCHANGEABILITY

BY J. P. BROPHY[*]


J. P. Brophy

The word "interchangeability" is used by almost everyone in the manufacturing business without really considering seriously what it means. It seems to be about as natural to use this word as it is to breathe, but let us consider its actual meaning. According to the dictionary, when you use this word in connection with machinery of any kind, it means that every piece of a given machine will fit all other machines of the same size and kind. Interchangeability means that any part can be taken from one position on one machine and placed in the same position on another, and will fit without the slightest alteration. How many are there engaged in manufacturing enterprises today who can truthfully apply the word interchangeable to their product?

If a machine tool is fitted up as closely as it should be, which means that there will be only a slight tolerance in all directions, no matter how many of such machine tools are manufactured, one must be an exact duplicate of the other as far as the working parts are concerned. Possibly there are a few manufacturers in this world making something from steel, iron or metal of any kind, who can honestly claim interchangeability, but we believe they are exceptionally rare. To live up to the true meaning of this word requires the best kind of ability in the manufacturing business. All drawings must be made with the view of avoiding, as far as possible, shapes that are either difficult or almost impossible to machine. The design of tool equipments, from the simplest cutting tool or fixture to the most elaborate that may be necessary, should be given fully as much consideration as the machine you are about to manufacture if you are going to attempt interchangeability, and the greatest care must be taken in your factory from the time the material arrives in the plant until the finished machine is tested.

For the purpose of this article we will assume that the machine to be manufactured is a lathe. The planer or milling machine that produces the flat surface must be first-class; and the cutting tools used must also be of the best quality and kept in good condition. In setting up the work, care must be taken to avoid straining the castings in a way that will cause them to spring when the clamps are loosened, as the necessity for such hand operations as fitting, scraping or filing after the machine work is finished must be avoided because they destroy interchangeability. Accurate surface plates for testing the flat surfaces are a necessity, and the same is true of ring and plug gages, the free use of micrometers, and drawings marked in decimals. In other words, leave no guessing to be done by your foreman or mechanics. Don't allow the words "good enough" to be made use of. If you do, goodbye duplication.

When holes are bored, the sizes must be kept exact to gage, allowing the necessary tolerance called for in the drawings. Hubs and projections of any kind, in a piece that has a hole in it, must be machined exactly true with relation to some fixed point. If the part goes to the milling machine, great care must be exercised to set it up the same as for the previous lot, and extreme care must be taken to make absolutely sure that the tools are kept in first-class condition, for the reason that the slightest wear in milling cutters or cutting tools of any description will change the height of the surface being machined. If the parts are hardened and ground, just as much care must be taken to be sure that the grinding is properly done.

In interchanging different parts on a machine of any kind, it should never be necessary to fit a part where it belongs to see whether it is right. All parts should be manufactured in the necessary quantities and with the right kind of fixtures of all descriptions, so that if any particular parts of a machine are being manufactured in advance of immediate needs, they can be laid aside finished and ready to be assembled, knowing that they will fit properly without the slightest trouble on the part of the vise or floor hands. From this explanation it will be seen that the word interchangeability means a great deal more than the average man realizes.

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[*] Vice-president and general manager, Cleveland Automatic Machine Co., Cleveland, Ohio.

In the manufacturing business we all know that even on drill presses, which some people seem to consider the cheapest tools in the plant, the fixtures of all kinds must be examined occasionally to be positively sure of maintaining their accuracy; and the same is true of the tables of the machines themselves in relation to the spindle. Legs that are either attached to the jigs or form an integral part of the jig body wear more or less through constant contact with the tables of drill presses, and this source of inaccuracy must be looked after. Bushings that guide the drills wear considerably from constant use, which means that the holes may be a few thousandths off in various directions, and unless new bushings are provided, this will seriously interfere with interchangeability. All other jigs used for all purposes require the same constant attention. Wherever possible, all tapped holes should be tapped on a machine and not by hand. The results of hand tapping are far from accurate when judged by the standards of first-class work. All tools used in a plant should be examined very carefully when returned to the tool-room, to be absolutely sure that they are not worn beyond the actual limits of tolerance, and to see that they are not bent or parts abused in any way, before they are handed out to the next man who uses them.

After all is said and done, with the greatest care exercised in the best plants in the country, and no matter how much skill may be used in manufacturing, each individual piece actually has to be tested with gages in order to be positively sure of exact duplication, for the reason that human nature continually errs and we are often under the impression that we are doing a thing just right, whereas something is going wrong and we are not aware of it. For instance, a workman may get it into his head that the job is "good enough" and not call it to the attention of the head of the department in which he is employed. It is easier to attain interchangeability in cheap machinery than in first-class tools. Reapers, mowers, steam pumps, engines, and various other articles manufactured in great quantities can come nearer to actual interchangeability because the limits of tolerance are much greater than could be allowed in the manufacture of machine tools or very accurate machinery.

The summary of the whole matter is this—that it pays, regardless of the expenditure required for good machinery and tools, to make the greatest effort to produce parts that are as nearly as possible duplicates of each other. The less hand work on the parts after they are machined, the more accurate the job, the consequence of which is better satisfaction and less expense in assembling the product. Finally, there is the great gratification of being able to ship a part to a customer a hundred miles away without much fear of its not fitting; and of being sure that if it doesn't fit a small amount of hand work will suffice. By way of conclusion it may be said that exact duplication of the parts produced in any shop means that the heads of departments must be thoroughly efficient, because nothing but the best possible organization, all the way from the casting-cleaner to the shipping room, can bring about the desired result of being able to truthfully say, "We claim interchangeability for our product."

* * *

What is stated to be the largest chain drive in existence is installed in a hydro-electric power plant on the Snake River, Copperfield, Oregon. This plant consists of a 3600 kilowatt generator, operated by two waterwheel units. The speed of the waterwheels is 147 revolutions per minute and each of the wheels is connected to the generator by four Morse chains, each 21 inches wide, with sprockets of two-inch pitch and shaft centers 10 feet apart.

BALANCING PRODUCTION WITH SALES

BY C. W. THAYER[*]

One of the dangers in a factory manufacturing a large variety of products is the possibility of accumulating too much stock, thus tying up working capital and reducing the turn-over, which has a very marked effect on the profits of the business. Only recently an automobile company was forced to wind up its affairs, though it was solvent, and examination showed over $1,000,000 tied up in stock parts. About a year ago an engineer was called into another factory where nearly a hundred different machines are made and carried in stock. From an examination of the balance sheet for the previous year he suspected that there was considerable danger of overstocking. The first step in analyzing conditions was to obtain an estimate of sales. The sales manager was called into a conference and asked to give a fairly optimistic estimate of the probable sale of each kind of machine for the ensuing year. Statistics had been gathered before the meeting, showing the sales of each kind of machine over a period of ten years, and graphic charts had been made to emphasize the tendencies in sales. This information, which the sales manager should always have had at hand, proved of the greatest assistance in checking up his estimates.

The sales manager considered each machine and gave an estimate of the probable sales for the ensuing year; and this figure was then analyzed by the engineer from the statistics. In a number of cases it was shown that the sales manager's estimate was too large and that he was not aware of the dropping off in sales. He made note of these things and promised to take them up with various salesmen. In other cases the sales had increased and he increased his estimate after reviewing the sales statistics. The next step was to call for an inventory of finished stock, machines in process, and parts on hand. The estimating department was then asked to compute the labor cost to complete the machines in process. These estimates served to show roughly the amount of labor required to complete the machines in process. A comparison of the year's requirement for sales, the finished stock on hand and machines in process brought out the startling fact that by the addition of labor to work in process to a value equal to four weeks' payroll, there would be enough machines to fill the estimated sales for the next nine months.

Analysis also brought out the fact that the finished stock on hand of one or two types was sufficient to last several years. Only in one or two cases, where the machines were small and inexpensive, was it found that the stock was too low, but these machines could be produced so quickly and at such a small labor cost, that they did not serve to compensate for even a small part of the other stock. The simple manner in which these facts had been brought out made the management wonder why they had not discovered the conditions before, and they immediately asked the engineer to devise a method which would prevent a similar occurrence in the future. A clerk in the sales department was assigned the duty of graphically recording the sales of each kind of machine on a separate sheet. Another "graph" curve on each sheet shows the number of machines in process, while a third shows the machines in process, plus the machines in stock, minus the machines on order. A quick review of these sheets now informs the sales manager at all times as to the sale of each kind of machine. It would be impossible now to surprise him by the statement that one machine is not selling well or that another machine is coming into demand. He can see the tendency and forecast the probable sale of each kind of machine. Where the tendency appears to be downward and in his judgment it should be upward, he is quickly informed and can take the matter up with his salesmen. Other records have been devised to supplement this particular one and the whole scheme is used by the planning department to balance production and keep the investment in raw materials, work in process, and finished machines at the lowest point consistent with the prompt delivery and service that the sales policy demands.

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TURNING, GASHING AND HOBBING WORM-WHEELS

BY N. I. MOSHER[*]

It is the purpose of this article to illustrate and describe the method of turning, gashing, and hobbing worm-wheels which is employed in the Machinery Division Shop of the United States Navy Yard, Boston, Mass. Fig. 1 shows a steel worm of 2½ inches lead, which meshes with two worm-wheels with 27 and 12 teeth, respectively. Fig. 2 shows the method of turning the throat of the worm-wheel on a boring mill, using a special radius tool which can be adjusted and clamped to any radius commonly found in worm gearing. Fig. 4 shows the method of gashing the teeth in a Gould & Eberhardt universal gear cutter. It was found that this operation would remove the stock more rapidly than was possible by cutting the entire tooth with the hob; but care must be taken not to cut so deeply that the hob will not cut out the full tooth.

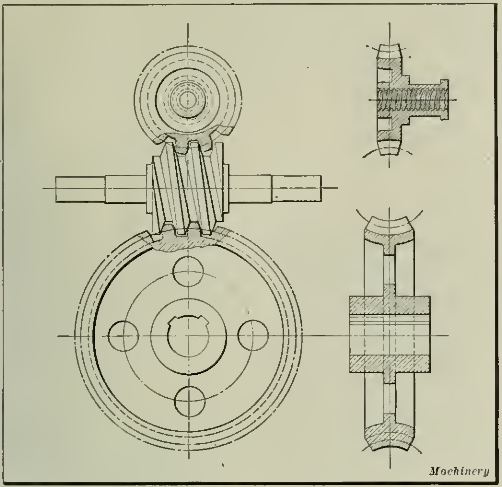

Fig. 1. Two Worm-wheels to be Turned, Gashed and Hobbed

Fig. 3 shows the inserted tooth hob keyed to a heavy arbor and mounted on the centers of a 48-inch triple gear Putnam lathe. This illustration shows the toolpost removed from the lathe and the gear hobbing attachment mounted on the toolpost base. The attachment is made up as follows: A base casting is secured to the toolpost sea tand a round table revolves freely on this casting. An index gear with 200 teeth is secured to the revolving table on which is carried the worm gear to be hobbed, distance pieces being used to raise or lower the work to line it up properly with the axis of the arbor. The worm-wheel shown in Fig. 3 has 27 teeth, and the gearing necessary to cut this wheel consists of a 28-tooth bevel gear on the arbor engaging a 54-tooth gear on the sliding shaft at right angles to the arbor; secured to this shaft there is a 16-tooth bevel gear engaging a 28-tooth gear on the short vertical shaft; and the vertical shaft carries a 25-tooth spur gear which meshes with the 200-tooth gear on the table. This gearing provides a ratio of 27 to 1 between the arbor and the gear to be hobbed, as shown by the following calculation:

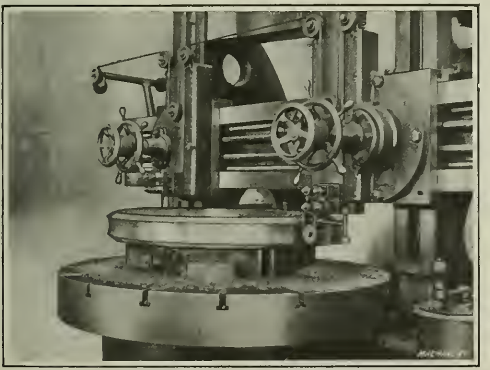

Fig. 2. Turning up Blank with Special Radius Tool

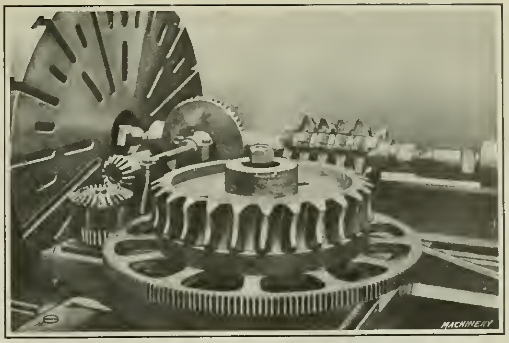

Fig. 3. Hobbing 27-tooth Worm-wheel

$$\frac{\text{Driven}}{\text{Driver}} = \frac{200 \times 28 \times 54}{25 \times 16 \times 28} = \frac{27}{1}$$

This outfit has been found very rigid and powerful, and the actual time required to hob the teeth to the proper depth was approximately one hour. Fig. 5 shows the same attachment that is illustrated in Fig. 3 mounted on another lathe and provided with different indexing gears, and a cone fixture supporting a small worm-wheel of 12 teeth which is being generated by the same hob that was used for the 27-tooth wheel. It will be seen from Fig. 1 that this small wheel has a quadruple thread cut in its bore. This unusual combination of worm and worm-wheels is part of a navy supply ship's steam steering gear.

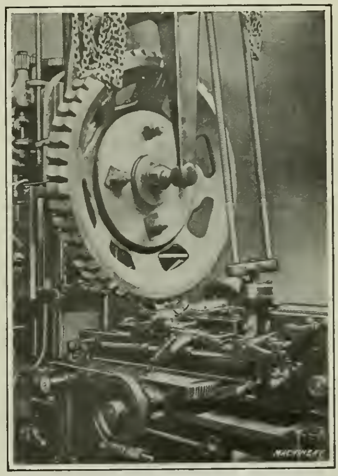

Fig. 4. Gashing 27-tooth Worm-wheel on Gould & Eberhardt Gear-cutting Machine

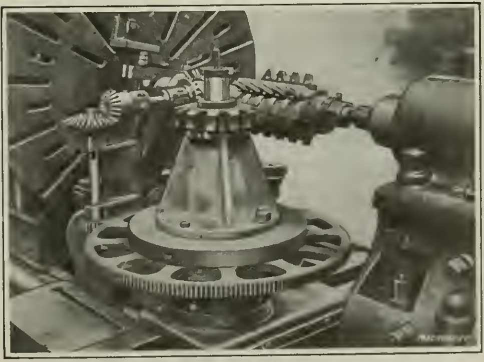

Fig. 5. Hobbing 12-tooth Worm-wheel

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JIG AND FIXTURE MECHANISMS*

A COLLECTION OF QUICK-ACTING AND EQUALIZING JIG CLAMPING DEVICES

BY GEORGE M MEYNCKE†

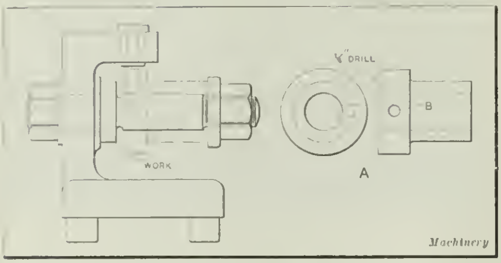

Fig. 1. Simple Way of clamping a Bushing for Drilling

WITH the universal realization of the advantages of interchangeable production, jig and fixture designs are receiving greater and greater attention, and as a result, high-grade fixtures are built for quantities that a few years ago would have been deemed insufficient to warrant so great an outlay in tool equipment. No single item influences the production rate to as great an extent as the design of jigs and fixtures. The saving of a few seconds clamping time means an increased production that offsets a high first cost. It is much easier for an operator to clamp his work by tightening one nut than the usual three, and aside from the saving of time, he is expending less energy and works to better advantage to himself and his employer.

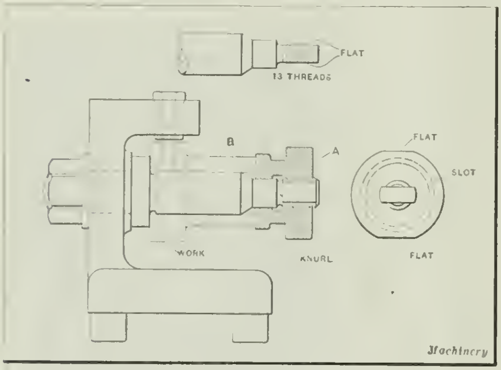

Fig. 2. Using a Quarter-turn Knob for clamping Work

It is usually necessary to equalize pressure in a jig before applying the clamping pressure. When equalizing and clamping mechanisms are both effected by a single operation, the danger of clamping before equalizing the pressure can be eliminated. Many object to the term "fool-proof," but the amount of work spoiled or sprung by careless clamping justifies care in designing jigs and fixtures that are at least "error-proof" in this respect.

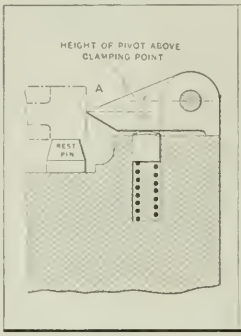

Fig. 4. Simple Means for drawing Work down firmly onto Locating Pins

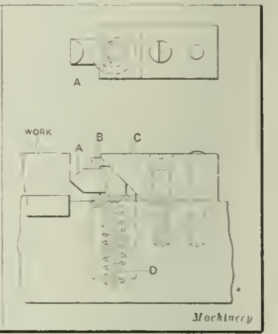

Fig. 5. Another Example of Clamps for drawing Work down firmly onto Locating Pins

The mechanisms here described are selected for their suggestive value, and only as much of the fixture is shown as is absolutely necessary. Great care should be used in selecting the mechanism desired, so that it meets the clamping or equalizing conditions of the work in hand.

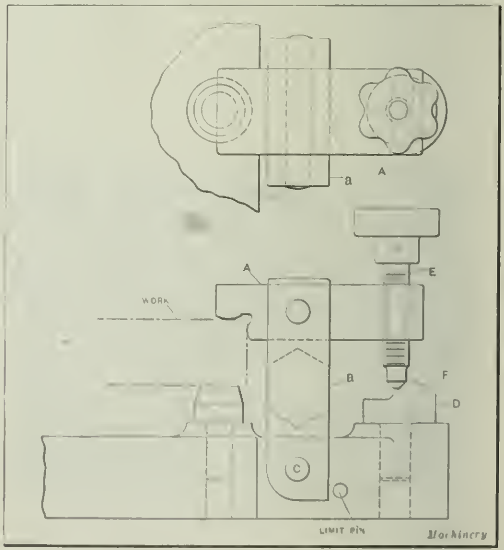

Fig. 6. Type of Double-movement Clamp

As an example in the choice of clamping mechanism, consider the piece *A*, Fig. 1. It is required to drill the hole *B*. A simple way of clamping this piece is illustrated in Fig. 1, using a hexagon nut and washer. The time required for running on and off the hexagon nut is avoided in the design shown in Fig. 2, using a quarter-turn knob. Stud *B* has a

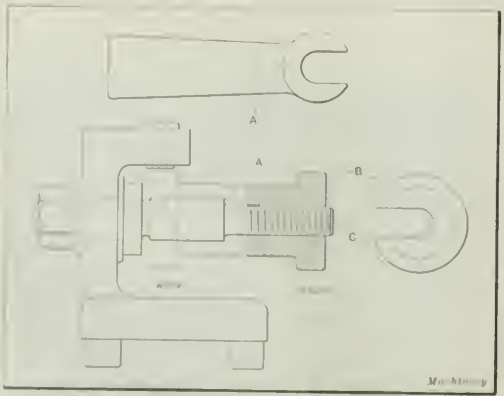

Fig. 3. Means used for clamping Bushing when Work varies in Length

flat milled on both sides of its threaded portion. The slot in knob *A* slides on over this flat and a quarter turn clamps the work. If the variation in the length of the work is not too great, this makes a rapid clamping arrangement.

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* For previous articles on clamping and locating devices used in jigs and fixtures see "Jig and Fixture Design," March, 1915; "Clamping Work in Jigs," December, 1913; and "Jigs and Fixtures," April, May, June and July, 1908. See also MACHINERY's Reference Book No. 41, "Jigs and Fixtures."

† Address: Dayton Engineering Laboratories Co., Dayton, Ohio.

Fig. 3 shows another means of clamping the same piece, in which the variation in length of the work and the time required for turning the knob to match the flat on the stud has been eliminated. The slotted washer *A* and knob *B* are dropped over stud *C*; washer *A* is held against knob *B*, which can then be screwed up as freely as a solid knob. This can be used for a variety of bushings of various lengths, the stud *C* being made to suit the longest piece of work.

Clamps that have a tendency to draw the work down firmly onto the rest-pins or stops are useful in all classes of fixtures. Fig. 4 illustrates a simple means of accomplishing this. Care should be taken to see that the stop is pivoted above the point *A*. Another and more rigid device is illustrated in Fig. 5. The plunger *A*, carried in plunger *B*, is forced down against the 45-degree side of stop *C*, compressing spring *D*. A fixture that clamps two clamps with a "down-and-in" pressure is illustrated in Fig. 7. Slides *B* are equalized by strap *C* and ball-and-socket washers *D* and *E*. This fixture is useful for milling and profiling, as the clamps and stops are below the surface of the work. Fig. 8 shows two down-and-in clamps equalized for holding a round piece of bored work for a milling operation. Lever *A* is tapped to receive screw *B*, and the clamping pressure equalizes with lever *C* by means of rod *D*. Levers *A* and *C* impart a down-and-in pressure to plungers *E*. This fixture can be applied to flat work.

In the double movement clamp shown in Fig. 6, the clamp *A* is carried by the hinge *B*, pivoted at *C*. Screw *E* gives clamp *A* a down-and-in movement by means of a 45-degree taper on stud *D*. The stud *D* is milled off at *F* to give the clamp sufficient movement to remove the work. A mechanism for drawing down both ends of two pieces, by means of a single nut, is illustrated in Fig. 9. Each piece is clamped independently, thus making it suitable for use on rough castings or forgings. Rod *A*, running through the fixture, carries ball-and-socket washers at each end and draws the end clamps *B* and *C* together. These clamps are given a down-and-in movement against the 45-degree wedge ends of rods *D* and *E*. The clamping thrust against rods *D* and *E* imparts a downward movement to the inner clamps *G* and *H*, pulling the work down on the inner rest-pins. The clamps are returned by means of plungers *K* and spring *J*.

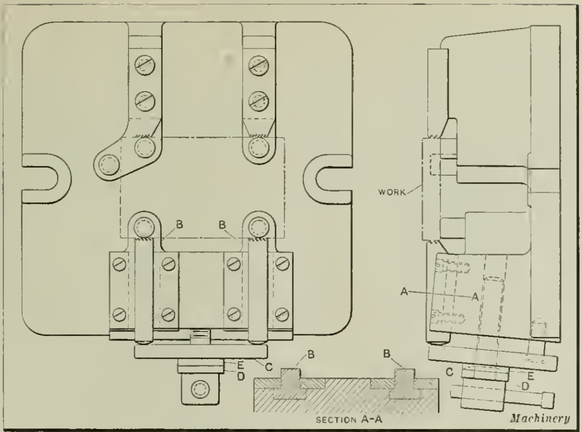

Fig. 7. Arrangement for clamping Two Clamps with a "Down-and-in" Pressure

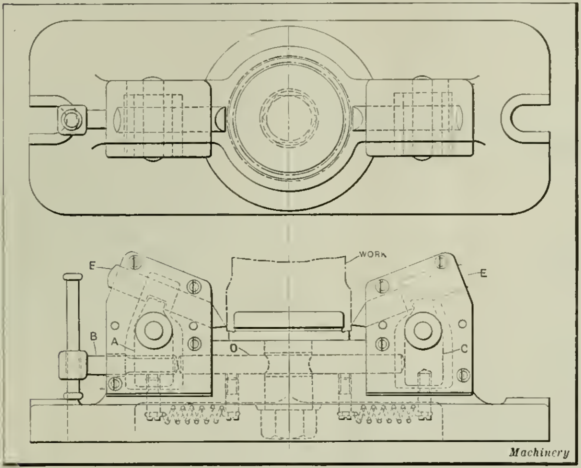

Fig. 8. Fixture having Two Equalizing Clamps

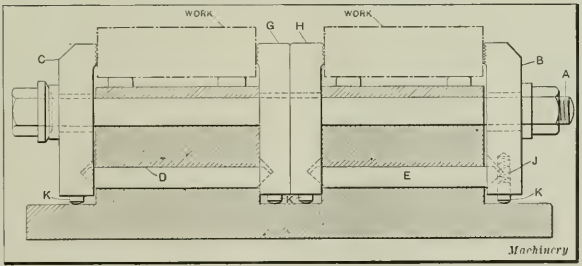

Fig. 9. Mechanism for drawing down Both Ends of Two Pieces by a Single Nut

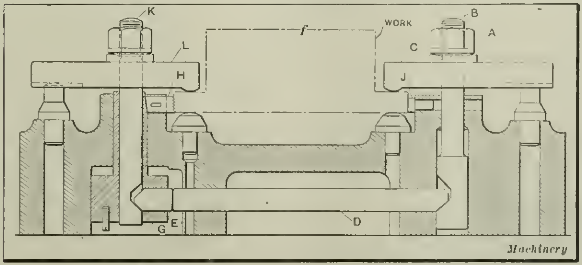

Fig. 10. Method for drawing down Two Clamps and forcing Work against Stop-pins by Single Clamping Operation

The fixture illustrated in Fig. 10 shows a method of drawing down two clamps and throwing the work against the stop-pin by a single clamping operation. Tightening nut *A* clamps down clamp *C* and pulls up rod *B* against the 45-degree tapered end of rod *D*, giving a lateral movement against plunger *E*. Plunger *E* is carried by the floating stud *G*. On the upper end of stud *G* is a 15-degree taper that operates against plunger *H*. Plunger *E* imparts, first, an upward movement to floating stud *G*, which, in turn, forces out plunger *H* and throws the work against stop-pin *J*; second, a downward pull on plunger *K*, drawing down the clamp *L*. Thus the work is thrown against the stop-pins before the final clamping pressure is applied. Clamps *C* and *L* are held up by spring plungers, which are not shown.

The clamping pressure on eight small washers is equalized, and the washers are clamped with

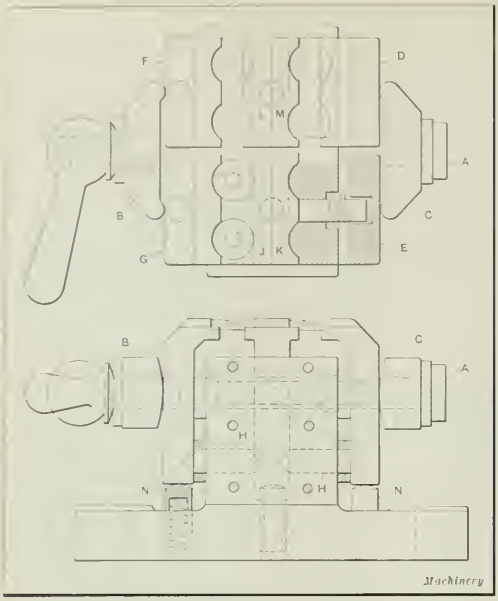

Fig. 11. Fixture for equalizing Clamping Pressure on Eight Small Washers

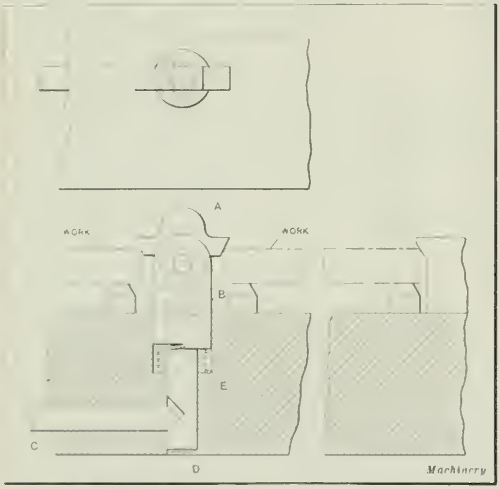

Fig. 12. Center Clamp giving a Downward and Outward Thrust

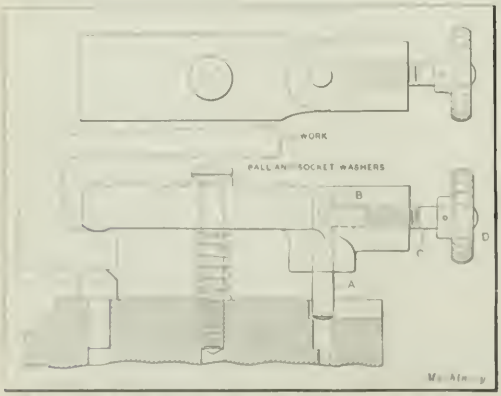

Fig. 13. Special Type of Clamp used where Projections on the Work prevent the Use of Plain Clamps

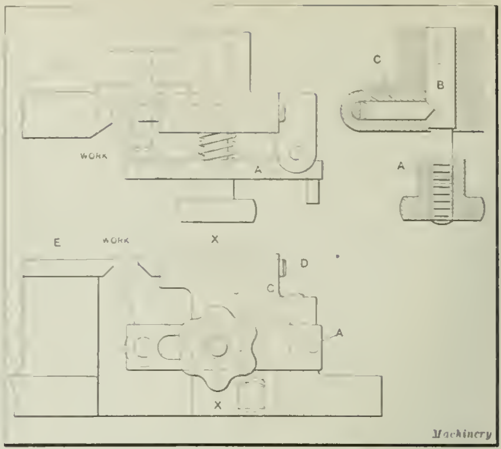

Fig. 14. Small Double-movement Clamping Mechanism

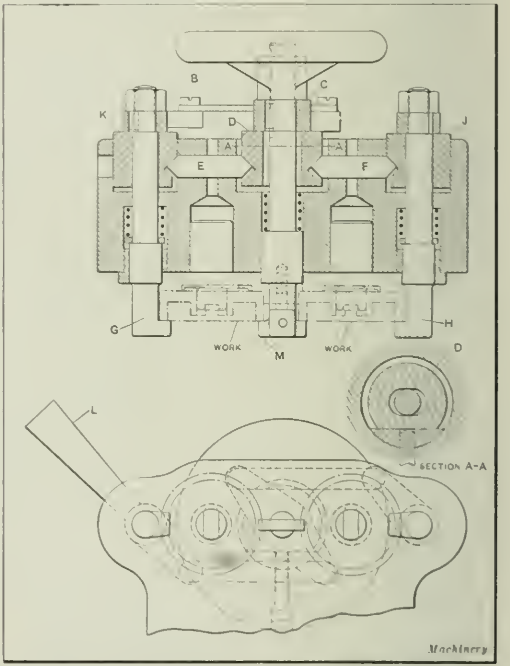

Fig. 15. Equalizing Clamping Arrangement using a Handwheel

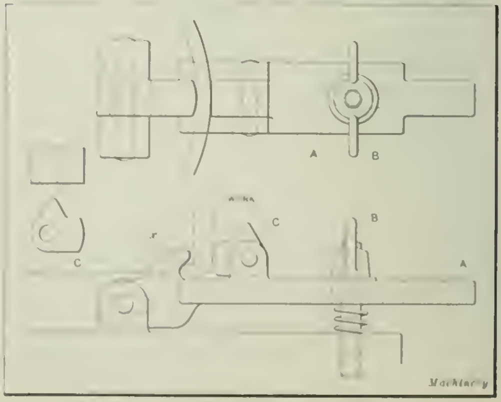

Fig. 16. Clamping Work by holding it with a Flange

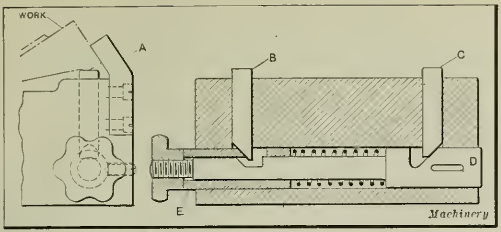

Fig. 17. Heavy Milling Fixture with Equalizing Clamping Device

a downd-and-in movement in the fixture shown in Fig. 11. Rod *A* clamps the equalizers *B* and *C*, which equalize the pressure against *D* and *E* on one side, and *F* and *G* on the other. Clamps *D*, *E*, *F*, and *G* are given a downward pull by four plungers *H*, which also impart a downward pull on the inner clamps *J*, *K*, *L*, and *M*. The clamps are bored to receive the washers, and are returned to a normal position by the spring plungers *N*.

Fig. 12 illustrates a center clamp that gives a downward and outward thrust by means of the tapered ends of plate *A*, which is carried by plunger *B*. Plunger *C* wedges down the plunger *D* which is tapped into plunger *B*. Plungers *B* and *D* are held up by a spring *E*. A small pin in plunger *D* allows a half turn of plunger *B*, so that the work may be lifted out.

In the fixture illustrated in Fig. 15, the work (two clutch shells) is equalized and clamped by a single movement of the handwheel *B*, drawing out rod *C* against the collar *D*. The section *A*-*A* shows how this collar equalizes its thrust with plungers *E* and *F*. The collar *D* is free to slip to either side as required for equalizing. The plungers *E* and *F* draw in rods *G* and *H* through the medium of collars *K* and *J*. The strap *M* held central by a small spring and plunger equalizes the pull on the center clamp. All clamps are made to clear the work, when it is to be removed, by means of the lever *L* and the system of levers shown in the lower view.

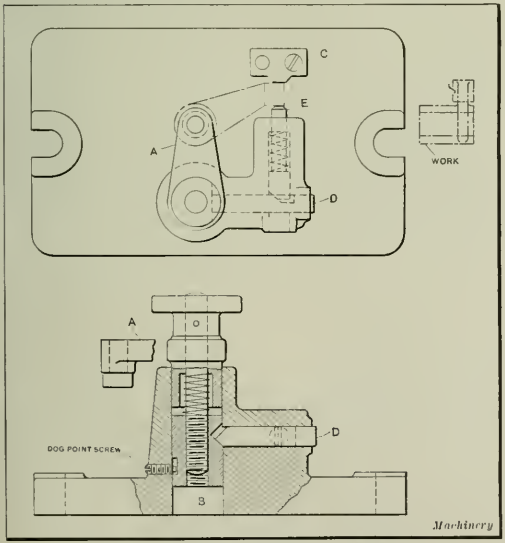

Fig. 18. Another Double-movement Clamping Mechanism

Figs. 14 and 18 illustrate a small double-movement clamping mechanism for hand milling or profiling use. In Fig. 14 the clamping pressure against clamp *A* also pulls out plunger *B*, throwing up plunger *C* and throwing the work against stop *E*, by means of plunger *D*. Spring plunger *G* is used to return plunger *D*. In Fig. 18, the pull through clamp *A* on plunger *B* throws the work against the stop *C* by means of plungers *D* and *E*.

In profiling or face milling fixtures, clamps on top of the work often interfere with the cutter. Fig. 16 illustrates a method of holding this class of work by means of a flange at the bottom. Clamp *A* is operated by the wing-nut *B* and floats in slots to allow for any casting variation, and for hooking the projection on the clamp over the flange. The piece *C* is thrown over after the clamp is hooked over the flange. Care must be taken that the point x is below the pivot *C*.

Fig. 17 illustrates part of a heavy milling fixture for clamping up against the stop-plate *A*, by means of the two plungers *B* and *C*, by equalizing with the plunger *D* and sleeve *E* working against *B* and *C* with 45-degree wedge cuts. Projections on the work often prevent the use of plain clamps. Fig. 13 shows an unusual, but efficient, clamp that meets these conditions. The use of plungers *A* and *B* permit the clamp to be operated from the rear by means of a screw *C* and knob *D*. When work is long in proportion to its width or when the locating pins must be placed close together, as in the piece illustrated in Fig. 19, there is danger of "cocking" or binding between one locating pin and the screw, if a plain screw is used to throw the work against the locating pins. The use of a roller instead of a screw prevents this. The roller *A* will turn until the work strikes both stop-pins. In the device illustrated, *B* and *C* are the fixed locating pins, and *D* is the clamp screw operating the sliding plunger *G*.

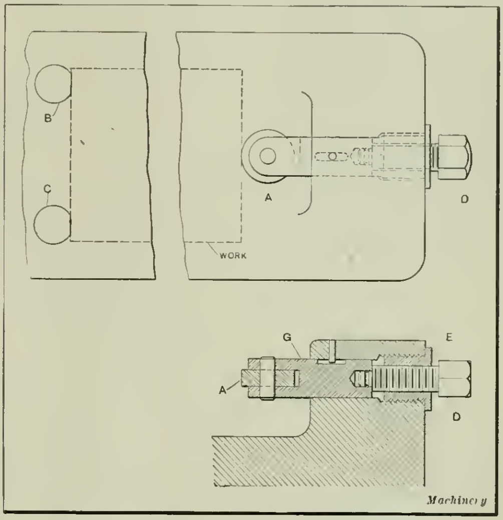

Fig. 19. Using a Roller to prevent Unequal Binding against Locating Pins

Fig. 23 shows the locating mechanism for a milling fixture in which two pieces are located by two plungers each, all operated by a single clamping operation. Lever *A* draws out plunger *B* and throws in sleeve *C*, operating the plungers *D* and *E*. Plungers *E* are smaller in diameter than plungers *D* and permit of enough lateral movement to equalize plungers *G* through the auxiliary plunger *H*.

Fig. 21 represents a milling fixture with a quick-release feature. The particular work illustrated is milling a flat on

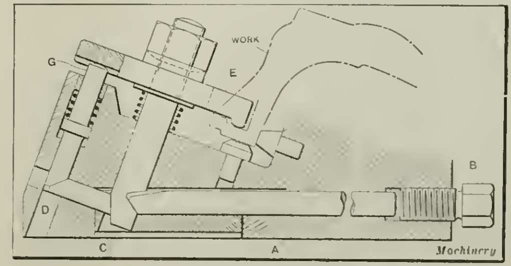

Fig. 20. Mechanism used when unusually Large Movement of Clamp is required

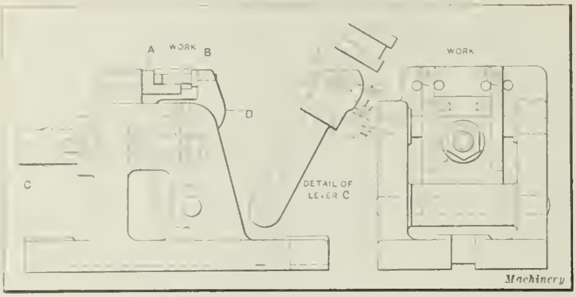

Fig. 21. Milling Fixture with a Quick-release Feature

a small bushing made on the screw machine. The bushings are held on the pins *A* and *B* and clamped with the eccentric handle *C*, which draws in the hinged leaf *D*. Details of the quick-release lever are given.

Fig. 22 illustrates half of a fixture for milling a concave surface on an unusual piece. The work is clamped against the pads *A* and *B* on previously milled surfaces, by means of two differentially operated plungers *C* and *D*, similar to a previously described device. To prevent springing under cut, the work is backed up with the floating plunger *E* on one side and *F* and *G* on the other. The plungers are operated by push-rods *H* and *J*. These push-rods are hand operated and are clamped by the bushing *K* and star knob *L*.

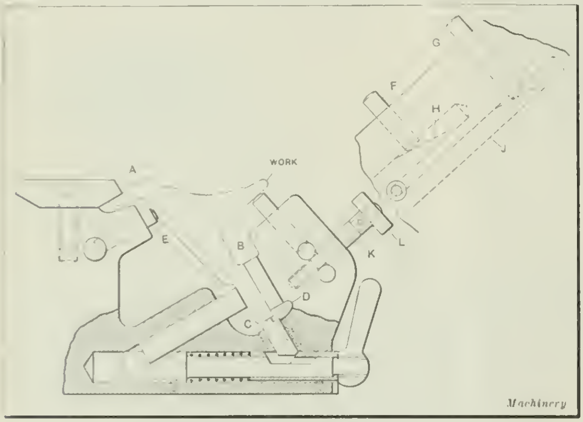

Fig. 22. Fixture for milling Concave Surface, provided with Adjustable Supports under Milled Surface

Some occasions arise in which the 45-degree plungers do not permit of sufficient clamping movement. The mechanism in Fig. 20 was designed to overcome this objection. An unusually large movement of the clamp is required to clamp directly over the rest-pin. Rod *A*, operated by screw *B*, imparts movement to both plungers *C* and *D*. Plunger *C* pulls clamp *E* down, and plunger *D* pushes up on clamp *E* through the plunger *G*. The wedge angle between plungers *C* and *D* should be less than between plungers *A* and *C*. There is considerable friction in this mechanism.

A very rigid mechanism for clamping at three points, by means of one screw, is shown in Fig. 24. In this case, it is shown applied to a drill jig, but it is rigid enough to permit its use in heavy fixtures. In these cases, the clamping pins become rest pins and are subject to the thrust of the cut. Screw *A* thrusts against equalizing plunger *B*. The details of this plunger mechanism are illustrated in the engraving. Plunger *B* is of smaller diameter than the drilled hole and rests on the piece *C*. This piece is cut from a rod of the same diameter as the hole, and is used to afford a flat base for plunger *B* to rest on and insure full contact of the wedge end against the plungers *D* and *F*. Plunger *G* is a duplicate of *B* and equalizes the plungers *F* and *H*.

Considerable saving of time may be effected by the use of ejectors. Fig. 25 is an example of the use of an ejector. Push-rod *A* has four notches milled tapering on one end. The pins *B* are bored and slotted to receive the rods *C*. These rods are operated by the wedge cuts in push-rod *A*. The four pieces of work are ejected by pushing in rod *A*.

An element that has lately entered into shop equipment, and which must be constantly kept in mind by the tool designer, is the safety-first movement. A milling cutter cannot be completely guarded and still perform its operation as a milling cutter. In work on Lincoln-type millers or on straddle-mill work the return table movement must be long in order to eliminate the danger of the operator's striking the cutters when unclamping or withdrawing the rear clamp. The necessity of the extra long table return is done away with in the straddle-milling fixture illustrated in Fig. 26. The clamps are operated entirely from the front of the fixture, thus making it unnecessary for the operator to reach in near the cutters. Clamps *A* and *B* are operated by the handle *C* through stud *D*, rod *E* and stud *F*. The clamps are withdrawn by lever *G*, which is pivoted on stud *H*, and operates clamp *A* by means of pin *J*. The strap *K* is connected to the other end of lever *G* and operates the rear clamp by means of the pin *L*.

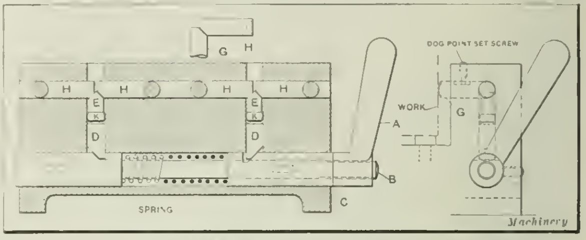

Fig. 23. Locating Mechanism where Two Pieces are located and clamped in a Single Operation

* * *

Some notion of the demand for rifles in the great European war may be gained from the fact that it is estimated by an expert that by July 1, 1916, this country will be manufacturing rifles for military purposes at the rate of 30,000 a day or over 9,000,000 a year. It is also estimated that this country will be turning out rifle cartridges at the rate of 25,000,000 per day.

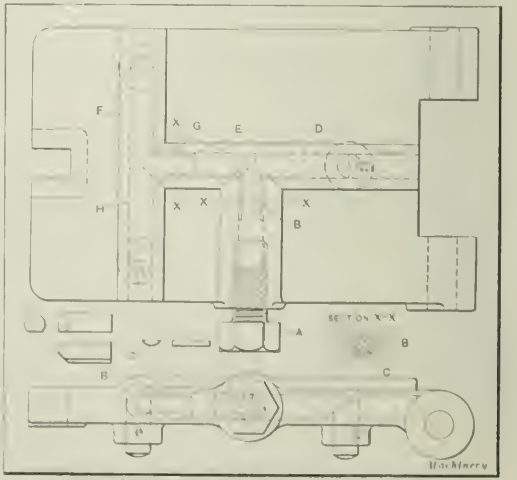

Fig. 24. Rigid Mechanism for clamping at Three Points by Means of One Screw

TEACHING SHOP WORK

Of recent years, the principle that shop work should be taught as nearly as possible under practical commercial shop conditions has steadily gained ground. The reason for this has been, no doubt, the lack of proper teaching methods in many of the trade schools and manual training schools; hence, the conclusion was near at hand that shop work could not be taught in a trade school. Some schools tried to meet this objection by adopting a plan and organization similar to that of a commercial shop, and building a simple line of machinery, or by taking in repair work; but it is doubtful if they have been able to turn out all-around machinists by this means.

At the Massachusetts Institute of Technology, a system of teaching shop work has been developed by Robert H. Smith, in charge of instruction, which disproves the idea that the principles of shop work shold be taught differently from any other engineering subject. Shop work, according to the Smith method, should be taught in a systematic manner, just the same as mathematics, mechanics, or book-keeping, starting with the simplest principles and working up to the more complex, following all the time a set, predetermined course. This cannot be done in a shop where the apprentice must work on any kind of job that comes along, but must be done in a school shop, where the commercial feature does not predominate. This does not mean that the commercial side is ignored—far from it. Every piece of work given to the student in this shop course is timed, and the student is also informed of the standard time in which a skilled workman would complete it. This gives him a better idea of commercial requirements than would be possible in a trade school taking in repair work, where it would be impossible to determine the time element correctly. In a training shop of the type described, with a set course, each student is taught every ordinary machining operation. In the so-called "commercial" trade school or in the actual commercial shop, there are dozens of operations with which he never comes in contact.

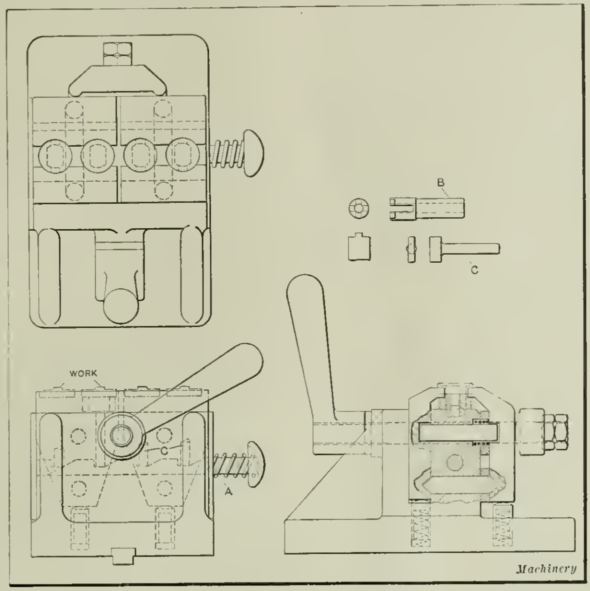

Fig. 25. Simple Ejecting Device

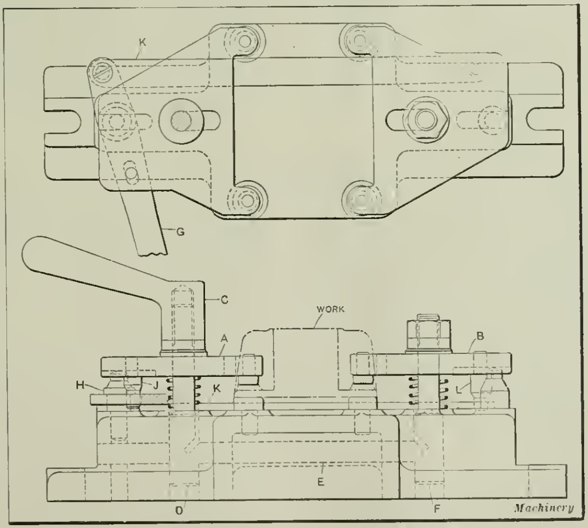

Fig. 26. Fixture designed for Use on Lincoln Milling Machine

The experience of the Massachusetts Institute of Technology shops indicates that it is possible to teach a boy a trade in a much shorter time, if a systematic course is adopted, than would otherwise be the case; and as the plan developed by Mr. Smith becomes more thoroughly understood and appreciated by educators and practical shop men, it is likely that it will be generally adopted by trade schools.

* * *

COMBINATION TOOLS

Inventors have been prolific in devising combination tools of the glass-cutter, can-opener and corkscrew variety for household use. Some of these combinations have been very profitable to the makers and fairly useful to the purchasers. But the combination tool has well defined limitations which should be fully appreciated before undertaking to develop a combination of tools for the use of mechanics.

A common tool that is seldom used by the average person may be combined with others of like nature, and if the design is well worked out, it may be successful. A householder needs a glass cutter perhaps once a year, and the combination tool serves his purpose satisfactorily. But if he is a glazier, a single-purpose tool—the best available—is none too good. He would not tolerate a tool combined with a corkscrew and can-opener. The condition is the same with mechanics generally. A machinist or toolmaker prefers tools designed and made for a separate and distinct use. It is true that there are exceptions; some combination tools have been very successful, but in general the tool user wants a tool for each purpose and one that does not require assembly and adjustment before it can be used.

A combination pick and root axe might be an acceptable combination tool to the amateur gardener who has comparatively little use for either, but a gardener working for his livelihood would insist on separate tools for each well defined purpose. When the saving of weight is important, however, combination tools are sometimes desirable. An aviator, for example, might tolerate a combination of tools that he would scorn if driving an automobile. It is highly important that the aviator's equipment be as light as possible and in his case utility would be sacrificed to lightness. But automobilists and others who need make no such sacrifices for lightness of their equipment usually prefer the separate tool for each purpose.

LAPS AND LAPPING*†

AN INVESTIGATION OF THE CUTTING PROPERTIES OF ABRASIVES WHEN USED WITH DIFFERENT LAPS AND DIFFERENT LUBRICANTS

In order to determine the cutting properties of abrasives when used with different lapping materials and lubricants, a series of tests was conducted, the results of which are given in the following. In connection with these tests a special machine was used, the construction being such that quantitative results could be obtained with various combinations of abrasive, lubricant, and lap material. These tests were confined to surface lapping. In the selection of the abrasive—both as to kind and size of grain—the metal of which the lap is made, the lubricant, and the lapping pressure, there is, of course, a wide range of possible combinations. The object of the experiments was to secure reliable data on the following points:

1. The relative efficiencies of the different abrasives.
2. The relative efficiencies of different lubricants.
3. The rate of cutting with laps made of cast iron, soft steel, and copper.
4. The wear of the laps, compared with each other and with the amount of steel ground off each.
5. The effect of pressure on the rate of cutting.
6. The rate of cutting by the wet and the dry methods.

TABLE I. SUM OF AMOUNTS IN MILLIGRAMS GROUND FROM SPECIMENS WITH PRESSURES OF 5, 10, 15, 20 AND 25 POUNDS PER SQUARE INCH

		Machine Oil	Lard Oil	Kerosene	Gasoline	Turpentine	Alcohol	Soda Water	Total
Cast Lap	Emery	1320	1673	3324	3955	2336	2392	3105	18105
	Alundum	1849	2313	3687	4291	3230	3251	3112	21733
	Carborundum ..	2825	3340	4230	4520	4458	4427	3873	27673
	Total	5994	7326	11241	12766	10024	10070	10090	67511
Steel Lap	Emery	1744	2460	2720	3034	2560	2608	2839	17965
	Alundum.......	1800	2537	3622	3627	3400	3388	3338	21712
	Carborundum ..	4199	4649	3805	3980	3983	3527	4045	28188
	Total......	7743	9646	10147	10641	9943	9523	10222	67865
Copper Lap	Emery	3250	3454	3756	3813	3598	3961	3780	25612
	Alundum	3971	4065	3763	3960	4171	4097	4472	28499
	Carborundum ..	4148	4540	3692	3724	4251	4081	4210	28646
	Total......	11369	12059	11211	11497	12020	12139	12462	82757
	Total for each lubricant.....	25106	29031	32599	34904	31987	31732	32774	

Machinery

The testing machine was equipped with a motor-driven lapping plate and a suitable holder for applying the test piece to the revolving plate. This plate was of circular form and was mounted at the top of the vertical spindle, so that it revolved in a horizontal plane. The holder for the test piece was arranged to reciprocate between the center and the outer edge of the lapping plate. The test piece was held against the lapping plate by the pressure of suitable weights, so arranged as to follow up the wear of the test piece with practically no friction. It was essential to have a uniform distribution of the abrasive charge over the surface of the plate. Centrifugal force was depended upon to work the charge from the center of the plate outward, and by means of a mechanically operated wiping device the abrasive was kept distributed over the surface of the lap. The test pieces were of hardened tool steel, cylindrical in form, the diameter being $\frac{5}{8}$ inch and the length ½ inch.

It was not the intention to test all the different abrasives on the market, three being selected as being representative; namely, "Naxos" emery, carborundum, and alundum. Abrasive No. 150 was used in each case, and seven different lubricants, five different pressures, and three different lap materials were employed. The lubricants were lard oil, machine oil, kerosene, gasoline, turpentine, alcohol, and soda water.

Starting a series of tests, say with emery as the abrasive and with a cast-iron lap, the first test was made with lard oil and with a pressure of 5 pounds per square inch on the specimen. The pressure was then increased to 10 pounds per square inch, other conditions remaining the same, and another run made. The pressures were then increased to 15, 20, and 25 pounds, giving a group of five runs with lard oil. Machine oil was then substituted for lard oil, and a like group of tests made, after which tests were made with the other lubricants in the same way. This gave for the cast-iron, emery-charged lap a series of thirty-five tests. Carborundum was next substituted for emery and the same number of tests repeated. This was followed by a like series with alundum, making the total number of tests with a cast-iron lap 105.

The cast-iron lap was then replaced by one of steel and a second series of 105 tests run with the steel lap. This was followed by a like series with the copper lap. Therefore, for making comparisons of the action of the three abrasives and also for the three lap materials, cast iron, copper, and steel, we have 105 tests of each.

Before starting a test run, the charge of abrasive and lubricant was distributed as uniformly as possible over the surface of the lap. The test was continued until the crank which moved the test piece over the plate had made 4000 revolutions. At the end of 500 revolutions the specimen was removed, cleaned with gasoline, and weighed. This was repeated at the end of the next 500 revolutions, and then for each 1000 revolutions until the 4000 revolutions were completed. A summary of all the results is given in Table I, which shows the results obtained with different lap materials, different abrasives, and different lubricants. The figures in the body of the table represent the amount in milligrams ground from the test pieces.

Effectiveness of Lapping Lubricants

The action of the different lubricants was found to depend upon the kind of abrasive and the lap material. A summary of the results obtained with different lubricants follows:

Lard and Machine Oil.—On account of their differences but similarity of action, lard and machine oil will be considered together. The test showed that lard oil, without exception, gave the higher rate of cutting and that, in general, the initial rate of cutting is higher with the lighter lubricants but falls off more rapidly as the test continues. Both the highest and lowest results of the entire series of tests were obtained with these two lubricants. The lowest was obtained with machine oil, when using an emery-charged cast-iron lap, lard oil giving slightly better results. With lard oil and a carborundum-charged steel lap, the highest results were obtained, but with machine oil, there was a reduction.

Gasoline and Kerosene.—On the cast-iron lap, gasoline was superior to any of the lubricants tested. It was not so good on copper and still less on steel. Considering all three abrasives, the relative value of gasoline, when applied to the different laps, is as follows: Cast iron, 127; copper, 115; steel, 106. Kerosene shows more nearly the characteristics of gasoline than of the heavier oils. Like gasoline, it gives the best results on cast iron and the poorest on steel. It does not work very well with carborundum on a copper lap. During the entire series of 315 tests, there were but two instances in which the values obtained by carborundum were not higher than those obtained with emery, and these two were with gasoline and kerosene on a copper lap.

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* Abstract of a paper prepared by W. A. Knight and A. A. Case, and presented before the spring meeting (June, 1915) of the American Society of Mechanical Engineers.

† For additional information on lapping previously published in MACHINERY see "Lapping Flat Work and Gage Jaws," November, 1907, and articles there referred to.

Turpentine and Alcohol.—There is no evidence to show that turpentine possesses a superior advantage over the other lubricants. On any lap it was found to do good work with carborundum. With emery it did fair work on the copper lap, but with the emery on cast-iron and steel laps, it was distinctly inferior.

Alcohol, in some ways, acts very much like turpentine, since it gives the lowest results with emery on the cast-iron and steel laps. Alcohol and turpentine were the only two lubricants that gave any evidence of having a solvent or chemical action on the abrasive, and these with emery only.

Soda Water.—Soda water gives reasonably good results with almost any combination of lap and abrasive; thus, while it is seldom the best, it is never the worst. Soda water does its best work on the copper lap and the poorest on the steel lap, although there is little difference between the results with the cast-iron and steel laps. On the cast-iron lap, soda water is better than machine or lard oil, but not so good as gasoline or kerosene. Soda water, when used with alundum on the copper lap, gave the highest results of any of the lubricants used with that particular combination. While soda water is objectionable, owing to the sticky residue and the hard crusty substance which it forms when dry, as far as the results go and as to first cost, it should rank ahead of turpentine and alcohol.

The Lapping Abrasives

As to the qualities of the three abrasives tested, it was found that carborundum usually began at a lower rate than the other abrasives, but when once started its rate was maintained better. The performance gave a curve that was more nearly a straight line. The charge or residue as the grinding proceeded remained cleaner and sharper and did not tend to become pasty or muck-like as is so frequently the case with emery.

Alundum, both as to its rate of cutting and cleanliness of residue, was found in general to be intermediate between carborundum and emery. Taking the total amount of steel ground from the specimens with each of the abrasives as a base for comparison, they stand as follows: Carborundum, 84,507; alundum, 71,944; emery, 61,682. These figures are for all three laps. When divided according to the amounts ground off with each individual lap, the results are as given in Table II. As will be seen, when using a copper lap, carborundum shows but little gain over the cast iron and steel laps, whereas with emery and alundum, the gain is considerable.

TABLE II. AMOUNTS IN MILLIGRAMS GROUND FROM SPECIMENS WITH DIFFERENT COMBINATIONS OF LAP AND ABRASIVE

Cast Lap	Steel Lap	Copper Lap
Emery.......18,105	Emery.......17,965	Emery.......25,612
Alundum 21,733	Alundum.....21,712	Alundum.....28,499
Carborundum 27,673	Carborundum 28,188	Carborundum 28,646

Machinery

These tests indicated throughout that there is for each different combination of lap and lubricant a definite size grain that will give the maximum amount of cutting. With all the tests, excepting when using the two heavier lubricants, some reduction in size of grain below that used in the tests (No. 150), seemed necessary before the maximum rate of cutting was reached. This reduction, however, was continuous and soon passed below that which gave the maximum cutting rate.

Comparison of Laps

Each lap consisted of a cast-iron backing plate faced with the proper material. The cast-iron plates were of a good grade of foundry iron but no attempt was made to secure a special mixture. The copper lap was made of plate copper ¼ inch thick, and the steel lap of the same thickness was made of fire-box steel. The surfaces of the steel and cast-iron laps were finished by grinding. The hardness of the different laps, as determined by the scleroscope, was, for cast iron, 28; steel, 18; copper, 5. The total amount ground from the test pieces with each of the three laps was, with cast iron, 67,511; with steel, 67,865; with copper, 82,757 milligrams. These figures show that taking the whole number of tests as a standard, there is scarcely any difference between the steel and cast iron, but that copper has somewhat better cutting qualities. However, since there is a great difference between the highest and lowest values obtained with each lap, it would seem more logical in comparing the relative merits to refer to the highest values obtained with each.

TABLE III. COMPARATIVE VALUES OF THE BEST COMBINATIONS, TAKING EMERY-CHARGED CAST-IRON LAP AND MACHINE OIL AS UNITY

Abrasive	Lap Material	Lubricant	Comparative Value
Carborundum	Steel lap.....	Lard oil.....	3.52
Carborundum	Copper lap...	Lard oil.....	3.44
Carborundum	Cast lap.....	Gasoline	3.42
Alundum....	Copper lap...	Soda water...	3.39
Carborundum	Cast lap.....	Turpentine ..	3.37
Carborundum	Cast lap.....	Alcohol	3.35
Alundum....	Cast lap.....	Gasoline	3.25
Carborundum	Copper lap...	Turpentine ..	3.22
Carborundum	Cast lap.....	Kerosene	3.20
Carborundum	Copper lap...	Soda water...	3.19
Carborundum	Steel lap.....	Machine oil..	3.17
Alundum....	Copper lap...	Turpentine ..	3.15
Carborundum	Copper lap...	Machine oil..	3.14
Alundum....	Copper lap...	Alcohol	3.10
Carborundum	Copper lap...	Alcohol	3.09

Machinery

Comparing them on this basis, they stand in the following order:

Steel, with carborundum and lard oil, 4649.
Copper, with carborundum and lard oil, 4540.
Cast iron, with carborundum and gasoline, 4520.

These figures show that with the proper abrasive and lubricant, steel and cast iron are as good for all practical purposes as copper.

One of the remarkable facts shown by the tests is the great differences in wear of laps, both as regards the material from which they are made and wear due to the different abrasives. The wear on all laps was about twice as fast with carborundum as with emery, while with alundum the wear was about 1¼ times that with emery. On an average the wear of the copper lap was about three times that of the cast-iron lap. This is not absolute wear but wear in proportion to the amount ground from the test pieces.

Lapping Pressures

Within the limits of the pressures used, that is, up to 25 pounds per square inch, the rate of cutting was found to be practically proportional to the pressure. That this is not strictly true is because of the change in the size of the abrasive grains as the lapping operation proceeds. There is an increasing rate for a time and then a decreasing one; the greater the pressure the quicker this change. During the early part of a run the rate of cutting was not only increased by additional pressure but there was another increment due to the change in size of grain. After the maximum rate has been reached, the cutting is not quite proportional to the pressure. The higher pressures of 20 and 25 pounds per square inch are not so effective on the copper lap as on the other materials. Of the 63 combinations tested, the 15 giving the best results have been selected and are presented in Table III.

Wet and Dry Lapping

There are two methods of using a surface lap which, for want of better definitions, will be termed the "wet" and the "dry" methods. With the wet method there is a surplus of oil and abrasive on the surface of the lap. As the specimen being lapped is moved over it there is more or less movement or shifting of the abrasive particles. The action may be conceived to be somewhat as follows: A particle becomes embedded in the softer surface of the lap, it remains stationary for awhile, but is finally dislodged by friction or change in direction of the rubbing surface. It then rolls around for awhile, only to lodge again and have the process repeated. Meanwhile the grains of abrasive are being broken up into smaller sizes, their sharp edges and corners worn away, and the cutting effect grows less, until it becomes necessary to recharge the lap with fresh material.

With the dry method, the lap is first charged by rubbing or rolling the abrasive into its surface. All surplus oil and abrasive is then washed off, leaving a clean surface, but one that has embedded uniformly over it small particles of the abrasive. It is then like the surface of a very fine file or oil stone and will cut away hardened steel that is rubbed over it. While this has been termed the dry method, in practice the lap surface is kept moistened with kerosene or gasoline. This is for the purpose of preventing small spots of steel, called "birds' eyes," building up on the lap surface; but there is not enough lubricant applied to "float" the piece being lapped.

Among mechanics there is some difference of opinion as to whether the cutting is more rapid with the wet or the dry method. By advocates of the dry method it is pointed out that in this the abrasive is permanently embedded in the lap surface, there is actual contact between the abrasive and the steel specimen, there is no floating on an oil film, no rolling on loose particles, that the cutting action is more nearly true, and hence more rapid than when these conditions fail to obtain.

Dry Lapping.—Experiments on dry lapping were carried out on the cast-iron, steel, and copper laps used in the previous tests and also on one of tin made expressly for the purpose. Like the others, the tin lap was made up of a cast-iron backing plate provided with a facing of block tin about 1/4 inch in thickness.

Carborundum alone was used as the abrasive and a uniform pressure of 15 pounds per square inch was applied to the specimen throughout the tests. In dry lapping much depends on the manner of charging the lap. The first tests were made on the steel lap, charged by rubbing the abrasive into the surface with a cast block 3 inches by 2 inches. With a small quantity of carborundum (F) and lard oil, the surface was worked down until of a uniform slaty color and free from deep scratches or marks left by the grinder. It was then washed clean with gasoline and used perfectly dry. Next the plate was charged in the same way, but instead of being washed with gasoline the surface was simply wiped clean with waste. This left the plate practically dry but with a light film of oil adhering to its surface.

The results of these tests show that with a lap perfectly clean and dry the rate of cutting is reduced quite rapidly after the first 100 revolutions. At the end of 500 revolutions, the total amount ground from the specimen was 10.6 milligrams. When the plate was wiped clean and not washed with gasoline, the amount ground off at the end of 500 revolutions was 63 milligrams or about six times as much as with the plate perfectly dry.

Experiments demonstrated that between these two extremes, results of any magnitude could be obtained, depending on how thoroughly the free abrasive was removed from the lap surface. When the lap is simply wiped clean there still remains a film of oil over its surface and this carries a certain amount of free abrasive. For all subsequent tests the plates were washed thoroughly clean, in order that there should be no variation in results due to a varying amount of free abrasive on the lap surface.

Wet vs. Dry Method.—Obviously with so many different results, a comparison between the various methods of wet and dry lapping is more or less unsatisfactory. With dry lapping, the rate of cutting decreased much more rapidly for the first 100 revolutions than with the wet method. In making comparisons, however, it seems fair to consider the amounts ground off during the first 100 revolutions. Moreover, the best result obtained with each lap was taken as the basis of comparison. It was found that with a tin lap charged by rolling No. 150 carborundum into the surface, the rate of cutting, when dry, approaches that obtained with the wet method. With the other lap materials, the rate with the dry method was about one-half that of the wet method. A comparison of the wet and dry methods is indicated by Table IV.

TABLE IV COMPARISON OF WET AND DRY LAPPING PRESSURE, 15 POUNDS. ABRASIVE, CARBORUNDUM. 100 REVOLUTIONS OF TESTING MACHINE

Lapping Method	Cast Lap	Steel Lap	Copper Lap	Tin Lap
Wet	20.0	24.0	22.0	....
Dry	8.6	10.3	11.3	18.6

Machinery

Conclusions of Lapping Tests

In order to present the results of these tests in a more usable form, the principal facts are here summarized:

1. The initial rate of cutting is not greatly different for the different abrasives.
2. Carborundum maintains its rate better than either of the others, alundum next, and emery the least.
3. Carborundum wears the lap about twice as fast, and alundum 1 1/4 times as fast as emery.
4. There is no advantage in using an abrasive coarser than No. 150.
5. The rate of cutting is practically proportional to the pressure.
6. The wear of the laps is in the following proportions: cast iron, 1.00; steel, 1.27; copper, 2.62.
7. In general, copper and steel cut faster than cast iron, but where permanence of form is a consideration, cast iron is the superior metal.
8. Gasoline and kerosene are the best lubricants to use with cast-iron lap; kerosene, on account of its non-evaporative qualities, being first choice.
9. Machine and lard oil are the best lubricants to use with a copper or steel lap. They are least effective on the cast lap.
10. For all laps and all abrasives (of those tested), the cutting is faster with lard oil than with machine oil.
11. Alcohol shows no particular merit as a lapping lubricant.
12. Turpentine does fairly good work with carborundum, but in general is not as good as kerosene or gasoline.
13. Soda water compares favorably with other lubricants. Taken as a whole, it is slightly better than alcohol and turpentine.
14. Wet lapping is from 1.2 to 6 times as fast as dry lapping, depending on material of the lap and manner of charging.

* * *

LARGE HYDRO-ELECTRIC POWER DEVELOPMENT

It is stated in *L'Industria* (Milan, Italy) that the electrification of 1880 miles of Swiss state railways has been definitely decided upon and that the first line to be electrified will be the St. Gothard line. The large power stations for the first sections are in the course of construction. In one of these there is a head of 902 feet and this station will develop 32,000 horsepower. Another power station will turn into account a head of 2624 feet and will have a total capacity of over 50,000 horsepower. The electrical energy will be transmitted as single-phase current at 60,000 volts from the power stations to sub-stations where the pressure will be reduced to 15,000 or 7000 volts. Two types of locomotives will be adopted, one a heavy type designed to pull trains of ten passenger cars at a speed of 56 miles per hour, and a lighter type for local traffic. The Swiss state railways are to own the power stations, and in no case will the current-supply be obtained from private companies. The advantages of electrifying the railways will be two-fold. It will render Switzerland independent of outside supplies of coal for the railways, and will do away with the smoke nuisance in the numerous tunnels. This latter advantage will be appreciated by those familiar with traveling in Switzerland. The tunnels are numerous and many are of considerable length.

* * *

It is believed that there will be a great demand for American automobiles in Europe after the conclusion of the war, and automobile engineers in this country are already beginning to consider the steps to be taken to meet the requirements of design and production that will be involved

RECENT LEGAL DECISIONS INVOLVING MACHINERY

Question of Fraud in Sales Contract

(Oklahoma) The case of Richardson Machinery Co. *v.* Duncan, recently decided by the Oklahoma Supreme Court, involved a question of fraud in a contract for the purchase of machinery.

The suit was brought by the plaintiff against the defendants for damages on account of an alleged breach of contract. The defendants entered into a written contract with the plaintiff for the purchase of a machine, and one of the conditions of the contract was that the defendants should pay all freight charges on the machinery from the factory and for its return thereto and 10 per cent of the purchase price in case they should cancel the order or decline to accept the machinery when delivered. And there was also a condition that, in case suit was brought to enforce the contract, they should pay all attorney fees. The machinery was shipped to the defendants, who refused to accept it, and this action was brought to recover the freight charges specified in the contract and 10 per cent of the purchase price of the machinery and attorney fees.

As a defense to the action the defendants admitted signing the contract, but claimed that they had a parol agreement with the plaintiff that they might have the right and could reserve the privilege of countermanding the order contained in said contract and thereby rescind the same upon any date within fifteen days from the time of sale, and that it was agreed that the right to countermand said order and to rescind the contract should be incorporated into and become a part of the written contract; that the contract was drawn up by plaintiff's agent, Benningfield, and, before signing it, defendants requested Benningfield to read the contract or permit them to read it, but Benningfield insisted that it was late, and he was crowded for time, and the contract was long and tedious to read, and that it contained all the conditions and promises agreed upon by plaintiff and defendants, and especially assured them that it contained the stipulation reserving to the defendants the full right to countermand the order and rescind the contract by giving notice to the plaintiff or its agents; that they believed and relied upon the statement of Benningfield that the contract did in fact contain said stipulation and signed the contract without knowing that said stipulation was not in it, and would not have signed the contract without reading it, had they not been induced by the statements and assurance of Benningfield to believe that this stipulation was in said contract.

The defendants notified plaintiff that they elected to countermand the order contained in said contract and to rescind the same, and that plaintiff should not ship said machinery and were thereupon notified by plaintiff that the contract did not contain any stipulation reserving the right to countermand, and ignored their notice and shipped the machinery.

Defendants claim was that the contract was procured by fraud. The issues were submitted to a jury, which found against the plaintiff, and judgment was rendered in favor of the defendants and against the plaintiff, from which judgment an appeal was taken to the Supreme Court where the judgment was affirmed, the court holding that the evidence disclosed sufficient fraud in the execution of the contract to warrant the jury in finding for the defendant. *(George O. Richardson Machinery Co. v. Duncan, 148 Pac. 80.)*

Conditional Sale

(Federal) The sale of a machine, by a contract which provided that title to the machine should be vested in the seller until the purchase price, note, draft, or judgment therefore was paid in full, was a conditional sale, and the title did not pass to the buyer, and it was beyond its power to transfer title to a third party. *(In re Benz, 221 Fed. 129.)*

Injuries to Machine Shop Employe

(Pennsylvania) Where three workmen pulled too hard on a rope attached to a steel plate, thereby jostling from its place another plate, which fell on a fourth workman, the resulting injuries, being the consequence of a pure accident, could not be attributed to the negligence of the employer. *(Buckley v. Brown Hoisting Machinery Co., 93 A. 825.)*

Operation of Machine was not in Line of Employment

(Iowa) An instruction by a court to the jury that, if a servant in operating the machine by which he was injured was not within the line of his employment, or duty, and that he had never been directed or requested by the foreman to operate such machine and that he voluntarily worked at and undertook to operate it, and in doing so was injured, he could not recover, and the jury should find for defendant, though they found defendant negligent, sufficiently stated the law as applicable to the case. *(Cashman v. Du Pont Powder Co., 151 N. W. 394.)*

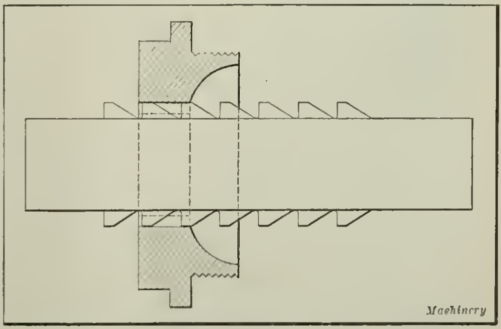
Misrepresentation in Sale

(Kentucky) Defendant, who signed a contract for the purchase of a number of machines, asserted that after he had agreed to purchase one, the agent, when he was busy with others, requested him to sign a memorandum showing that he should represent the company. He did not claim that the agent made any representations as to the contract other than that it provided that he should be agent for the company, which was true. Held, that as defendant could read, and signed the contract relying on the agent's honesty, he was liable, for to sustain a charge that a party's signature was obtained by misrepresentation, it must appear that the misrepresentation was material, that it was relied on by the person whose action was intended to be influenced, and that it was made with knowledge of its falsity, under circumstances warranting a belief in its truth. *(United Machine Co. v. Metcalf, 175 S. W. 357.)*

* * *

BROACHING KEYWAYS IN A TURRET LATHE

The Pierce-Arrow Motor Car Co. of Buffalo, N. Y., has cut down the time of manufacturing the cast brass union parts illustrated, by combining a broaching operation with the turning operation. The part is made from a casting, and the machining consists in turning and then broaching two keyways on opposite sides of the central hole. These keyways are 3/32 inch deep and 3/32 inch wide. The two operations were formerly conducted in different departments, and by combining them the cost of production has been greatly reduced. The part is machined on a Warner & Swasey turret lathe and is greatly facilitated by the use of an air chuck. After the turning has been done and before the piece is taken from the chuck, the operator inserts a small broach in the central hole of the piece and, with a "pusher" on the turret, forces the broach through, cutting the two keyways as shown. The broaching is done with a broach-travel of about two inches, and the action of the turret pushes the broach entirely through the piece so that when it is released from the air chuck the broach drops out with it. In the illustration, the broach is shown part way through the work. The piece is shown full-size.



Broaching Two Keyways Simultaneously in a Warner & Swasey Turret Lathe

MACHINING THIN BRONZE BUSHINGS

METHODS OF ROUGHING AND FINISHING THIN WORK IN LARGE QUANTITIES WITHOUT DISTORTION

BY ALBERT A DOWD*

THE bushings shown at *A* and *C* in Fig. 1 were to be machined in large quantities, and to within very close limits as indicated by the dimensions. It was desired to produce the bushings as economically and rapidly as possible, and to so design and arrange the tooling that distortion and variation in sizes would be reduced to a minimum. The matter of holding the work was first considered and a pot form of casting was decided upon as offering the best facilities. The bushing *C* was, therefore, cast with a 3-inch flanged portion *D* which was afterward cut off and scrapped. Bushing *A* was made of similar form, but in this instance the flanged portion *B* was so designed that after cutting off it could be re-machined to form the threaded collar *E*, which was used on one of the devices produced by the company. The utilization of this flange was more an accident than otherwise, a similarity in appearance leading the tool designer to look up the drawing of the threaded collar, which he had very recently had occasion to machine, and proportion the flange in such a way that it could readily be used for the other piece.

Particular attention was paid to the finish allowance in the cored hole, 3/32 inch on a side being provided so as to permit the tools to get well under the scale which is frequently so disastrous in its affect on cutting tools. When finish allowances are insufficient, a lack of truth in the casting sometimes permits the tool to ride on the surface for a part of a revolution, so that it encounters the scale and is thereby speedily ruined. An ample supply of cutting lubricant is a great advantage when cutting material of this kind, and as it could not be directed to the proper points by means of the regular supply pipes, it was found necessary to make special arrangements for this purpose. Illustrations and a description of these will be noted during the progress of this article, and attention will be called to special features of construction.

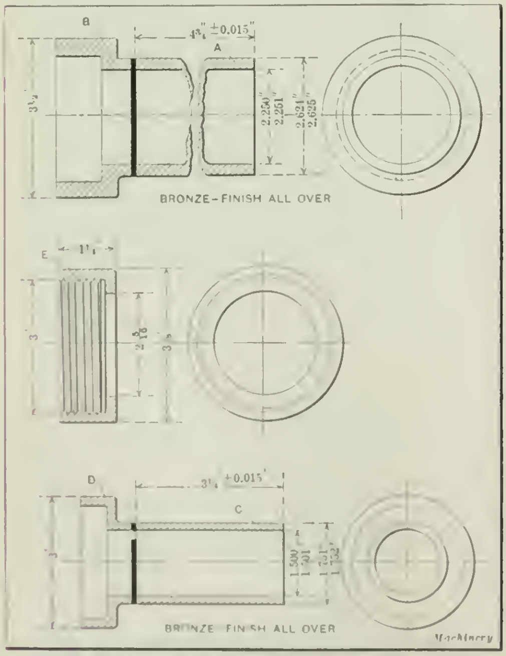
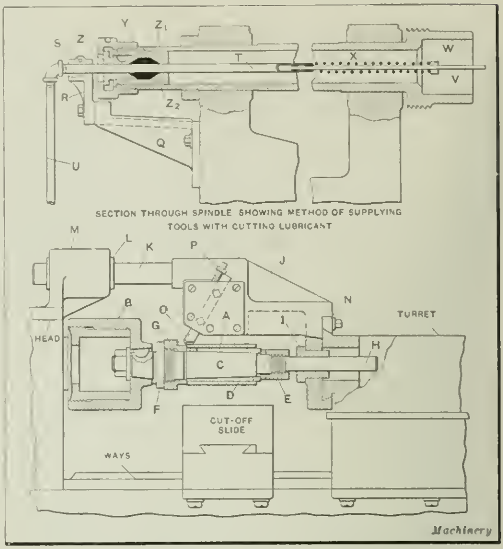


Fig. 1. Bushings to be machined and Threaded Collar E made from Flange B


Y
Z1
S
Z
W
X
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V
R
Z2
Q
U
SECTION THROUGH SPINDLE SHOWING METHOD OF SUPPLYING TOOLS WITH CUTTING LUBRICANT
M
L
K
P
J
B
O
A
N
TURRET
G
I
HEAD
H
C
D
E
F
CUT-OFF SLIDE
WAYS
Machinery

Fig. 2. Turret Lathe Set-up for Finishing Operations; and Cross-sectional View showing Method of lubricating Work

First Setting of the Work

The same method of tooling is used for both pieces but the boring and reaming bars are necessarily smaller for bushing *C*, although the same turning tools, being adjustable, are used in each instance. The tooling and method of handling for the larger piece are shown in Fig. 3. The flanged portion of the work *A* is held in a set of special jaws *F* in a regular three-jaw geared scroll chuck, the jaws being brought up against the outside of the flange very lightly, so as not to cause distortion. The hook bolts *G* are then set up tightly by means of the nut and washer at *H* so that a metal to metal gripping contact of great holding power is formed, which in addition to preventing distortion, tends to kill vibration in the work and thereby prevent "chatter."

The turning tool-holder *I* is of cast iron and made of partial U-section; it extends entirely across the turret to the dovetailed faces of which it is gibbed by the straps *J*. Long bolts *K*, of special construction, pass down through the body of the holder and pull up on these straps so that the turning tool practically forms a unit with the turret. Each end of the holder has a steel pilot *L* which is ground to a sliding fit in the bronze bushing *M*. This bushing is contained in a bracket *N* which is carefully fitted and screwed to the top of the spindle cap bracket *O*, so that a very rigid and unyielding support is formed for the turning tool-holder. It may seem that a heavy turning tool-holder of this character is unnecessary, when the work is such that it does not call for heavy cutting, but it should be remembered that when the work is thin, every precaution must be taken to guard against vibration in any of the working parts. An unsupported tool may be rigid enough to do good work on a casting of heavy section, and yet it may utterly fail when used on a piece of thin work on account of slight vibrations in the piece being transferred to the tool itself.

The boring-bar *P* is held in the turret by the shank *Q* and is also piloted at the forward end *R* in a hardened and ground bushing in the chuck. Attention is called to the manner in which the boring tool *S* and the turning tool *T* are set in opposition to each other so as to lessen the possibility of chatter and variations in sizes which might be caused by the work springing slightly away from the tool under the cut. As an additional precaution against inaccuracies, the turning tool-holder is supplied with a pair of rollers *U* which are set in adjustable blocks and backed up by screws in the plates *V*, the rollers being set a trifle behind the turning tool so that they bear on a finished surface. A partial section through the turning tool-holder is shown in the lower right hand portion of the illustration, which shows the rollers and tool in contact with the work. During the roughing operations of turning and boring, the tool *W* in the regular tool-holder *X* on the front of the cut-off slide, is fed forward and rough-faces the end of the pot. The plan view in the upper part of the illustration is partially broken away to show the facing tool in its working position. Attention is called to the fact that this tool is not employed until after the turning tool-holder with its back-rests has passed by, for an interference with them would otherwise take place.

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The finish-turning and boring operations are accomplished by tools in the other end of the tool-holder, and these are identical with the roughing tools except that they are ground with a slight "drag." The reaming bar *Y* is of somewhat unusual construction; it is held rigidly in the turret but piloted at the forward end in the same manner as the boring-bars. There are two flat reaming cutters *Z*, one of which is used for roughing the other for finishing, being interchangeable and having a slight vertical "float" so that they will accurately follow the hole generated by the boring tools. The roughing blade removes from 0.010 to 0.012 inch of stock, while the finisher has about 0.006 inch to take out. The rougher is ground very nearly on center but the finisher is slightly in advance of it so that it has a scraping effect and produces a very smooth hole. A hardened steel backing-up pin Z_1 takes the thrust of the reamers and reduces wear to a minimum. After the two reaming cuts have been completed, the tools Z_2 and Z_3 held in a special block on the rear of the cut-off slide, are brought into play to cut off and finish-face the bushing, respectively, the facing tool being set so that it will complete its work before the cutting-off tool has cut through the work. This completes the first setting of the work and for many kinds of commercial work the accuracy obtained would be sufficiently close without any further machining, but in this case such close limits are required that a final operation of turning the outside on an arbor was found necessary.

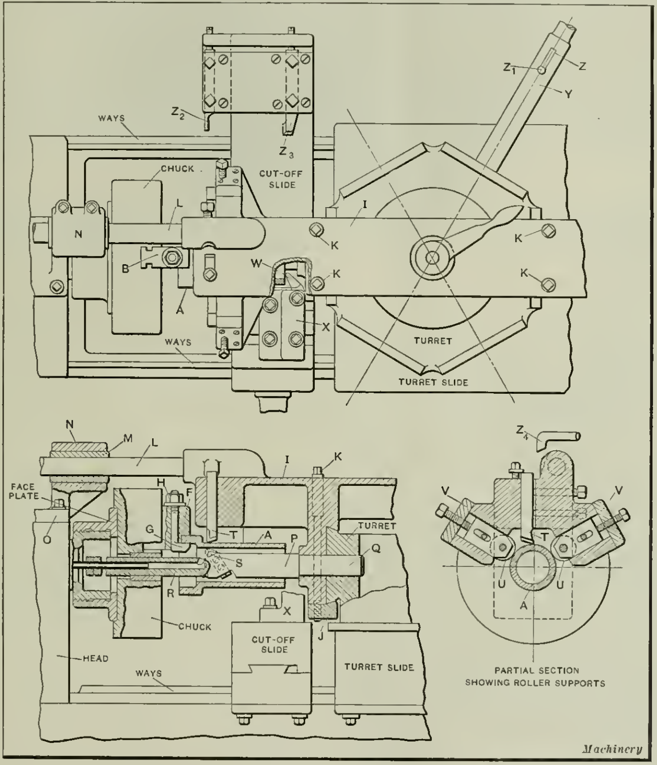


Fig. 3. Turret Lathe Set-up for Roughing Operations on Bushing A in Fig. 1

Second Setting of the Work

The work *A* is held for this setting on a special expanding arbor shown in the lower portion of Fig. 2. a special "nose-piece " *B* being screwed to the end of the spindle to receive the end of the arbor which is tapered and keyed to prevent turning. The body of the arbor is tapered at *C* and the sleeve *D* is expanded by a longitudinal movement along it, being split in six places, with three cuts from each end, to allow for the expansion. The sleeve is expanded by means of the nut and washer at *E* and the longitudinal location of the work is assured by the shoulder *F* on the arbor. The interposed nut *G* bears up against this shoulder and is also used to release the work after the machining has been done. The end of the arbor *H* is ground to fit the bushing *I* which is located in the turning tool-holder.

This holder *J* has some points of similarity with that used for the rough-turning operations, for although it is only a single ended holder it has a steel pilot *K* which enters a guide bushing *L* in the bracket *M* on the spindle cap, as in the preceding instance. The body of the holder is gibbed to the dovetailed face of the turret by the angular gib *N*, and the turning tool *O* is secured in place by square-head set-screws shown in the steel block. Provision is made for fine adjustment to the tool by the collar head backing-up screw *P*. The final finishing cut taken with this device was very light, and was taken at a speed of 150 feet per minute with a feed of 0.040 inch per revolution, so that this operation was a very rapid one, the production ranging from 70 to 75 bushings an hour. The material was cut dry in this operation. Feeds for the first setting of the work were 0.025 inch per revolution for the roughing cut at a speed of 70 feet per minute, and 0.040 inch for the finishing cut at a speed of 100 feet per minute. Hand feeds were used for the reaming operation at a speed of about 50 feet per minute. Sixteen to eighteen bushings an hour were produced.

Method of Lubricating the Cutting Tools

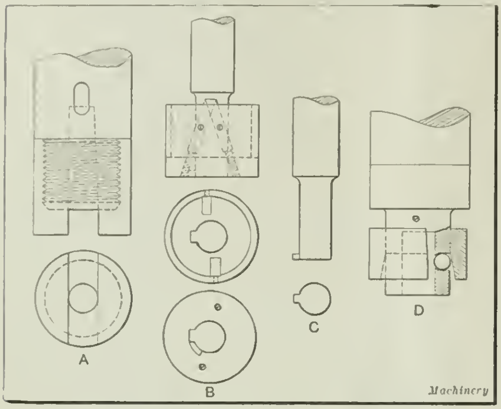
The upper part of Fig. 2 shows a sectional view through the spindle of the machine with the lubricating device for the boring-bars in position. A special bracket *Q* is fastened to the rear of the machine and carries a clamping bracket *R* at its outer end, this bracket being split at *S* and clamped together on the pipe *T* by a screw. The pipe *U* leads to the pump which supplies the lubricant, a suitable shut-off cock being provided to stop or regulate the flow as desired. A smaller tube which enters the ends of the boring-bars at *V*, until stopped by the collar *W*, is bushed to fit the larger tube and is kept in contact with the bars by the long coiled spring *X*. The manner in which the lubricant is directed onto the tool through the boring-bar is shown in the lower view in Fig. 3, and attention is called to the fact that the hole which leads the fluid to the tool is drilled angularly so that the stream strikes directly on the face of the tool where it will do the most good. This application of a lubricating device to internal cutting tools is especially good, for in addition to insuring thorough cooling, it washes the chips forward out of the hole so that they are not troublesome. The lubrication of the turning tools is shown at Z_4 in Fig. 3, the slot alongside the tool permitting the fluid to run down on the cutting point. The pipe Z_4 is a part of the regular equipment of the machine. In order to prevent leaks at the rear end of the spindle, a screw cap Y (Fig. 2) is used to draw up the gland Z on Z_1, and compressing the packing Z_3 between the two. The writer has seen a number of cases where a device of this kind was used with great success.

* * *

DRILL PRESS TOOLS

BY A. A. BERTRAND*

We experienced considerable trouble due to the tangs twisting off large sized reamers, and to overcome this, we threaded the end of the drill press spindle to provide for using a driver of the form shown at *A*. This did not interfere with the driving of small reamers in the usual way. All reamers over 15/16 inch in diameter were made with a collar on the shank just below the taper. This collar was turned to 1½ inch in diameter, and was milled away on both sides to fit the slot in the driver.



A. Driver for Large Reamers; B, Facing Head; C, Shank for Facing Head; and D, Chuck for holding Shank C

The design and purpose of the facing head shown at *B* will be apparent from the illustration, without requiring more than a very brief description. The slots for the cutters are planed at an angle and a sleeve is shrunk on the outside of the head. A screw carried by this sleeve at each side of the head provides for holding the cutters in place; and two screws through the bottom of the head afford a means of adjusting the vertical position of the cutters. To provide for driving the head, a slot was cut in the bore and a recess on the under side of the head, to receive the driver on the shank *C*. This head was used for facing the under side of a frame after it had been bored, without requiring the work to be removed from the jig.

As the facing operation was performed by raising the spindle, it can readily be seen that the ordinary taper shank to fit in the drill press spindle would not give satisfactory results. Consequently the ball chuck *D* was made for use in connection with the facing tool. The end of the drill press spindle was threaded to enable the chuck to be screwed onto it, and a straight hole was bored in the lower end to receive the shank of the facing head. The outside of the chuck was turned to leave a wall ½ inch thick, and a ⅝-inch hole was drilled in this wall, leaving a flange which would prevent a ⅝-inch hardened steel ball from dropping through. When the ball is up tight against this flange it still projects far enough on the outside of the chuck to prevent the ring from dropping off, and a small pin or screw above the ring prevents it from being raised far enough to allow the ball to fall out. The shank of the facing head is a close fit in the body of the chuck, and the side of the shank is spotted with a drill. When the shank is inserted in the chuck, the ball enters this cavity in the shank and the ring drops down, thus holding the ball in the cavity and providing the necessary drive for the head. The same form of chuck could be used for holding boring tools.

* * *

SPACING OF BOLTS FOR WRENCH CLEARANCE

BY LOUIS J. SCHROEDER*

Any mechanic who has had experience in assembling machinery knows that trouble is sometimes encountered through having bolts spaced in such a way that there is not sufficient room between the nuts of adjacent bolts to afford the necessary wrench clearance. It is the purpose of the present article to show just what requirements must be met in spacing the bolts, in order that the work of assembling may be handled in an expeditious manner. Referring to the accompanying illustration, it will be seen that the following notation is used:

D = distance from center of bolt to nearest side of corner;
D_1 = distance between centers of adjacent bolts;
d = diameter of bolt;
C = distance across corners of nut;
W = maximum width of head of wrench.

Again referring to the illustration, we see that:

$$D = \tfrac{1}{2} W \cos 15 \text{ degrees} = 0.483W. \qquad (1)$$

But according to William L. Cathcart, the value of W is:

$$W = 3\tfrac{1}{2}\,d + \tfrac{1}{8}. \qquad (2)$$

Combining Formulas (1) and (2) we have:

$$D = 1.7\,d + 0.06 \text{ (approximately)}.$$

It will be noted from the illustration that this formula provides for a slight clearance at the sides. An additional clearance may be added, according to the nature of the sides of the work forming the corner. For bolts placed side by side with one bolt located in a corner as shown in the illustration, we have the following expression for the distance D_1 between centers of adjacent bolts:

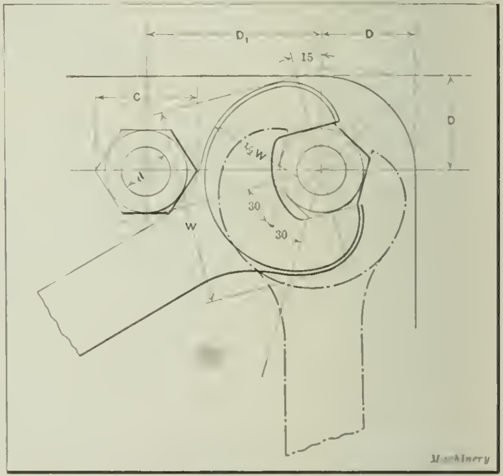


Diagram illustrating Notations used in Formulas

$$D_1 = \tfrac{1}{2} W + \tfrac{1}{2} C + \tfrac{1}{2} d. \qquad (3)$$

where the distance C across the corners of the nuts has the following value:

$$C = 1.155\ (1\tfrac{1}{2}d + \tfrac{1}{8}) = 1.73\,d + 0.144.$$

Substituting this value of C in Formula (3) and using the value W in Formula (2), we have:

$$D_1 = 1.75\,d + 0.062 + 3.11 + 0.072 + 0.5\,d = 0.86\,d + 0.134. \qquad (4)$$

The value of W as given by Mr. Cathcart will be found ample for any wrench on the market; in fact, the clearance will be more than ample for many types of wrenches. Formula (4) may also be applied to cases where there are no corner bolts; but in such cases there will be a slightly greater clearance.

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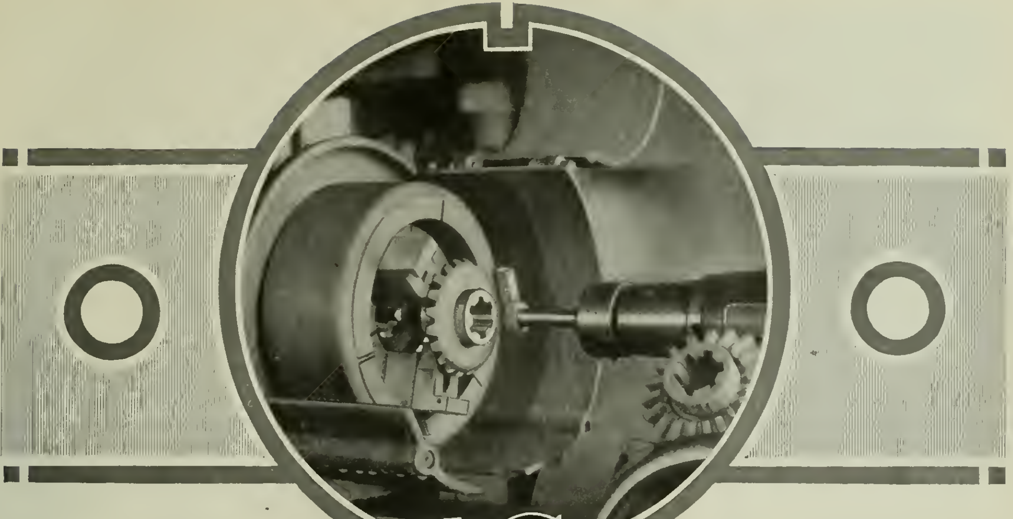

Internal Grinding

Machines Used, Methods of Handling and Examples of Work*

by Douglas T. Hamilton†

INTERNAL grinding, which refers to the grinding of holes, is not only a broad subject, but is one of great importance to the machine tool builder, as well as the general manufacturer. Up to within the last eight or ten years, internal grinding was done only where hardened parts were used and the holes had to be finished to an exact size. In many cases, lapping was resorted to for finishing holes in the hardened pieces, only a thousandth or two of stock being left for this purpose in order that the operation should not take more time than absolutely necessary, which was too long at the best. The internal grinding machine has completely displaced lapping from the rough and at the present time lapping as a finishing operation is used only when surfaces of great smoothness or extreme accuracy are to be produced, beyond the limits of ordinary grinding operations.

With the improvements made in internal grinding machines, the field has been developed and extended to such a great degree that not only is it considered good practice to grind hardened work, but also parts made of soft steel, cast iron and bronze, whenever accurately round and straight holes are desired, of accurate diameters, so that proper and uniform fits can be secured. In fact, on bushings of bronze, Lumen and cast iron, it is often less expensive and far more satisfactory than finishing by reaming.

Types of Machines Used for Internal Grinding

Internal grinding is done both on universal grinding machines and on special types of machines designed exclusively for handling this work. The use of the universal grinding machine on this work is confined more particularly to tool rooms for making jib bushings and similar parts, and is not commonly employed in a manufacturing way for producing interchangeable work in large quantities. The reason is that the universal grinding machine being designed for handling plain grinding, face grinding and internal grinding, cannot be so constructed as to be as efficient on any one line of work as a machine which is designed and built for that special purpose.

Universal grinding machines are regularly furnished with internal grinding attachments consisting of a bracket supporting the grinding wheel and spindle, which can be mounted on the swivel base carrying the main grinding spindle. Fig. 1 shows the internal grinding attachment furnished on a Brown & Sharpe universal grinding machine. This attachment is supported on the slide carrying the wheel spindle, the slide being turned 180 degrees from the position it usually occupies when the machine is arranged for plain grinding. To use the internal grinding head, the wheel spindle used in plain grinding is removed and a special arbor with pulley for driving the internal attachment is substituted. The vertical driving belt is crossed and the grinding spindle runs in the direction shown by the arrow.

In operation, the grinding wheel may be brought in contact with either the front side or the rear side of the hole in the work. The relation of the wheel to the work differs, however, in general practice among the makers of the different types of machines; this point will be treated more fully later.

Internal Grinding Machines

In the construction of these machines, there are two types in use. In one type the work head is stationary and the wheel spindle is traversed to and from the work. The wheel spindle moves forward and back during the grinding, and is moved away from the work for the purpose of gaging. In the other type, the wheel spindle is supported by a stationary

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* For articles on grinding previously published in MACHINERY, see "Plain Cylindrical External Grinding" in the July, 1915, number and other articles there referred to.

† Associate Editor of MACHINERY.

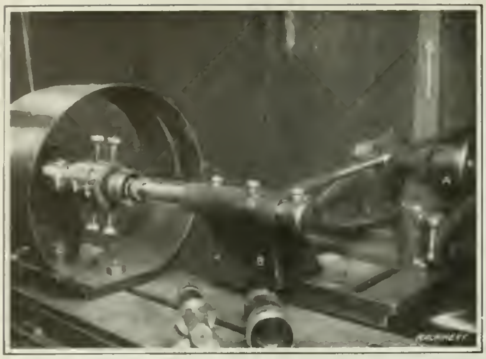

Fig. 1. Internal Grinding Attachment applied to Brown & Sharpe Universal Grinding Machine

portion of the frame and the work head is mounted on the table of the machine and travels to and from the grinding wheel. The former type is used to a large extent in machines especially designed for internal grinding, while the second type follows the construction of the universal grinding machine more closely.

Internal grinding machines, of course, are made in different sizes adapted for grinding a large range of work and also in small sizes with special features in some cases for grinding small holes exclusively. They may be subdivided also, into two classes: one adapted for internal grinding exclusively and another type in which a combination machine is furnished which will grind both internal and external diameters on the work at the same chucking. In the following, one machine of each type will be illustrated and described.

The Heald Internal Grinding Machine

A machine designed especially for internal grinding, which is built by the Heald Machine Company, is shown in Fig. 2. In this machine the designer has departed from previous types which were built on the plan of the universal grinding machine, and put the head stock on a bridge at the left-hand end of the machine, giving it a firm and solid support. The grinding wheel spindle is mounted on a cross-slide *A* carried on the main table *B* of the machine, which gives a solid support to the wheel spindle. The wheel spindle is driven from the overhead countershaft by a belt connecting with an idler pulley at the rear of the cross-slide, and the speed for the grinding spindle is controlled by the diameter of the pulley on this spindle.

The speed at which the work rotates is varied by change speed mechanism forming a part of the countershaft. The changes of table feeds, i. e., the speed at which the wheel travels through the work, are effected by operating the lever *C*. The headstock will swing to an angle up to 45 degrees either side of the center-line, for grinding tapered holes, and it is graduated both in degrees and in inches of taper per foot. This type is especially adopted for producing interchangeable parts in large quantities, because of the firmness and rigidity of the work support and the wheel support, enabling relatively soft and free cutting wheels to be used. The machines are made in two styles, one being fitted with both power and hand feed, and the other with a pilot handwheel for hand feed only.

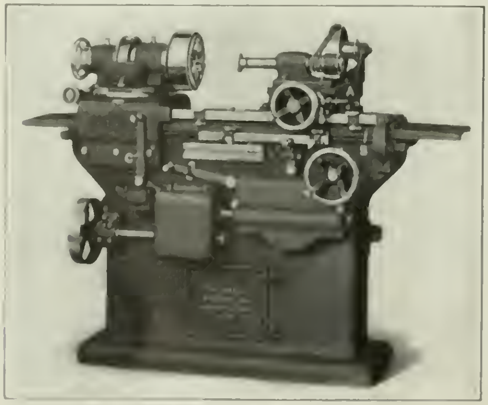

Fig. 2. Heald No. 75 Internal Grinding Machine

Rivett Internal Grinding Machine

For small work, such as grinding bushings, sleeves, and similar parts where high peripheral wheel speeds are necessary, the internal grinder shown in Fig. 3, built by the Rivett Lathe & Grinder Co., is especially suited. In this machine the wheel spindle *A* is held in a bracket *B* fastened to a slide that can be traversed at right angles to the travel of the work-table by operating handwheel *C*. Button *D* is used to engage the cross-feed for the wheel slide. The wheel spindle is driven by two belts from the rear countershaft, which, in turn, is belted to the overhead works from which suitable speeds can be obtained by means of the cone-pulley countershaft.

The table of the machine is in two sections, the lower section is mounted on the base and slides on cross-bearings, being controlled in its movement by a reciprocating mechanism so designed that as the center of the stroke is approached the speed of the table is slightly retarded. This speed variation does away with the tendency of the wheel to take a lighter cut at the center of the work, and at the same time allows a coarser feed. Three different feeds for the table, independent of the head, are obtained through a three-step cone pulley at the rear of the machine. The stroke of the table can be varied within a thousandth inch to any length within its capacity by adjusting screw *E* with a crank handle. The table may be operated by hand by pilot wheel *F*; when operated by power, reciprocation of the table can be stopped by loosening clamp *G* without stopping the machine. The upper section of the table is arranged to swivel 5 degrees in either direction from the center, and is adjusted by hand screws *H*. Clamps *I* and *J* serve to lock it to the lower section of the table.

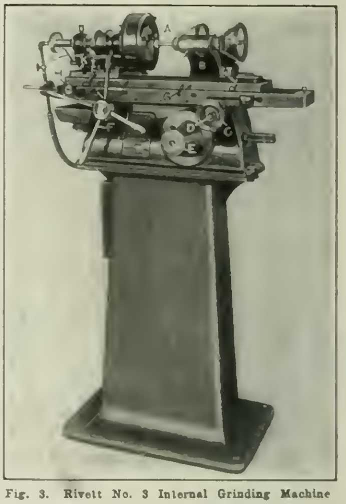

Fig. 3. Rivett No. 3 Internal Grinding Machine

The base upon which the work head rests is graduated in degrees and the slide can be set at any angle up to 90 degrees in either direction. The work head is mounted on a cast-iron plate fitting the table slide and can be moved any required distance along the slide and clamped in position by lever *L*. Adjustment of the work head is secured through screws *K*. The front end of the work spindle is ground on the inside to hold split chucks, and the rear end to fit a draw-in spindle furnished with the machine. Special fixtures are provided, so that it can be adapted to a general line of toolroom work for external grinding, etc.

Bryant Chucking Grinder

Another type of grinding machine that is used for internal work as well as for external work is shown in Fig. 4. This is built by the Bryant Chucking Grinder Co. The machine is compact, it is possible to swing the wheel spindle out of the way to gage the work, and, on the multiple-spindle type, external and internal diameters can be ground at the same setting, thus insuring that they are concentric with each other.

The work is held in a chuck *A* operated by handwheel *B*. This chuck is driven by pulley *P*, and the work head has an angular adjustment for grinding tapers up to and including 30 degrees. Internal grinding is done with wheel spindle *C*, whereas spindle *D* is used for external or face grinding. Spindle *D* is driven from the overhead works by a belt running on pulley *E*, and spindle *C* is driven from the same pulley by a separate and shorter belt. The wheel slide *F* is held on a hardened and ground cylindrical bar and can be swung on this bar to obtain the cross-feed for diameter control and face grinding. The diameter control is secured through handwheel *G* which carries an automatic knock-off cam operating through lever *H*. The backward and forward motion for the wheel slide is secured through a belt running on pulleys *I*; the gear *J* carries reversing trips for controlling the length of traverse. An automatic trip is also provided for throwing out the feed of the work slide. The reversal of the wheel slide can be effected by hand lever *K*, whereas lever *L* is used to disengage the power traverse. The pilot wheel *M* is for moving the slide back and forth by hand.

Internal Grinding Wheel Spindles

In the grinding of small holes having a length of say four or five times their diameter, some difficulty is often experienced in getting wheel spindles which are stiff enough to grind absolutely straight holes, owing to the tendency of the wheel spindle to spring away from the work when its length is many times its diameter. In the older types of internal grinding spindles, such as used in connection with universal grinding machines, the wheelhead was always made up of a tube with thin walls, carrying a small bushing at the end, to support the grinding spindle near the wheel, and, of course, the largest diameter of the outside tube had to be somewhat smaller than the diameter of the hole to be ground, to allow for a reasonable amount of wear to the wheel. This made a very light spindle necessary for holes one inch in diameter or less.

The Heald Machine Company has developed a different type of spindle in which a solid spindle extends out beyond the bearings, to enter the hole, and carries the wheel at a sufficient distance out to reach through the hole. By this construction, which will be described later, it is possible to provide bearings which are larger and more accessible for adjustment and oiling. A similar construction, namely, the use of a naked spindle carrying a wheel, is also used in the small precision grinding machines for grinding very small holes, such as made by the Rivett Lathe and Grinder Company and the Van Norman Machine Tool Company.

On large spindles for grinding holes 2 inches in diameter and larger, it is the universal practice to keep the bearings close to the grinding wheel, the bearing as well as the wheel passing into the hole in the work. The smaller the hole to be ground, of course, the higher the spindle speed should be to give the wheel a reasonable surface velocity. About 6000 feet per minute has been demonstrated to be a desirable surface speed for plain grinding machines and relatively large wheels, but it would require excessively high speeds for internal spindles to secure this circumferential velocity in running small wheels for grinding of small holes, and these speeds would involve lubrication difficulties and extreme refinement in the adjustment of bearings, which it is not so easy to secure in internal spindles of small diameter. The modern grinding wheel which can be furnished in soft and free cutting grades, now renders it unnecessary for internal grinding spindles to run at such extremely high speeds to produce high grade work in large quantities, and this has simplified to a great degree the problem of getting suitable spindle speeds for internal grinding machines. Many internal grinding wheel spindles have been devised for this work, and a few of those incorporating representative features of design will be described.

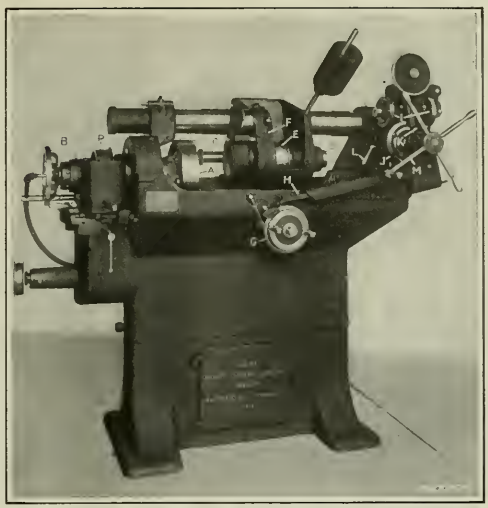

Fig. 4. Bryant Two-spindle Chucking, Face, and Hole Grinder

Brown & Sharpe Internal Grinding Spindle for Universal Grinding Machine

The internal grinding spindle shown in Fig. 5 consists primarily of a grinding spindle of comparatively small size mounted in a bearing in telescopic tubes of sufficiently large diameter to give the required rigidity. These tubes or shells are adjustable longitudinally relative to each other, and support the bearings for the spindle in close proximity to the grinding wheel. The small diameter of the spindle enables it to be revolved at the high speed necessary. The pulley spindle *A* is mounted in two annular ball bearings which take the pull of the belt. The bronze box *B* for the wheel spindle is tapered on the outside to fit in the tapered hole of the outer shell, and this shell is made to screw onto the inner shell. It will be seen that the outer shell moves the bronze box longitudinally toward or from the inner shell, thus decreasing the end play of the wheel spindle collar *C*.

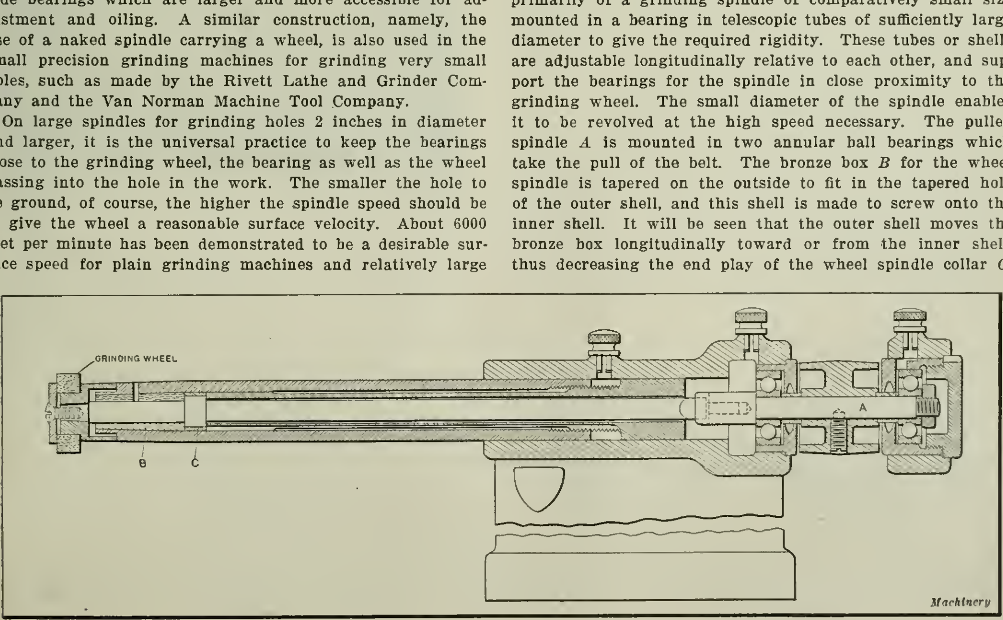

Fig. 5. Brown & Sharpe Internal Grinding-wheel Spindle for Universal Grinding Machines

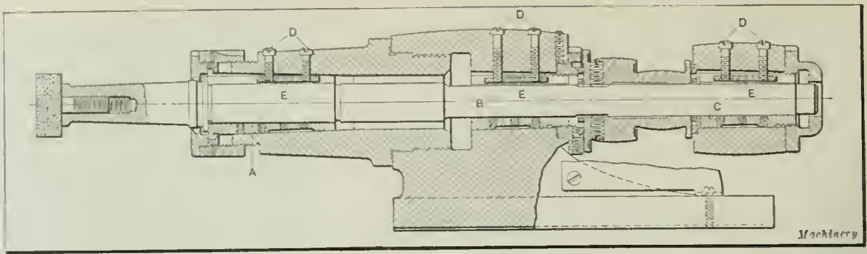

Fig. 8. Heald Internal Grinding-wheel Spindle

When the outer shell has been screwed onto the inner one far enough to take up all end play of collar *C*. still further movement will force the box into the taper end of the outer shell and close it to compensate for wear. After the box has been forced far enough into the tapered hole, the outer shell is unscrewed sufficiently to relieve the pressure on the collar and make a running fit. To make this adjustment, a screw in the bracket (not shown) should be loosened and the outer shell turned by the knurled section. By loosening the screw in the bracket, the wheel spindle with its connecting shells can be removed from the stand without disturbing the pulley spindle, as the connection is made by a clutch. In this spindle, provision is made for excluding dust from the bearings, and rigidity at high speeds is attained.

Heald Internal Grinding Spindle

Fig. 8 shows one type of internal grinding spindle used on the Heald Nos. 70 and 75 internal grinding machines. By referring to this illustration, it will be noticed that the spindle is a solid shaft and is supported in three phosphor bronze bearings *A*, *B* and *C*. These are tapered on the outside diameter and adjusted by means of "take-up" nuts as illustrated. The method of adjusting the bearing is to first tighten up a nut until the bearing fits the spindle snugly; then the screws *D* which are threaded into tapered expanding blocks *E*, are adjusted, drawing up the blocks in the tapered slot in the bearings and in this way slightly expanding them. This adjusting device provides a suitable and positive lock for the bearings, and seats them securely and firmly in their housings.

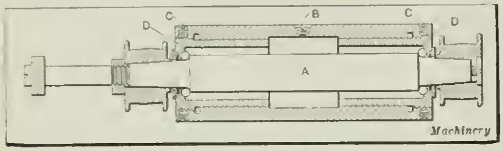

Fig. 6. Rivett Internal Grinding-wheel Spindle

Rivett Internal Grinding Spindle

An internal grinding wheel spindle designed to run at high peripheral velocities is shown in Fig. 6. This spindle, which is used on the Rivett internal grinding machines, is operated at speeds of from 25,000 to 30,000 R. P. M. with satisfactory results. The spindle *A*, which is of the solid shaft type, is driven by two belts running on pulleys located at each end and is supported by ball bearings as shown. The bearings are completely submerged in oil supplied through screw hole *B*. They are enclosed in a dust-proof cast-iron shell, adjustment being made by loosening screws *C*, and turning adjusting nuts *D* with a spanner wrench, turning to the right to tighten and to the left to loosen. When properly adjusted, there should no no end play and the spindle should run freely when whirled by the fingers.

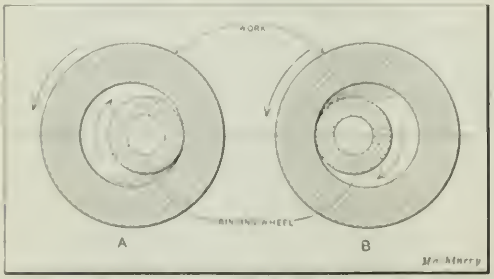

Fig 7 Diagram Illustrating Relation of Wheel to Work for Internal Grinding

Holding Work for Internal Grinding

Next in importance after selecting the right wheel to use on the internal grinding machine for a certain job, is the selection and construction of the chucking fixture for holding the work; in fact, there are many cases in which the chucking of the work is more important than the selection of the grinding wheel, because where you have a difficult piece to hold, more time may be required to satisfactorily chuck the piece and get it running right, than it takes to grind it afterwards. This explains to quite a degree the difference in output and accuracy obtained in different shops operating on identically the same classes and kinds of work. For instance, in chucking gears, one shop will equip its machine with a high grade type of gear holding chuck, in which the gear is trued up instantly by a system of pitch-line control, and the draw-in collet used takes but a moment to operate. In another shop the chucking fixtures will be so crude that the same gear will be held in a 3-jaw chuck and the operator will either true it up with a piece of chalk, or use some other truing device which will require a longer time for chucking than for chucking and grinding the hole to size, when using a properly designed chuck.

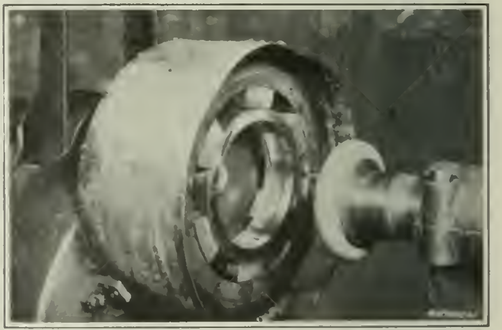

Fig. 9. Rough-grinding Semicircular Ball Race in Universal Grinding Machine fitted up for Internal Grinding

When grinding thin bushings, a special form of chucking device should be used, in which the bushing is clamped endwise, because any radial pressure such as would result from using a 3-jaw chuck or similar arrangement would distort the piece so that after it was removed from the grinding machine, a "three-cornered" hole would be produced instead of one which was truly cylindrical. Very little clamping pressure is required to hold a bushing endwise, and these chucks can be made so that they are simple and quickly operated, thus producing work accurately and efficiently. There are two ways of grinding bushings; one is to grind the interior first and then slip them on an arbor and finish on a plain grinding machine; by this method accurate work is secured and the exterior and interior holes can be made truly concentric with each other. The other method is to grind the exterior of the bushing first and then slip this into a holder or bushing chuck fitted to an internal grinding machine, and grind the hole last. While this may seem to be a very satisfactory method, in practice it is not, for the following reasons:

1. It seems to be true that a bushing will change shape more when the inside is ground last than when ground first.

2. It is more difficult to grind the outside of a bushing to accurate limits when the hole is rough and cannot be satisfactorily supported on a grinding arbor, than it is to grind the hole in the bushing first (the bushing being held by clamping endwise) and then slip the bushing on an arbor and finish the outside; the bushing in this case fits the arbor perfectly and has a good solid support for the grinding wheel at all points.

3. In fitting up a bushing chuck, it must be put onto the internal grinding machine spindle and be ground to size after being mounted, in order that the hole will run true. After one lot of bushings is finished, the chuck will be removed from the grinding machine and later replaced when another lot of bushings is to be handled. In making the second, third, and following replacements of the bushing chuck, the operator will find it very difficult to get the chuck back on the grinding spindle and have the hole run "dead true"; therefore, he must either grind out the hole again to make it run true (and then the bushings are not a good fit), or else the subsequent lots of bushings must be ground to a larger diameter to fit the new diameter of hole in the chuck, all of which is avoided when the hole is ground first and the bushing finished externally last.

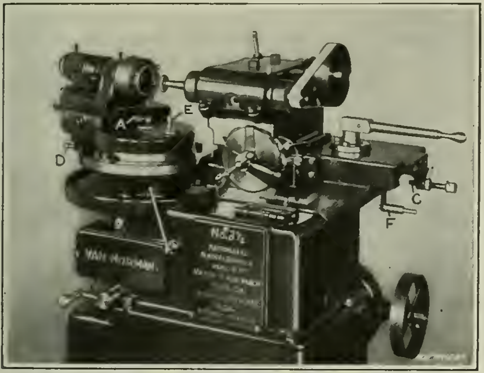

Fig. 10. Van Norman No. 3½ Automatic Radial Grinder for grinding Single-row Ball Bearings

The subject of holding work on internal grinding machines is a broad one and one that has developed a great number of exceedingly ingenious and interesting devices, and will, therefore, be dealt with in a separate article.

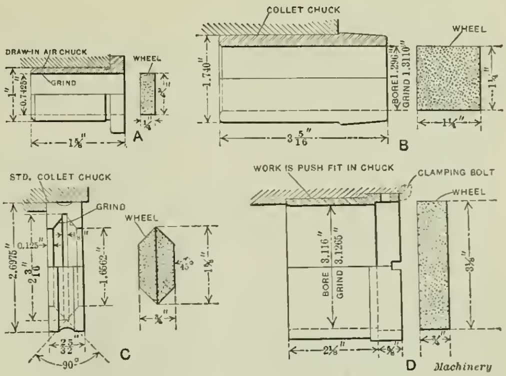

Fig. 11. Examples of Bushings, Sleeve, and Ball Race Grinding

A

Work:—Bushing, 0.15 per cent carbon open-hearth steel, carbonized 0.030 inch deep, and hardened.

Operation:—Grinding hole with Detroit (vitrified) grade M, 67 grain wheel, ¾ by ¼ inch; speed, 17,600 R. P. M.—3450 feet surface speed; amount removed from diameter, 0.005 inch; work speed, 740 R. P. M.—145 feet surface speed.

Remarks:—Wheel trued to ¾ inch diameter; hand feed or "pumping action" used for feeding wheel; production, 425 pieces in nine hours; machine used, Lansing Stamping & Tool Co.'s grinding machine.

B

Work:—Bushing, 0.15 per cent carbon open-hearth steel, carbonized 0.030 inch deep, hardened in oil.

Operation:—Grinding hole with Norton (vitrified) alundum, grain 46, grade K wheel, 1¼ inch by 1¼ inch; speed, 10,600 R. P. M.—3400 feet surface speed; work speed, 280 R. P. M.—95 feet surface speed; amount removed from diameter, 0.015 inch.

Remarks:—Power feed used, 65 inches per minute, 20 traverses to complete piece; production, 80 pieces in nine hours; machine, Heald No. 70 internal grinding machine.

C

Work:—Double cone race internally form ground; material, 0.15 per cent carbon, open-hearth steel, carbonized 0.030 inch deep, and hardened.

Operation:—Grinding internal ball race with Norton (vitrified) alundum, combination grain wheel; grain 38-60, grade J, 1⅝ inch by ¾ inch; speed, 10,600 R. P. M.—4500 feet surface speed; work speed, 400 R. P. M.—170 feet surface speed; material removed from 0.010 to 0.020 inch on diameter.

Remarks:—Grinding wheel moved in until both sides touch, then fed directly into work by operating cross-feed by hand; 50 pieces ground for each truing of wheel; production, 300 pieces in nine hours; machine used, No. 75 Heald internal grinding machine.

D

Work:—Sleeve, 0.15 per cent carbon, open-hearth steel, carbonized 0.030 inch deep, and hardened.

Operation:—Grinding internal diameter with Norton (vitrified) alundum wheel, 3⅛ inches by ¾ inch, grain 36, grade J; speed, 8600 R. P. M.—7035 feet surface speed; work speed, 400 R. P. M.—327 feet surface speed.

Remarks:—Wheel traversed by power for roughing, 55 inches per minute; for finishing, 18 inches per minute; six traverses to complete work; production, 75 pieces in nine hours; Heald internal grinding machine.

Grinding Straight Holes

Owing to the close limits of accuracy demanded of a grinding machine, it is often desirable to make some simple test to show that the machine is grinding perfectly straight. This can be determined when the hole is to size, by trying a sizing plug, and the operator can easily determine whether the hole is larger or smaller at the rear from what it is at the front end. There is a danger, of course, in testing the first pieces according to this method, that the machine may be grinding larger at the rear end than at the front end, and if one has only the sizing plug to use in testing, it is impossible to tell until the front end of the hole is up to size, whether the rear end is too large or not, by this method. Therefore, a very clever scheme is often resorted to, to determine if the hole is cylindrical or not. This is done by feeding the grinding wheel

TABLE I. ALLOWANCES FOR INTERNAL GRINDING—ALL MATERIALS

Diameter of Hole in Inches	Length of Hole in Inches											
	½	1	1½	2	3	4	5	6	7	8	10	12
	Allowance in Inches											
½	0.005	0.006	0.007	0.008	.....	.....	.....	.....	.....	.....	.....	.....
1	0.006	0.007	0.008	0.009	0.010	0.011	0.012	0.013	.....	.....	.....	.....
1½	0.007	0.008	0.009	0.010	0.011	0.012	0.013	0.014	0.015	0.016	.....	.....
2	0.008	0.009	0.009	0.010	0.011	0.012	0.013	0.015	0.016	0.017	0.020	0.022
2½	0.009	0.010	0.010	0.011	0.011	0.013	0.014	0.015	0.017	0.018	0.020	0.023
3	0.009	0.010	0.010	0.011	0.012	0.013	0.015	0.016	0.017	0.019	0.021	0.024
3½	0.010	0.010	0.011	0.012	0.013	0.014	0.015	0.017	0.018	0.019	0.022	0.024
4	0.010	0.011	0.012	0.012	0.013	0.015	0.016	0.017	0.018	0.020	0.022	0.025
5	0.011	0.012	0.013	0.013	0.015	0.016	0.017	0.018	0.019	0.021	0.023	0.026
6	0.012	0.013	0.014	0.014	0.016	0.017	0.018	0.019	0.020	0.022	0.024	0.027
7	0.014	0.015	0.015	0.016	0.017	0.018	0.019	0.020	0.021	0.023	0.025	0.027
8	0.016	0.016	0.017	0.017	0.018	0.019	0.020	0.021	0.022	0.024	0.026	0.028
9	0.017	0.018	0.018	0.019	0.020	0.020	0.021	0.022	0.023	0.025	0.026	0.028
10	0.018	0.019	0.019	0.020	0.021	0.021	0.022	0.023	0.024	0.025	0.027	0.029
11	0.019	0.020	0.020	0.021	0.022	0.022	0.023	0.024	0.025	0.026	0.028	0.030
12	0.020	0.021	0.021	0.022	0.023	0.023	0.024	0.025	0.026	0.027	0.028	0.030

Machinery

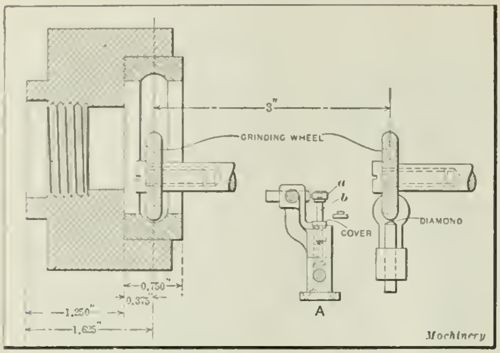

Fig. 12. Diagram showing Method of arranging and truing Wheel on Van Norman Radial Grinding Machine

over to the opposite side of the hole after the latter has been roughed out by a few passes of the wheel and the original roughness of the hole removed. Now, if on bringing the grinding wheel against the opposite side of the hole and making a very light cut, the sparks are uniform throughout the length of the hole, the machine will be grinding parallel or cylindrical, but if the sparks grow heavier as the wheel feeds in against the opposite side from where it has previously been grinding, the operator knows then that the hole is tapering and smaller at the back end. If the wheel fails to cut as it goes in, it shows that the hole is larger at the rear end, and the headstock should be correspondingly adjusted so that the hole will become more nearly straight. In carrying the wheel across to the opposite side of the hole from that to which it has been grinding, the error is doubled, so that if the headstock should have been set one degree out of correct alignment, the apparent error on the opposite side will be just double that.

Grinding Taper Holes

In setting the headstock to secure the correct taper wanted in a tapered hole, the headstock will, of course, be set to the graduations provided on it, but if the work is desired to be very accurate and interchangeable with other parts, it will be most desirable to have a hardened standard plug gage with the correct taper on the end, to use in testing the taper secured by this setting.

TABLE II. REVOLUTIONS PER MINUTE FOR VARIOUS SURFACE SPEEDS OF WHEELS

Diameter of Wheel in Inches	Surface Speed in Feet per Minute										
	2000	2500	3000	3500	4000	4500	5000	5500	6000	6500	7000
	Revolutions per Minute										
1/4	30,558	......	......	......	......	......	......	......	......	......	......
3/8	20,372	25,465	30,558	......	......	......	......	......	......	......	......
1/2	15,279	19,099	22,918	26,738	30,558	......	......	......	......	......	......
5/8	12,221	15,279	18,335	21,390	24,442	27,500	30,558	......	....	.....	......
3/4	10,186	12,733	15,279	17,825	20,372	22,918	25,465	28,011	30,558	......	......
7/8	8,731	10,913	13,096	15,279	17,461	19,643	21,827	24,009	26,192	28,375	30,558
1	7,639	9,549	11,459	13,369	15,279	17,189	19,099	21,008	22,918	24,828	26,738
1¼	6,111	7,639	9,167	10,695	12,221	13,750	15,279	16,806	18,335	19,862	21,390
1½	5,093	6,366	7,639	8,913	10,186	11,459	12,733	14,005	15,279	16,552	17,825
1¾	4,365	5,457	6,548	7,639	8,731	9,822	10,913	12,005	13,096	14,187	15,279
2	3,820	4,775	5,729	6,684	7,639	8,594	9,549	10,504	11,459	12,414	13,369
2¼	3,395	4,244	5,093	5,942	6,791	7,639	8,488	9,337	10,186	11,034	11,883
2½	3,055	3,820	4,583	5,347	6,111	6,875	7,639	8,403	9,167	9,931	10,695
2¾	2,778	3,472	4,167	4,861	5,555	6,250	6,945	7,639	8,334	9,028	9,723
3	2,546	3,183	3,820	4,456	5,093	5,729	6,366	7,003	7,639	8,276	8,913
3½	2,182	2,728	3,274	3,820	4,365	4,911	5,457	6,002	6,548	7,094	7,639
4	1,910	2,387	2,865	3,342	3,820	4,297	4,775	5,252	5,729	6,207	6,684

Machinery

In using this plug gage, the customary practice is to color it with prussian blue or red lead, and note the contact that the ground hole makes on the plug; if it bears harder at the smaller end than at the larger end, the headstock should be swung so that the grinding wheel will produce a little less taper, and swung in the opposite way if the outer end should be tight and the hole loose at the small end of the plug. If the error is large, the operator can quickly feel that the plug does not fit the tapered hole properly. If the error is small, the testing by color will give satisfactory results.

Relation of Wheel to Work

There are two methods of applying the wheel to the work for internal grinding. One is to feed the wheel against the rear side of the hole, and the other is to bring the grinding wheel forward to make a contact with the front side of the hole, the latter method being used on machines of the type built by the Heald Machine Company.

In using grinding attachments on universal grinding machines, since the automatic feed of the wheel would be toward the operator, it would be necessary to grind on the front side of the hole if this feed were used. According to the Brown & Sharpe Mfg. Company, the automatic feed is seldom used on their machines for internal grinding work; hence it is the usual practice of this company to feed the wheel in the opposite direction and grind on the rear side of the hole. The special Brown & Sharpe internal grinding machines are arranged for handling the work in this way. The principal advantage in grinding at the rear side of the hole seems to be that in grinding tapers, the head stock will be swung toward the operator, making it a little easier to see into the hole, and also a little easier to gage the hole with standard plugs. On the other hand, it appears to be less easy to protect the operator from the splashing of the water and also to keep the water from being thrown over the front of the machine and on the floor, when tapers of high degree are being ground, it being much easier to arrange water guards at the rear of the machine than at the front. While the operator can become accustomed to feeding the wheel from him, this is an opposite direction to which all plain grinding and universal grinding machines naturally operate, and, therefore, by some manufacturers it has been thought more natural to do the grinding on the front side of the hole.

Another difficulty in connection with grinding on the rear side of the hole, is that in truing the wheel the diamond should, preferably, be mounted at the back of the wheel, so as to operate on the rear side, i. e., true the wheel on the side that does the grinding; this would appear to be a trifle more awkward for the operator than when the grinding is done on the front side of the hole and the diamond can be mounted on the front side.

In regard to the direction of rotation of the work, it is customary with almost all manufacturers to have the work-head rotate so that the top comes toward the operator. In grinding dry it does not matter particularly in regard to the direction of rotation, but when water is used, rotation of the work in this direction seems to assist in the proper control of the water, particularly where it flows out from the bottom of the chuck and water guards.

The two methods of applying the wheel to the work are shown diagrammatically in Fig. 7. At *A* is shown the method generally followed on a universal grinding machine, whereas at *B* is shown the method that is adopted generally on regular internal grinding machines. The natural position of the wheel in relation to the work for internal grinding is on the front face of the hole. For instance, when using a universal grinding machine for external cylindrical grinding, the wheel is fed forward to grind the work, and it is natural when using an internal attachment that the same method of feeding the wheel to the work be followed.

Allowances for Internal Grinding

The amount of metal to be left for the internal grinding machine to remove is another point that requires careful

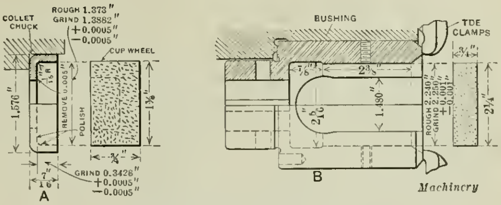

Fig. 13. Two Examples of Internal Grinding requiring the Use of Different Grinding Wheels

A

Work:—Cup for fan shaft bearing, No. 12 Birmingham wire gage (0.109 inch thick) pressed steel, carbonized 0.030 inch deep and hardened in oil.

Operation:—Grinding inside back face and internal diameter with a Norton (vitrified) alundum cup-shaped wheel, grain 46, grade K; 1⅜ inch diameter, ¾ inch face; speed, 17,660 R. P. M.—6360 feet surface speed; work speed, 740 R. P. M.—266 feet surface speed; amount removed, 0.005 inch from back inside face, and 0.015 inch from internal diameter.

Remarks:—Grinding wheel is brought in to finish bottom first, and in doing so also grinds the internal diameter. To finish internal diameter, wheel is traversed. To get a good polish, machine oil is squirted in the hole just as the wheel is finishing it. Wheel must not wear down much below full diameter of hole, and one wheel turns out 100 pieces; production, 225 to 230 pieces in nine hours; machine used, Lansing Stamping & Tool Co. internal grinding machine.

B

Work:—Universal transmission drive shaft yoke, 0.15 per cent carbon open hearth steel; carbonized 0.030 inch deep and hardened.

Operation:—Grinding hole which is partly cut away on both sides with a Norton (vitrified) alundum wheel, grain 36, grade K; 2¼ inches diameter, ¾ inch face; speed, 7200 R. P. M.—4240 feet surface speed; work speed, 216 R. P. M.—154 feet surface speed; amount removed from diameter, 0.010 to 0.015 inch.

Remarks:—Power traverse is used at the rate of 65 linear inches per minute, twenty-four traverses being required to complete work; production, 160 in nine hours; machine used, No. 70 Heald internal grinding machine.

consideration. In the old days, when light grinding spindles and relatively light machines only were available, it was desirable to leave as little stock for grinding as possible, to reduce the time required for grinding. With the modern internal grinding machine, however, this is not true, and it is now considered wiser to leave a liberal amount of stock to be removed, as this reduces somewhat the high degree of accuracy that would be necessary in chucking the pieces if but a small amount of stock was left to be ground out.

For instance, suppose a bushing is to be finished externally after the hole is ground. This bushing, if it has thin walls, should be held in a special bushing chuck, but if it has heavy walls, it might be held in a 3-jaw chuck and in that way would run only approximately true. The hole might run out 0.002 or 0.003 inch. Under such conditions, the first thing to do is to get the hole rounded out so that it runs practically true, and in doing this, of course, more stock will be ground off one side of the hole than the other. This would involve the grinding out of 0.006 or 0.007 inch of stock by the time the hole was running true, and if there were 0.002 or 0.003 inch left to grind to get the exact diameter, there would be from 0.008 to 0.010 inch stock to remove from this hole during the grinding operation.

It is now considered more satisfactory with the modern internal grinding machine to leave an ample amount of stock so that the wheel can take heavy cuts, than to leave a small amount of stock and make it necessary to take several very light cuts to true the hole, because there is such a limited amount of stock. On the other hand, if work is accurately machined and the chucking fixture is one that is not only accurate to begin with, but remains accurate so that the holes run quite true, then the stock to be removed can be reduced to advantage and a considerable saving in time effected. The tendency is in many cases, however, to reduce the stock to a point where the operator has to grind slowly at first because the hole is not running true, whereas he would actually make a greater gain in time and quality of work if a little more stock were left, provided he has a modern manufacturing machine to work with.

With hardened parts, of course, there is the question of distortion, and oftentimes the distortion due to hardening makes it necessary to leave more stock than would otherwise be necessary. One reason why records on similar work in different shops vary so greatly is because of the difference in the way the work comes to the grinding machine, so far as the previous machining operations are concerned, and secondly, owing to the difference in chucking devices and methods of holding the work, adopted in different factories.

The following is an example which illustrates the relation of the amount of material removed, to wheel wear. An extended experiment was made in the grinding of a tapered hole in a pinion blank. These pinion blanks were made from vanadium steel drop-forgings, heat-treated, and were drilled and reamed so that 0.015 inch was left on the diameter for grinding. Various grains and grades as well as makes of wheels were tried, and the greatest number of pieces that could be obtained from one wheel was sixty. The limit of allowance was then reduced from 0.010 to 0.008 inch on the diameter and the production from one wheel increased to eighty. The limit was again reduced to 0.005 inch on the diameter, whereupon the production increased to two hundred pieces from one wheel. The wheel found to give the best results on this particular example was a Norton alundum (vitrified) grain 60, grade K wheel, ¾ inch diameter by 1 inch face. This wheel was operated at a speed of 12,500 R. P. M. (2460 feet surface speed) and the work was rotated at 400 R. P. M., or an average surface speed of 100 feet per minute.

Table I gives the amounts to leave for grinding holes of various diameters and lengths, but does not take into consideration special cases, such as thin wall bushings, etc.

Wheel and Work Speeds for Internal Grinding

The cutting efficiency of grinding wheels depends largely upon the speed of rotation, and wheels for internal grinding,

TABLE III. REVOLUTIONS PER MINUTE FOR VARIOUS SURFACE SPEEDS OF WORK

Diameter of Work in Inches	Surface Speed of Work in Feet per Minute															
	50	55	60	65	70	80	90	100	110	120	130	140	150	160	170	180
	R. P. M. of Work															
⅜	509.0	560.0	611.0	662.0	713.0	815.0	916.0	1018.0	1121.0	1222.0	1323.0	1425.0	1528.0	1629.0	1731.0	1833.0
7/16	436.0	481.0	524.0	568.0	611.0	699.0	786.0	873.0	961.0	1049.0	1136.0	1222.0	1311.0	1398.0	1486.0	1573.0
½	382.0	420.0	459.0	497.0	535.0	611.0	688.0	764.0	840.0	917.0	993.0	1070.0	1146.0	1222.0	1299.0	1375.0
⅝	305.0	337.0	367.0	398.0	428.0	489.0	552.0	611.0	673.0	736.0	796.0	857.0	918.0	979.0	1040.0	1102.0
¾	254.0	279.0	305.0	330.0	357.0	408.0	458.0	509.0	559.0	611.0	661.0	711.0	764.0	813.0	864.0	914.0
1	191.0	210.0	229.0	258.0	267.0	305.0	344.0	382.0	420.0	458.0	497.0	535.0	573.0	611.0	649.0	688.0
1¼	153.0	168.0	183.0	199.0	214.0	244.0	274.0	305.0	337.0	367.0	398.0	428.0	459.0	490.0	520.0	551.0
1½	127.0	140.0	153.0	165.0	178.0	204.0	230.0	254.0	279.0	305.0	330.0	356.0	382.0	406.0	432.0	457.0
1¾	109.0	120.0	131.0	142.0	153.0	174.0	196.0	218.0	240.0	262.0	283.0	305.0	327.0	349.0	371.0	392.0
2	95.5	105.0	115.0	124.0	134.0	153.0	172.0	191.0	210.0	229.0	248.0	267.0	287.0	305.0	325.0	344.0
2¼	85.5	93.5	102.0	111.0	119.0	136.0	153.0	170.0	187.0	204.0	221.0	238.0	255.0	272.0	289.0	305.0
2½	76.4	84.2	91.7	99.5	107.0	122.0	138.0	153.0	168.0	184.0	199.0	213.0	230.0	244.0	260.0	275.0
2¾	69.5	76.4	83.4	90.4	97.2	111.0	125.0	139.0	153.0	167.0	181.0	195.0	209.0	222.0	236.0	250.0
3	63.7	69.9	76.4	82.6	89.1	102.0	114.0	127.0	140.0	153.0	165.0	178.0	191.0	204.0	216.0	228.0
3½	54.5	60.0	65.5	70.8	76.4	87.4	98.1	109.0	120.0	131.0	142.0	153.0	164.0	174.0	186.0	196.0
4	47.8	52.6	57.3	62.1	66.9	76.4	86.0	95.6	105.0	115.0	124.0	134.0	143.0	153.0	163.0	172.0

Machinery

TABLE IV. WORK SPEEDS FOR INTERNAL GRINDING—VARIOUS MATERIALS*

Material	Abrasive	Wheel Bonding Process	Grain	Grade	Surface Speed of Work in Feet per Minute
Aluminum (Cast)	Carbolite, Carborundum or Crystolon	Elastic Vitrified Elastic	46 to 50 50 36	2½ E P 2½	150 to 180
Brass or Bronze (Cast)	Alundum, Corundum, or Aloxite	Vitrified	36 to 46 46 to 50 46 to 50	K K O	130 to 150
Iron (Cast)	Carbolite, Carborundum or Crystolon	Vitrified	36 to 40	K P K	110 to 120
Steel-Alloy, Heat-treated	No. 38 Alundum, or Aloxite	Vitrified	46 46 50	J J M	80 to 100
Steel 0.20 to 0.50 Per Cent Carbon (Soft)	No. 38 Alundum, No. 58 Corundum No. 58 Corundum or Aloxite	Vitrified	46 46 50	J J M	60 to 80
Steel 0.20 to 0.50 Per Cent Carbon (Hardened)	No. 38 Alundum, No. 58 Corundum or Aloxite	Vitrified	46 46 50	K K M	80 to 110

Machinery

* Work speeds based on 4500 to 5000 feet surface speed for Alundum, Aloxite and Corundum wheels, and 4000 to 4500 feet for Carbolite, Carborundum and Crystolon wheels.

to work efficiently, should be operated at speeds as near the theoretical peripheral speed as possible. The theoretical speed at which any particular wheel should be operated is not always practical to obtain, because of the limitations of the machine on which the wheel and wheel spindle is mounted, thus making compromises necessary to a certain extent. For instance, when using a wheel ½ inch in diameter, a wheel speed of about 30,000 R. P. M. would be necessary, to get a surface velocity of 4000 feet per minute. Now, while it may be possible in certain machines to get this speed for a wheel of that diameter, it would usually be found to be true that lubrication difficulties and heating due to such a high speed would overbalance the advantages, and since modern grinding wheels can be obtained readily, which will cut efficiently, rapidly and smoothly at slower speeds, by selecting the proper grain and grade it will be found, in almost every instance, that more moderate speeds will be more satisfactory because less care will be needed in oiling and adjustment of the bearings, and no falling off in the actual amount of work produced need be expected. On the other hand, wheelheads adapted for carrying grinding wheels of 2 inches in diameter and larger can be run at the speeds which will bring the circumferential velocity up to what is usually considered theoretically correct, and the foregoing remarks apply, as will readily be understood, to wheels of relatively small diameter, used in grinding machines having a large range of work.

In the examples of work given in the following, the wheel speeds used range from 1570 to 7035 feet surface speed, whereas the work speeds vary from 29.5 to 510 feet surface speed. The only reason that can be given for such wide variations in wheel and work speeds, is that the subject of correct wheel and work speeds has not been given sufficient attention. In collecting this data it was found that one manufacturer was satisfied with a hard-bond, fine-grain wheel and a low production, as long as he obtained a good finish, whereas another manufacturer was more interested in production than finish, and, consequently, used a coarser grain wheel of softer bond. For internal grinding of soft steel, a harder bond wheel than M is seldom used, whereas for heat-treated steel a wheel harder than grade L is uncommon. For chrome-nickel or chrome-vanadium steel, heat-treated, grade K is about the hardest wheel used. In the examples given in the following, it will be noticed that these grades have not always been adopted and, consequently, the work and wheel speeds do not agree to any extent.

It can be definitely stated that in most cases the lower the wheel speed and the harder the bond of the wheel, the higher must be the work speed to get satisfactory results. When using a hard bond wheel glazing takes place unless the work speed is high enough to remove the abrasive grains from the bond as soon as they become dull; therefore it is always advisable to have the wheel speed correct and then vary the grade and grain of the wheel and the work speed until satisfactory results are obtained. Wheel speeds for internal grinding are found to vary all the way from 2000 to 7000 feet surface speed; but the most satisfactory wheel speeds are between 4000 and 6000 feet surface speed. As a rule, grinding wheels made from such abrasives as carbolite, carborundum or crystolon are operated at lower wheel speeds than grinding wheels made from abrasives such as alundum, aloxite, or corundum. For grinding wheels made from carbolite, carborundum or crystolon the most suitable wheel speeds range between 4000 and 4500 feet surface speed, whereas for wheels made from alundum, aloxite or corundum the most suitable speeds are between 4500 and 5000 feet surface speed. Table II gives the equivalent R. P. M. of wheels ranging from ¼ to 4 inches in diameter, operating at surface speeds ranging from 2000 to 7000 feet surface speed.

Considering the many variables that enter into the problem, it is difficult to state the correct speed at which the

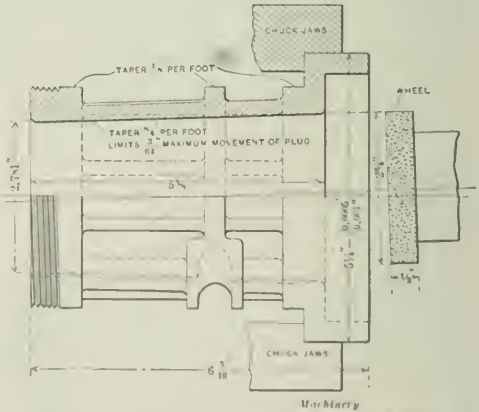

Fig. 14. Internal Grinding Phosphor-bronze Spindle Bearing

Work:—Front spindle box made from phosphor-bronze casting.

Operation.—Grinding internal diameter of taper bearing with a Norton (elastic) alundum wheel, grain 46, grade ¼; 2¾ inches diameter, ½ inch face, speed, 5555 R. P. M.—4000 feet surface speed; work speed, 198 R. P. M.—150 feet average surface speed, amount removed from 0.010 to 0.012 inch.

Remarks.—Wheel is traversed by power at the rate of 48 linear inches per minute, production, 3 per hour; machine used, No. 22 Brown & Sharpe internal grinding machine.

work should be operated unless the character of the work and the wheel used is known. There are also other conditions which have a bearing on this problem, such as type of machine used, finish required, condition of work—whether hard or soft—and diameter of hole in relation to diameter of wheel. The correct speed at which the work should rotate, therefore, cannot be decided absolutely. There are a few points, however, that are worthy of consideration. For instance, the work should not run at the same speed for grinding a 3-inch hole as it would for grinding a 1-inch hole. The reason is that the higher surface speed of the work with the larger hole tends to break down the working face of the wheel, and consequently a wheel of harder grade is necessary than if the work speed were moderate. It is also true that the hard wheel does not cut as freely as the softer wheel, and therefore, the time required for grinding may actually be longer than would be the case with a moderate speed and a freer cutting wheel.

Table IV gives what might be called the average surface speeds for grinding various materials when using grinding wheels of the grades and grains listed. As has been previously mentioned, the relation of the diameter of the hole to the diameter of the wheel has a considerable bearing on the work speed, but, of course, this can only be determined by experiment. The speeds given in the table can be used as a basis upon which to start, which is always valuable. For the average internal grinding operation the work speeds range from 75 to 125 feet per minute, the average being in the neighborhood of 100 feet surface speed. Table III gives a list of the equivalent R. P. M. for various diameters of holes ranging from ¼ to 4 inches, and work speeds ranging from 50 to 180 feet surface speed.

Width of Face of Grinding Wheels

The width of face of the wheel for internal grinding is another point that requires careful consideration. Various automobile manufacturers and other concerns throughout the country have adopted different widths of wheels for internal grinding, ranging all the way from ¼ to 2 inches. The Reo Motor Car Co., Lansing, Mich., after several years of experimenting with different widths of wheels, has found that for ordinary plain internal grinding on holes larger than 1 inch, a grinding wheel with a ¾-inch face gives the best results. This width of face of wheel is used exclusively on all internal work over 1 inch and under 3 inches in diameter, that is not provided with grooves or keyways. For a considerable length of time wheels of ½-inch face were used, but it was found that these did not have sufficient cutting surface or width of face to remove the metal efficiently. On the other hand, it was found that with a wheel wider than ¾ inch, there was too much wheel surface in contact with the work and trouble was experienced with the work's heating. For the finishing of small internal holes, less than 1 inch diameter, it was found that a Detroit wheel ⅞ or ¾ inch in diameter, ¼ inch wide, grain 67, grade M, gave the best results. This wheel was used exclusively on hardened work, as the greater portion of the work turned out by this company is low carbon steel, carbonized and hardened.

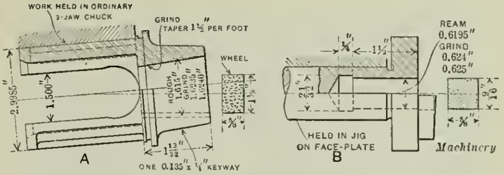

Fig. 16. Method of grinding Universal Transmission Drive Shaft Yoke and Transmission Main Drive Pinion

A

Work:—Universal transmission drive shaft yoke, chrome-vanadium steel, hardened in oil.

Operation:—Grinding tapered hole with a Norton (vitrified) alundum wheel; grain 60, grade K; 1⅛ inch diameter, ⅝ inch face; speed, 12,000 R. P. M.—3534 feet surface speed; work speed, 300 R. P. M.—118 feet average surface speed; amount removed from diameter, 0.015 to 0.020 inch.

Remarks:—Wheel is fed back and forth by pilot wheel; 15 to 20 traverses to complete each piece; production averages 25 to 28 pieces per hour; machine used, No. 70 Heald internal grinding machine.

B

Work:—Transmission main drive pinion, chrome-vanadium steel, oil hardened.

Operation:—Grinding hole with a Norton (vitrified) alundum wheel; grain 60, grade K; 9/16 inch diameter, ⅝ inch face; speed, 12,000 R. P. M.—1766 feet surface speed; work speed, 300 R. P. M.—50 feet surface speed; amount removed from diameter, 0.005 to 0.007 inch.

Remarks:—Wheel is fed back and forth by pilot wheel; 7 or 8 traverses to complete each piece; production averages 20 to 22 pieces per hour; production limited by type of fixture used; machine used No. 70 Heald internal grinding machine.

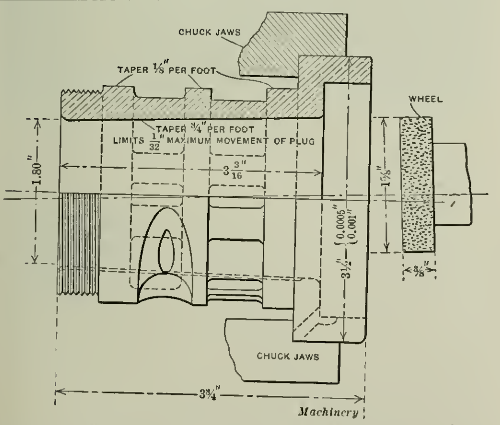

Fig. 15. Another Example of Internal Grinding of Spindle Bearing

Work:—Front spindle box made from phosphor-bronze casting.

Operation:—Grinding internal tapered bearing with a Norton (elastic) alundum wheel, grain 46, grade ¼; 1⅝ inch diameter, ⅜ inch face; speed, 8235 R. P. M.—3500 feet surface speed; work speed, 306 R. P. M.;—150 feet average surface speed; amount removed from diameter, 0.010 to 0.012 inch.

Remarks:—Wheel is traversed by power at the rate of 48 linear inches per minute; production, 8 to 10 per hour; machine used, No. 22 Brown & Sharpe internal grinding machine.

For grinding holes in which keyways are cut, a narrow face-wheel cannot be used with success because it does not present sufficient wheel surface to the work in order to stand up for any length of time. The greater the number of splines or keyways as a rule, the harder the wheel must be. For this class of work, the Reo Motor Car Company used a wheel with a 1⅛-inch face on holes up to 2 inches in diameter, and for larger work, a wheel of 1½-inch face. A wheel which has been found to give excellent results on this work is a Norton (vitrified) No. 38 alundum wheel, grain 60, grade M and N. Such wide wheels are used only on internal grinding machines especially designed for manufacturing.

Relation of Diameter of Internal Grinding Wheel to Diameter of Hole in Work

Usually, in ordering grinding wheels for internal work, especially for grinding holes less than 1½ inch in diameter, the wheel is specified to be about the same diameter as the hole in the work, and is then turned down with a diamond until it enters the hole with a reasonable amount of clearance. Theoretically, this is not the most efficient diameter and wheels of this size are ordered for economic reasons. The larger the diameter of the wheel in relation to the hole in the work, the larger is the arc of contact and the greater the tendency to glaze and heat the work. In addition to a greater arc of contact, a wheel used for internal grinding has less body or volume to carry out the heat generated, and will heat up and glaze much quicker than a wheel used externally. Usually, wheels for internal grinding are used until completely worn out. Wheels are ordered as large as possible in order that the greatest possible number of pieces may be turned out with one wheel, thus reducing wheel expense. From a purely theoretical standpoint, however, the smaller the diameter of wheel in relation to the hole in the work, the less will be the arc of contact and the higher will be the cutting efficiency of the wheel. Owing to this and other considerations, wheels of softer bond should be used for internal than for external grinding. A harder grade of wheel should be used for soft than for hardened work. Hardened work has a tendency to glaze the wheel much more rapidly than soft work, and glazing is one of the greatest difficulties met with in internal grinding.

Preventing Chatter Eccentric Holes

Chatter marks in internal grinding are generally caused by using a wheel that is too hard, taking too heavy a cut, or by using a grinding spindle with the bearings out of adjustment and slenderly supported. Great care should always be taken to keep the spindle bearings correctly adjusted so that there is no play or end shake of any kind, as this is bound to produce chatter, and tends to make the ends of the hole "bell-mouthed." Work provided with keyways or splines is difficult to grind true and free from chatter marks, and special care should be taken to see that all bearings of the machine are tight. The same applies to the bearings of the work-head. Having the wheel run out of true will also cause chatter and will produce a roughened surface on the work. It is therefore necessary to keep the wheel true and sharp, and this should not be done with a dresser but with a diamond held in a fixed support.

Eccentric holes are also caused by having the wheel spindle too loose or by putting excessive clamping strains on the work so as to spring it out of shape; using a wheel that is too hard also produces the same result in some cases. All other factors being considered, a soft wheel will grind a truer hole than a hard one.

Wet vs. Dry Grinding

Internal grinding is generally done dry in the tool-room, but this practice is not recommended for manufacturing parts in large quantities. The general practice in regard to the use of water for internal grinding is to grind soft and hardened steel work wet, and to grind cast iron, bronze and brass dry. There are, of course, exceptions to this rule, and sometimes work that is hardened is of such a shape that the use of water is either inconvenient or not necessary. For instance, when the surface to be ground is narrow and a small amount of stock is to be removed in proportion to the mass of the piece, the grinding can be done without any appreciable change in the temperature of the work. As a general rule, however, soft and hardened steel parts should be ground wet. Wet grinding produces a smoother and truer hole than dry grinding, and also facilitates gaging. Where a part has been heated to a considerable extent by grinding and a cold gage is placed in it, the gage is likely to "freeze" and difficulty will be experienced in removing it. Minute cracks in the surface of the work are also likely to develop in dry grinding, especially when a wheel of too fine a grain and too hard a bond is used, or where too heavy a cut is taken. A further reason for wet grinding is that it is impossible for the operator to know just what size the hole will be if the work has warmed up 20 or 30 degrees during the grinding, after it has been removed from the machine and has cooled down to the normal temperature. On interchangeable work and where accurate limits must be maintained, wet grinding is, therefore, imperative.

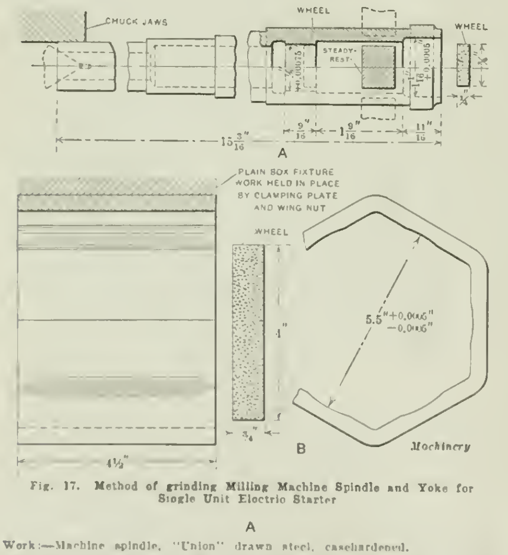

Fig. 17. Method of grinding Milling Machine Spindle and Yoke for Single Unit Electric Starter

A

Work:—Machine spindle, "Union" drawn steel, casehardened.

Operation:—Grinding two internal diameters with an American (vitrified) corundum wheel, grain 80, grade J, ¾ inch diameter, ¼ inch face; speed, 17,825 R. P. M.—3500 feet surface speed; work speed, 407 R. P. M.—100 feet average surface speed, amount removed from diameter, 0.010 inch.

Remarks:—Power traverse is used for grinding two internal diameters at the rate of 50 linear inches per minute, wheel is trued up after grinding each hole because of oil in spindle; carborundum or crystolon block used for truing wheel, put through in lots of 50, production, 8 per hour, machine used, No 2 Brown & Sharpe universal grinding machine fitted up for internal grinding.

B

Work—Yoke for single unit electric starters of six-pole type, low carbon strip steel, bent into shape and electrically welded, bored before grinding.

Operation:—Grinding internal diameter of yoke for pole pieces with a Norton (alundum) wheel, grain 46, grade K, 4 inches diameter, ¾ inch face, speed, 5800 R. P. M.—[illegible] feet surface speed; work speed, 250 R. P. M.—360 feet surface speed, amount removed from diameter, 0.008 to 0.010 inch.

Remarks—Power traverse is used at the rate of 50 inches per minute; production, 12 to 14 pieces per hour, machine used, No. 70 Heald internal grinding machine.

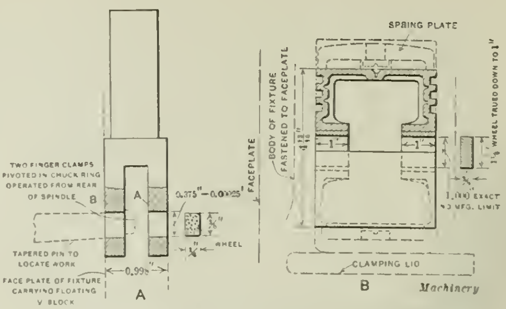
TWO FINGER CLAMPS PIVOTED IN CHUCK RING OPERATED FROM REAR OF SPINDLE
B
A
0.375"—0.0025"
⅜"
WHEEL
¼"
TAPERED PIN TO LOCATE WORK
0.998"
FACE PLATE OF FIXTURE CARRYING FLOATING V BLOCK
A
FACEPLATE
BODY OF FIXTURE FASTENED TO FACEPLATE
$4\frac{11}{16}$"
SPRING PLATE
1"
1"
1¼ WHEEL TRUED DOWN TO 1"
¾"
1.000 EXACT NO MFG. LIMIT
CLAMPING LID
B
Machinery

Fig. 18. Two Interesting Examples of Internal Grinding

A

Work:—Valve lifter, 0.20 per cent carbon steel, casehardened.

Operation:—Grinding cross holes with a Norton (vitrified) alundum wheel, grain 60, grade M, ⅜ inch diameter, ¼ inch face; speed 16,000 R. P. M.—1570 feet surface speed; work speed, 300 R. P. M.—29.5 feet surface speed; amount removed from diameter, 0.004 to 0.005 inch.

Remarks:—Work is first accurately located by tapered centering plug, then wheel is fed in by hand and hole (A) is first ground to within 0.001 inch of finished size. Hole (B) is then ground likewise. Then both holes are ground to gage size. (See illustration for limits.) Production, 150 pieces per hour. Machine used, Rivett internal grinding machine.

B

Work:—Automobile gas engine piston made from iron casting.

Operation:—Grinding wrist-pin holes which have been bronze bushed, with a Norton (vitrified) crystolon wheel, grain 60, grade J, 1¼ inch diameter, ⅝ inch face; speed, 14,000 R. P. M.—3660 feet surface speed; work speed, 434 R. P. M.; 114 feet surface speed; amount removed from diameter, 0.010 inch.

Remarks:—Piston is held in a special fixture and is located from the open end by a spring pad. It is lined up with the grinding wheel spindle by a plug and clamped. Hand traverse is used; production, 3 minutes for each piston; machine used, No. 70 Heald internal grinding machine.

There are cases where cast-iron parts should be ground wet. When the work must be ground to very accurate limits water has to be used to keep down the temperature in order to prevent any change of diameter or shape. This applies more particularly to the grinding of thin, cast-iron bushings. It has been found that a cast-iron bushing, ground dry, will spring out of shape to some extent after it is taken out of the machine. By keeping the part at a uniform temperature by means of a cooling lubricant, any change in diameter and shape is avoided. The subject of grinding cast iron internally is a broad one, and will be dealt with more fully in a subsequent article on "Cylinder Grinding." When dry grinding is done, it is necessary to provide the machine with an exhaust system to draw off the dust, both for the protection of the operator and to keep the machine clean and in a satisfactory working condition.

Cause of Bell-mouthed Holes

Another difficulty sometimes experienced in internal grinding is the production of bell-mouthed holes. There are two chief causes for this; one is due to a loose spindle and the other to completely removing the wheel from the hole at each traverse. The wheel should never be pulled out of the work except when it is necessary to remove it to gage the hole. While the power traverse is being used for advancing and withdrawing the wheel, the wheel should never pass clear through the work, but about one-half of the wheel surface should still remain in the hole. The reason for this is that when the wheel is withdrawn, any slackness in the spindle tends to throw it out to one side because the strain of cutting has been removed. Consequently the hole is made bell-mouthed.

Examples of Internal Grinding

The variety of grinding operations is so great that it is difficult to give definite data for all. The best that can be done is to show typical examples and give all the details in regard to how the work is handled, giving the grain and grade of wheel used, the speed at which the wheel rotates, the speed of the work, the amount of metal removed, the traverse feed of the wheel and the limits required. With this data properly arranged, it is then possible, when similar parts must be ground, to have a fair idea of what wheel should be used, what speed it should be rotated at, and the other points regarding the way in which the work should be handled. In the following examples of internal grinding, the data has been arranged in this manner.

Grinding Bushings

Considerable difficulty is usually experienced in grinding bushings, especially when they are hardened and have thin walls. The greatest trouble is in getting a true hole of the same size from end to end. If the external diameter is to be ground first, which is the practice followed in some shops, the work should be held on a "floating mandrel" which grips the work by the ends and not from the internal diameter. This obviates springing the work out of shape. The work is then ground accurately on the external diameter to the final dimensions, care being taken to see that it is true and of the same size from end to end. Following the external grinding operation, the work can be held in several ways for grinding internally, depending on the accuracy required.

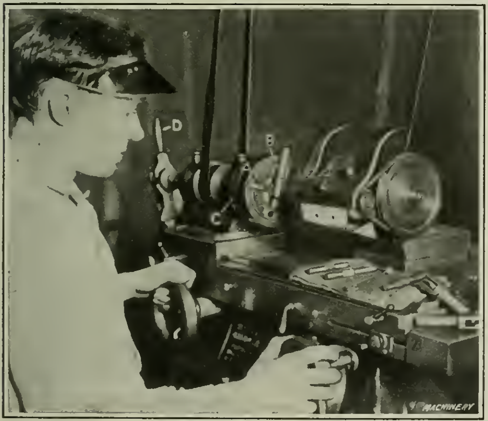

Fig. 19. Set-up for grinding Valve Lifter on Rivett Internal Grinding Machine

One example is shown at *A* in Fig. 11. This bushing has to be ground both externally and internally. The limits are not extremely close, so that an ordinary draw-in air chuck can be used for holding it. The bushings is ground carefully so as to give an even bearing on the externally ground surface. Another example is shown at *B*. Here the accuracy of the work is not close, and the collet chuck method of holding the work is satisfactory. The example shown at *D*, however must be accurate and the external diameter is first finished accurately; then the work is slipped into a solid bushing chuck and held in place by a clamping bolt from the end, as illustrated. In this way the work is not put under any clamping strains when being ground.

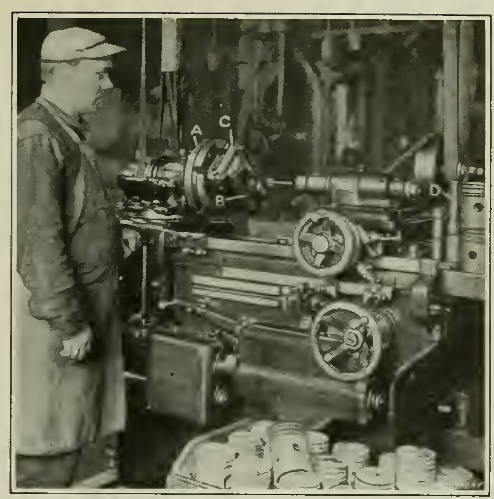

Fig. 20. Method of grinding Wrist-pin Hole in Gas Engine Piston

Referring again to the example shown at *A*, this is held in a Hannafin air chuck. The air chuck method of holding work has been found to be satisfactory for the reason that the pressure is constant. Of course when the work is extremely thin, the air chuck is not recommended.

Grinding Ball Races

Ball races for spherical balls are made in two principal shapes: one is the V-groove type and the other the semicircular. To finish a ball race of the V-groove type it is necessary to form the wheel and keep it trued to the desired shape. Usually in grinding this type of race, roughing and finishing operations are done at the same setting, a grinding wheel being selected that gives fairly good results for both operations.

Where the ball race is of the semicircular type, a formed wheel sometimes held on a regular internal grinding machine spindle is used for roughing out the groove, and the finishing is done in another machine of the radial type. Before proceeding with a description of the grinding of ball races in a radial grinder, attention will be given to the rough grinding of the face.

Rough-Grinding Semicircular Ball Races

Fig. 9 shows a close view of a semicircular ball race grinding operation. The ball race is held in a collet chuck provided with six block-type jaws that grip equidistantly about its circumference. The work-table is advanced to a stop set to locate the wheel approximately central with the race, and then is fed in radially to the correct depth. The wheel is trued approximately to the correct radius by a diamond truing device of the radius type. The amount left on the diameter for finish-grinding varies from 0.002 to 0.008 inch, depending on the size of the bearing and the arc of the curve in the race.

Finish-Grinding Semicircular Ball Races

As an example of finish-grinding a ball race on a radial grinding machine of the Van Norman type shown in Fig. 10, we will assume that an outer race having a ball circle of 1½ inch diameter is to be ground as shown in Fig. 12. For making the traverse setting of the work-holding head, a plug exactly 0.750 inch long is placed between stops *A*, Fig 10, the slide being adjusted until both stops engage with the plug. The cross-slide of the work head is then locked in this position.

The next step is to move the work-head back the required distance longitudinally so that the radial center of the race is exactly over the pivoted point about which the head oscillates. For this purpose the shoulder near the front end of the spindle is taken as a reference point, which as shown in Fig. 12 is 1.625 inch from the center of the ball race. This adjustment is made by placing a plug exactly 1.625 inch long

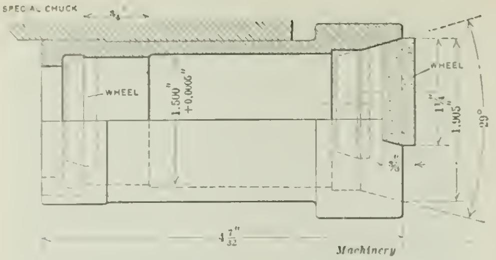

Fig. 21. Example of Straight and Taper Internal Grinding

Work:—Spring collet sleeve for automatic screw machine made from tool steel, hardened.

Operation:—Grinding straight and tapered holes with a Norton (alundum) wheel, grain 38-80, grade J; 1¼ inch diameter, ¾ inch face; speed, 11,600 R. P. M.—3800 feet surface speed; work speed, 225 R. P. M.—100 feet average surface speed; amount removed from diameter, 0.010 inch on straight portion, and 0.012 inch on tapered portion.

Remarks:—For grinding straight hole the table is traversed by power at 48 linear inches per minute; for grinding tapered portion, the wheel-slide is set off at an angle and the wheel is brought in by hand power; production, 4 per hour; wheel is not trued up at all after first truing; machine used, No. 2 Brown & Sharpe universal grinding machine.

between the stops located on the rear side of the longitudinal slide of the work-head.

Next the grinding wheel is located over the center-line of the work, as shown to the left in Fig. 12. The wheel-head is mounted on a slide which is moved back and forth by a hand-operated rack and pinion, and to make this setting, stop *C*, Fig. 10, which bears against the frame, is adjusted to the proper point and locked. In order to true the wheel, the work head is moved around to the central position, where a plunger *D* enters a hole on the swivel slide support, holding the truing device securely in place. In this position the post *E* upon which the diamond holder is mounted is properly located.

The distance between the axis about which the work-head oscillates and the center of the stud upon which the truing device is mounted is approximately 3 inches. Therefore, in order to true the wheel it is necessary to move it back to the diamond point, which is accomplished by means of distance plug *F*. In starting to true the wheel, the wheel slide is moved back a distance slightly greater than 3 inches, after which the distance plug *F* is swung into position and the slide moved forward to bring the stop *C* into contact with it. A detail view of the wheel truing device is shown at *A* in Fig. 12. Means for setting the diamond holder for truing wheels of different radii is provided for by different size disks *a* held on a plunger *b*. The diamond is brought in contact with a disk of the proper size and the holder clamped in position.

Development of Cracks When Grinding Ball Races

In grinding ball races, trouble is sometimes experienced with minute cracks developing in the surface of the work. Many reasons have been given for this, but the most plausible one is that the exterior surface of the work is sometimes heated so rapidly that the elastic limit of the metal is exceeded before the heat has time to dissipate. This may be caused by using a wheel of too fine a grain and too hard a bond; forcing the wheel beyond its cutting capacity; using a wheel that has become glazed and is not free cutting; grinding dry. Strains set up in hardening are a contributory cause to grinding cracks, and as a remedy it has been suggested to let the work season for some time after hardening and before grinding.

The grain and grade of grinding wheel to use is determined largely by the character of the work and the treatment it receives. As a rule, for grinding hardened ball races it is not advisable to use a wheel of a bond much harder than *J*. A combination of different size grains in the wheel is also preferable to a "straight-grain" wheel, as the combination grain wheel holds its shape much longer. Another way to obviate grinding cracks is to keep the wheel free cutting, and not force it beyond its cutting capacity.

Internal Grinding a V-Shape Ball Race

An example of ball race grinding of the V-type is shown at *C* in Fig. 11. In grinding this race, the wheel is located by bringing it slowly in until it touches both sides of the V-shape race. Then the traverse motion of the grinding wheel slide is stopped and the wheel slide advanced toward the operator, or in other words, the wheel is fed directly in on the work until the approximate diameter is reached. The wheel is then withdrawn and the work gaged. This continues until the ball race has been ground to the correct diameter. In order to obviate the frequent withdrawal of the wheel to gage the work, the micrometer collar on the wheel operating slide screw is used. The race is measured by an internal calliper type of gage furnished with ball ends. As is shown in Fig. 11, a combination grain soft-bond wheel is used for this work. The combination of grain in the wheel enables a greater number of pieces to be turned out for each truing of the wheel, as it holds its shape much better than a straight-grain wheel.

Grinding a Cup for a Fan Shaft Bearing

Still another example of ball race grinding is shown at *A* in Fig. 13. This requires the use of a cup-shape grinding wheel. This part, which is a cup for a fan shaft bearing, is made from sheet steel formed into shape, then carbonized and hardened in oil. One of the specifications on the job is that the hole must not only be true and accurate as regards size, but must be smooth and free from scratches. The manner of grinding this part is as follows:

The cup-shape wheel used is brought in until it touches the bottom of the hole and this surface is ground first. The action of forcing the wheel against the bottom throws the spindle slightly out of line and, consequently, the internal diameter is also ground. Allowance is made for this on the work so that by the time the desired amount is removed from the bottom the hole is practically ground to size. The amount removed from the diameter is 0.015 inch, whereas the amount removed from the bottom of the hole is only 0.005 inch. The reason for allowing so much material to be re-

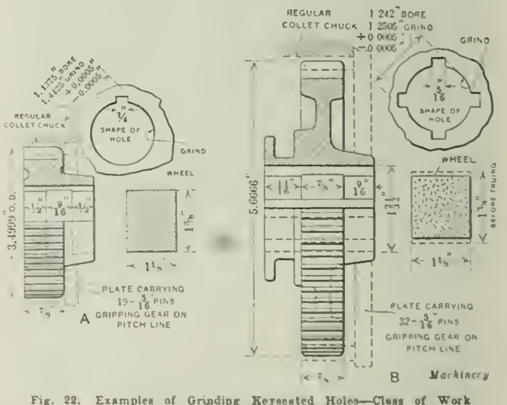

Fig. 22. Examples of Grinding Keyseated Holes—Class of Work that is Hard on Grinding Wheel

A

Work:—Low countershaft gear, 0.15 per cent carbon open-hearth steel drop-forging; carbonized 0.030 inch deep and hardened.

Operation:—Grinding internal diameter with a Norton (vitrified) alundum wheel, grain 60, grade M; 1⅜ inch diameter, 1⅛ inch face; speed, 10,200 R. P. M.—3670 feet surface speed; work speed, 400 R. P. M.—151 feet surface speed; amount removed from diameter, 0.005 to 0.008 inch.

Remarks:—Wheel is fed back and forth by pumping action, and is trued up with a carbon block; number of truings varies from 10 to 50 pieces; production, 200 in nine hours; machine used, No. 70 Heald internal grinding machine.

B

Work:—Low speed and reverse sliding gear, 0.15 per cent carbon open-hearth steel drop-forging, carbonized 0.030 inch deep and hardened.

Operation:—Grinding splined hole with a Norton (vitrified) alundum wheel, grain 60, grade N; 1⅜ inch diameter, 1⅛ inch face; speed, 10,200 R. P. M.—3670 feet surface speed, work speed, 400 R. P. M.—131 feet surface speed; amount removed from diameter, 0.005 to 0.008 inch.

Remarks:—Wheel is fed back and forth by pumping action and is trued up with carbon block, every 10 or 50 pieces; wheel is harder because of the greater number of splines, production, 200 in nine hours; machine used, No. 70 Heald internal grinding machine.

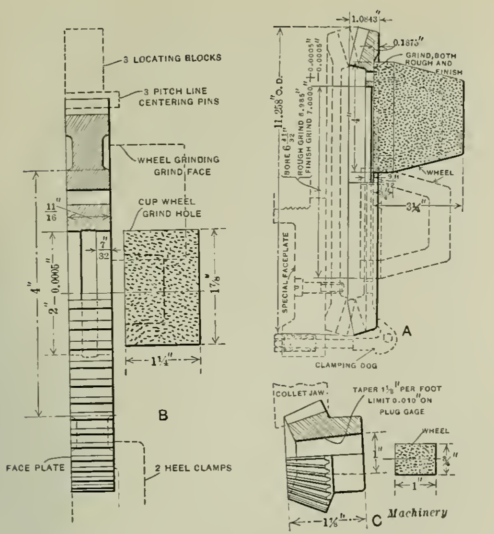

Fig. 23. Examples of Internal, Face and Taper Hole Grinding

A

Work:—Bevel ring drive gear, 0.15 per cent carbon open-hearth steel drop-forging, carbonized 0.030 inch deep and hardened in oil.

Operation:—Grinding back face and internal diameter with a Norton (vitrified) alundum special-shaped wheel, 4 inches diameter, ¾ inch straight face, 3¼ inches wide; speed, 5400 R. P. M.— 5670 feet surface speed; work speed, 260 R. P. M.—510 feet average surface speed; amount removed from diameter and back face, 0.010 inch when soft and hard.

Remarks:—In both cases hand feed is used, and owing to a peculiar fancy of the operator, the same grit and grain of wheel is used for grinding work when soft and hard; production when grinding soft is 200 in nine hours; when hard, 125 in nine hours; machine used, Heald No. 75 internal grinding machine.

B

Work:—Automobile transmission gear, alloy steel, heat-treated, and hardened.

Operation:—Grinding hole and face with a Norton (vitrified) alundum wheel, grain 46, grade K; 1⅞ inch diameter, 1¼ inch face; speed, 7500 R. P. M.—3675 feet surface speed; work speed, 225 R. P. M.—110 feet surface speed; amount removed from diameter of hole, 0.010 inch; amount removed from face, 0.005 inch.

Remarks:—Power traverse is used for grinding holes at the rate of 48 linear inches per minute; wheel is fed across face of gear by hand power; 10 gears turned out per truing of wheel; production, 9 per hour; machine used, Bryant single-spindle chucking grinder.

C

Work:—Automobile rear axle drive pinion, 0.20 to 0.25 per cent carbon, 0.17 per cent vanadium steel drop-forging, heat-treated.

Operation:—Grinding taper hole with a Norton (vitrified) alundum wheel; grain 60, grade K; ¾ inch diameter, 1 inch face; speed, 12,500 R. P. M.—2460 feet surface speed; work speed, 400 R. P. M.—100 feet average surface speed; amount removed from diameter, 0.005 inch.

Remarks:—Wheel is fed in and out by pilot wheel; wheel is just trued down to start and then is not touched until worn down to about size of spindle; 200 pieces secured from each wheel; production, 700 pieces in eight hours; machine used, Bryant single-spindle chucking grinder.

moved from the diameter of the hole is that the wheel must rest against the internal diameter at the same time that the bottom is being ground in order to steady the spindle.

The wheel must be kept to approximately the same diameter, and it requires a large number of wheels to turn out a large quantity of work. The reason for this is that as soon as the wheel is worn down much smaller than the diamter of the hole, it produces cross marks on the bottom or inner face, which are objectionable on this job.

Another requirement as previously mentioned, is that the work must have a polished surface. The method of accomplishing this is interesting. Just as soon as the grinding wheel finishes the internal diameter to size, a small amount of lard oil is squirted onto the work. Then, when the wheel is passed back and forth a couple of times, the result is an excellent polish. While it is not advisable, as a rule, to use oil on a grinding wheel because of the glazing effect, in this case it produced the results desired. As soon as this same wheel strikes a rough piece, all the glazing effect is removed so that it is not necessary to dress the wheel until it is worn down too small.

Internal Grinding Phosphor-Bronze Bearings

Two examples illustrating the internal grinding of phosphor-bronze bearings are shown in Figs. 14 and 15, respectively. These two bearings are practically the same in every respect, except the size, one having a hole 5⅜ inches long to grind, and the other a hole 3 3/16 inches long. The method of grinding these bearings is to hold them in a three-jaw chuck, necessitating the truing up of each piece. The hole is ground first, and then the bushings are slipped onto a mandrel and the external diameter ground to size. For internal grinding, the power traverse is at the rate of 48 linear inches per minute; the production on the small bearing is 8 to 10 per hour and 3 per hour on the large bearing.

Grinding a Taper Hole in a Drive Shaft Yoke

The drive shaft yoke shown at *A* in Fig. 16 is a good example of taper hole grinding. This particular job is held in an ordinary three-jaw chuck in a No. 70 Heald internal grinding machine, and is rough- and finish-ground in one operation. By referring to this illustration, it will be noticed that the work has one keyway, and, consequently, a harder bond wheel is used than if the hole were plain. In this case, a Norton (vitrified) alundum wheel, grain 60, grade K, was found to give the best results. The grinding wheel is fed back and forth by the pilot wheel and it requires from fifteen to twenty traverses to complete each piece.

Grinding a Transmission Main Drive Pinion

An example of straight internal grinding of the plain variety is shown at *B* in Fig. 16. This is a transmission pinion made from chrome-vanadium steel, oil-hardened. For grinding, the work is held in a special fixture, clamped to the faceplate of the machine, and it is necessary to true up each piece before grinding. This, to a certain extent, limits the production, which is at the rate of 20 to 22 per hour. The same grain and grade of wheel is used as in the previous example, but the wheel is rotated at a lower surface speed, and the work speed is correspondingly reduced.

Internal Grinding a Machine Spindle

Diagram *A*, Fig. 17, shows a machine spindle made from "Union" drawn, casehardened steel, that is ground on two internal diameters. It is located by a center and then driven by the chuck jaws of a three-jaw chuck. It is centered on the outer end by a standard center steadyrest. This is a difficult job because of the extreme accuracy required. The external diameters have previously been ground and it is necessary to true up the spindle before grinding the two internal diameters. Because of oil on the spindle, the grinding wheel has to be trued up after grinding each hole. This is done by using a carborundum or crystolon block. It will also be noticed that a corundum (vitrified) grain 80, grade J wheel is used. This is a fine grain, soft-bond wheel, and it is operated at a surface speed of 3500 feet per minute.

Internal Grinding an Electric Starter Yoke

An unusual internal grinding job is shown at *B* in Fig. 17. This is a yoke for a single unit electric starter of the six-pole type and is made from low carbon strip steel which is bent into shape and then electrically welded. Following the electric welding operation, the yoke is bored out, after which the internal surface is ground. It will be noticed that the grinding wheel only contacts with the work at six points, allowing the use of a high wheel and high work speed. The wheel speed is 5539 feet and the work speed 360 feet. For grinding, the work is held in a special fixture that locates it from the external diameter and is clamped in place by a strap passing over the front of the work with pins on one side, and a wing-nut on the other.

Grinding a Valve Lifter

The valve lifter shown at *A* in Fig. 18 is an interesting example of internal grinding, because of the extreme accuracy required. The holes in the fork ends of this piece must be ground to a limit of 0.00025 inch on the diameter and must be absolutely in line with each other. This is accomplished in an interesting manner in a Rivett internal grinding machine, as shown in Fig. 19. The work is held on a special faceplate by two fingers *A*, pivoted in the faceplate and held in ring *B*. The fingers are operated to grip the work by turning collar *C*, screwed onto the body of the face-

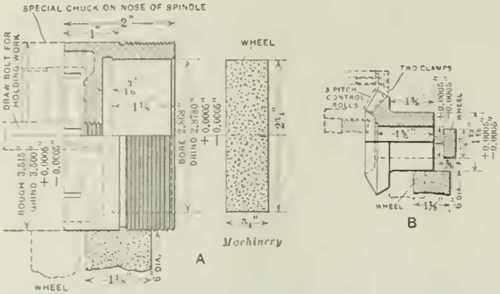

Fig. 24. Two Examples of Combined Internal and External Grinding

A

Work:—Sleeve for transmission countershaft bearing, 0.15 per cent carbon open-hearth steel drop-forging, carbonized 0.030 inch deep and hardened.

Operation:—Grinding internal and external diameters; external diameter ground with a Detroit wheel, grain 46, grade M; 6 inches diameter, 1 1/8 inch face; speed, 2160 R. P. M.—3391 feet surface speed; work speed, 240 R. P. M.—220 feet surface speed; amount removed from diameter, 0.015 inch. Internal diameter ground with a Norton (vitrified) alundum wheel, grain 50, grade K, 2 3/4 inches diameter, 3/4 inch face; speed, 5600 R. P. M.—4000 feet surface speed; work speed, 240 R. P. M.—180 feet surface speed; amount removed from diameter, 0.010 inch.

Remarks:—Wheel is traversed by power for grinding both internal and external diameters; for grinding external diameter, traverse is at the rate of 64 linear inches per minute, and for internal diameter, at the rate of 66.5 linear inches per minute; production, 100 pieces in nine hours; machine used, Bryant two-spindle chucking grinder.

B

Work:—Bevel pinion, 0.15 per cent carbon open-hearth steel drop-forging, carbonized 0.030 inch deep and hardened.

Operation:—Grinding internal and external diameters and facing shoulder; external diameter ground with a Norton (vitrified) alundum wheel, grain 36, grade M; 6 inches diameter, 1 1/8 inch face; speed 2500 R. P. M.—3927 feet surface speed; work speed, 240 R. P. M.—114 feet surface speed; amount removed from diameter, 0.015 inch. Internal diameter ground with a Norton (vitrified) alundum wheel, grain 50, grade K, 7/8 inch diameter, 5/8 inch face; speed 15,279 R. P. M.—3500 feet surface speed; work speed, 240 R. P. M.—63 feet surface speed; amount removed from diameter, 0.015 inch.

Remarks:—Wheel is traversed by power for grinding both internal and external diameters, at the rate of 64 linear inches per minute; shoulder is faced by bringing wheel up slowly before grinding external diameter; production, 15 pieces per hour. Machine used, Bryant two-spindle chucking grinder.

plate. The work is located by a tapered centering plug extending through the spindle, and operated by lever *D*. The method of grinding, as shown at *A* in Fig. 18, is to first accurately locate the work by the tapered centering plug, then operate the grinding wheel slide by hand to finish the first hole to within about 0.001 inch of the final size. The hole in the rear fork of the piece is then ground to 0.001 inch of the final size, after which both holes are ground accurately in line with each other and to the correct diameter.

Grinding Wrist-pin Holes in a Gas Engine Piston

The example of work shown at *B* in Fig. 18 is of a somewhat similar nature as far as accuracy is concerned, to that shown at *A* in the same illustration, but is much larger and is handled in an entirely different manner. In this case, the piston is bushed with bronze bushings and the latter are ground to the correct size and in perfect alignment with each other. A special fixture of the faceplate type, as shown in Fig. 20, is used for this purpose. Fastened to the faceplate *A* is a cylindrically shaped holder *B*, into which the piston is placed. The piston rests on a spring plate and is gaged from the open end by another plate fastened to the clamping strap *C*. Before locking clamping strap *C*, the piston is aligned with the grinding wheel by means of plug *D* which is ground down on the front end to fit the bronze bushings and is larger near the shank to fit the hole in the fixture. The grinding wheel is operated by hand traverse, and removes about 0.010 inch from the diameter. For grinding this bronze-bushed hole, a Norton (vitrified) crystolon wheel, grain 60, grade K, has been found to give the best results. This is operated at a surface speed of 3660 feet, and the work speed is about 114 feet surface speed. No manufacturing limits of tolerance are allowed on the hole, which must be ground to an exact dimension of 1 inch. This means that it must be made a perfect fit for a 1-inch plug gage.

Grinding a Spring Collet Sleeve

The spring collet sleeve for an automatic screw machine shown in Fig 21 is ground at two points—tapering at the front and straight near the rear end. This job is handled in a Brown & Sharpe universal grinding machine, fitted up for internal grinding as shown in Fig. 1. The work is held in a special collet carrying eight knurl-head screws that are used for centering and holding the work. The straight hole is ground by traversing the table by power at the rate of 48 linear inches per minute. For grinding the tapered hole, the wheel slide is set off to the required angle and is brought in by hand, finishing the taper to the required angle. Several cuts are taken across the tapered face before it is finished. By this method of handling the work, the straight and tapered surfaces can be ground at one setting and in perfect alignment with each other. In starting out with a new wheel is is trued up with a slight taper on the front end, but after that it is not touched with the diamond until it has been completely worn down. After grinding a few pieces, the front end of the wheel wears down much quicker than the other portion and soon becomes beveled, as shown in Fig. 21. The production on this piece is rather low because of the method used in handling—about four per hour.

Grinding Holes Having Keyways

The grinding of a hole that has keyways is more difficult than the grinding of a straight or plain hole. A keyway has a tendency to tear out the grains from the bond of the wheel, and, consequently, a much harder wheel is needed for this work. Fig. 22 presents two examples of internal grinding of holes having keyways. The example shown at *A* is a countershaft gear made from a drop-forging of 0.15 per cent carbon open-hearth steel, and is casehardened 0.030 inch deep and hardened. This gear was ground on a No. 70 Heald internal grinding machine, provided with a special chuck for locating the gear blank from the pitch circle of the teeth.

There are several points to observe in the grinding of keyseated holes. In the first place, a much wider wheel should be used than that recommended for a plain hole, also the wheel should be operated by hand rather than by power feed, and should be moved rapidly back and forth in order to secure a concentric hole. The use of a wide face wheel and a rapid traverse generally prevents the keyways in the work from making the wheel grind out of round, as would be the case with a narrower wheel operated by power feed.

The example shown at *B* in Fig. 22 has four keyways instead of one, and in this case a grade N instead of a grade M wheel is used. This wheel is slightly harder than that used for the example shown at *A*, as it has been found that the greater the number of keyways in the work, the harder the bond of the wheel should be. The grade N wheel requires dressing more frequently than the grade M wheel, but gives better results because in a softer wheel the grains tear out too easily from the bond and do not give the desired finish, or give as large a production.

Considerable difficulty was at first experienced in grinding the holes in these gears, and a large number of experiments were made with different grains and grades of grinding wheels. It has been found that wheels for internal grinding of small size do not come of as even a grade as large wheels used for external cylindrical grinding. Various means have been adopted to remedy this, and one method is to treat the

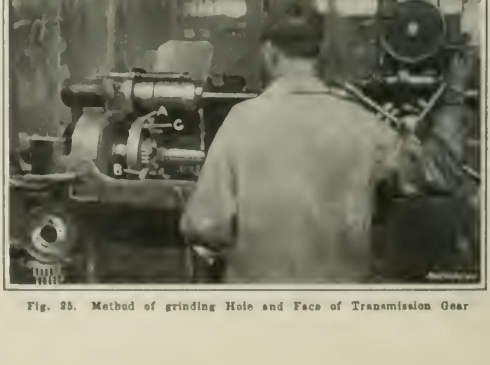

Fig. 25. Method of grinding Hole and Face of Transmission Gear

wheels before using them. Where the work to be ground is hardened, and has keyways, making the use of a hard-bond wheel necessary, it has been found that the wheel will give much better results by being soaked in regular machine oil before using. The practice followed in one shop is to leave the wheel soaking in this oil for about twenty-four hours, and also, when not in use in the machine, to leave the wheel in the oil. The operator generally keeps a number of these wheels beside the machine in a can of oil, and uses one wheel for several hours, then takes it off the spindle, places it in the oil and replaces it with a fresh one. The wheel is taken out of the oil, placed on the spindle and cleaned off by means of an air blast, then dressed up with a carborundum block. The oil treatment seems to make the wheel act as though it were softer and prevents it from glazing to a large extent.

Grinding a Universal Drive Shaft Yoke

The universal drive-shaft yoke shown at *B* in Fig. 13 is a still more difficult proposition to grind than keyseated gears. In this case, over half the hole is completely cut away, leaving the work open on both sides. This increases the tendency to pull the grain from the bond of the wheel, and, therefore, requires a wheel which will stand up to the work. A hard bond wheel, however, does not work very satisfactorily, because it glazes rapidly and has a tendency to throw the grinding wheel spindle out of line. The chief trouble met with in grinding the work shown at *B* in Fig. 13 was in getting the hole round; this was due to the tendency of the wheel to shift when it struck the open portion of the work, thus forming a flat instead of grinding a true circle. The difficulty was finally overcome by adjusting the wheel and work-spindles so that they were rigidly supported, and also supporting the work in a special fixture, and clamping it from the end, so that all clamping strains were removed. It will be noticed in this case that the bond of the wheel was considerably softer than that used for the examples shown in Fig. 22, but the conditions in this case are not quite the same, and a hard grade wheel was not satisfactory. The amount of metal to remove from the diameter was reduced to the minimum, so that the work was just cleaned up when ground to the finished size.

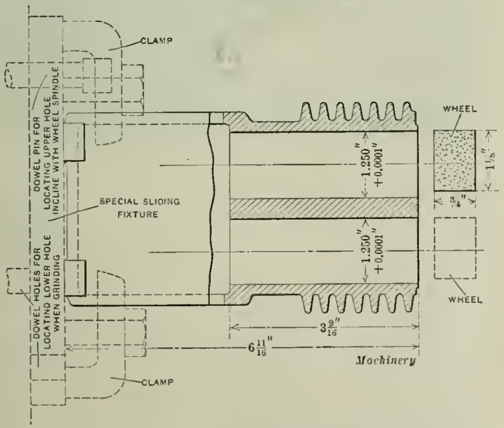
CLAMP
DOWEL PIN FOR LOCATING UPPER HOLE INCLINE WITH WHEEL SPINDLE
SPECIAL SLIDING FIXTURE
DOWEL HOLES FOR LOCATING LOWER HOLE WHEN GRINDING
WHEEL
1.250" +0.0001"
1⅛"
¾"
1.250" +0.0001"
WHEEL
3 9/16"
6 11/16"
Machinery
CLAMP

Fig. 26. Grinding Data on Twin Air Compressor Cylinders shown in Fig. 27

Work:—Compressor-cylinders for dental air compressors, made from fine grain hard cast iron.

Operation:—Grinding two cylinders with a Norton (vitrified) crystolon wheel, grain 46, grade I; 1⅛ inch diameter, ¾ inch face; speed, 14,500 R. P. M.—4205 feet surface speed; work speed, roughing, 320 R. P. M.—105 feet surface speed; work speed, finishing, 238 R. P. M. —78 feet surface speed; amount removed from diameter of hole 0.006 to 0.007 inch; 0.010 inch left for finishing.

Remarks:—Power traverse is used at the rate of 12 linear inches per minute for roughing, 4 linear inches per minute for finishing; special faceplate fixture is used for holding work, provided with two dowel holes for locating each cylinder alternately in line with the grinding wheel spindle; production, 6 to 8 holes per hour, limited on account of extreme accuracy desired; machine used, Heald No. 70 internal grinding machine.

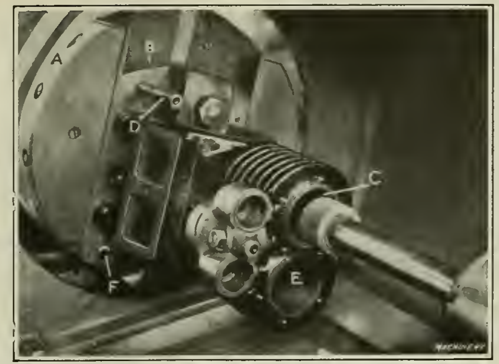

Fig. 27. Interesting Set-up for Internal Grinding a Small Twin Air Compressor Cylinder

Examples of Combined Internal and Face Grinding Operations

The bevel ring drive gear shown at *A* in Fig. 23 is a good example of combined hole and face grinding. The operations to be performed are the grinding of the hole and the back face. In order to cut the teeth, these surfaces are used for locating, so that the work is ground both before being hardened and after hardening. One method of holding a gear of this kind for grinding is shown in the illustration. A duplicate ring gear is fastened to the faceplate to locate the gear to be ground from the teeth, two clamping dogs holding the gear to be ground in place. The wheel used is of cup shape, 4 inches diameter and 3¼ inches wide, having a grinding face about ¾ inch. For grinding the work in a soft condition, a Norton alundum (vitrified) wheel, grain 46, grade K, is used. In the first grinding operation, the back face is just trued up and about 0.010 inch is removed from the hole. The production when the gear is soft is 200 gears in nine hours.

After the teeth are cut in the gear it is carbonized and hardened, and is then brought back to the grinding department. It is held on the same type of fixture as before, and the same grade and grain of wheel is used. The back face and hole are both ground by feeding the wheel by hand. Generally the same grade and grain of wheel is not recommended for hard and soft work, as a soft wheel gives better results on hard than on soft work. In this case the operator previously used a softer wheel on the hardened work, but found that the grain was not sufficient to warrant the changing of wheels. Another point is that the amount of surface being ground is so small that the grain and grade of wheel does not make so much difference. In fact, a rather wide range of wheels could be used. The production after hardening was considerably less than when the gear was soft, and averaged about 125 gears in nine hours.

Still another example of combined hole and face grinding is shown at *B* in Fig. 23, and the method of grinding is shown in Fig. 25. For this operation, a Bryant single-spindle chucking grinder is used. The work is located on a special faceplate *A*, to which three blocks *B* are fastened. The inner ends of these blocks are ground concentric with the axis of the work-spindle, and hardened and ground pins are then located at three points between these blocks and the teeth of the gear, locating the latter from the pitch circle. Two toe-clamps *C* are used to fasten the gear quickly to the faceplate. The grinding is done with a cup-shaped wheel 1⅞ inch diameter by 1¼ inch face, grain 46, grade K. The hole is ground first and the power traverse is used. After this is finished, the wheel is backed out from the hole and the wheel-head is moved over to grind the face of the gear, this being done by hand feed.

Another interesting example of internal grinding is the automobile rear axle drive pinion shown at *C*. Fig. 23. This is made from a drop-forging of carbon-vanadium steel, heat-treated. On this particular example, considerable experimenting was done to obtain the greatest number of pieces from each wheel. A start was made allowing about 0.010 inch on the diameter, but the limits were finally reduced to 0.005 inch, and production increased from 60 to 200 gear blanks from one wheel.

Combined Internal and External Grinding

Fig. 24 shows two examples of combined internal and external grinding, performed on a Bryant two-spindle chucking grinder. The example shown at *A* is a sleeve for a transmission countershaft bearing, the internal and external diameters of which are ground at the same setting, by bringing the external and internal grinding wheels alternately into position. The other example, shown at *B*, is a bevel pinion that is handled in a similar manner. In addition to grinding the external diameter of the pinion, the back face is also ground, and the method of accomplishing this is to bring the wheel up slowly against the face of the work when taking the roughing cut from the external diameter.

Grinding Twin Cylinders for Dental Air Compressors

A rather unusual internal grinding job is shown by the example in Figs. 26 and 27. This is a twin cylinder casting for dental air compressors, and is made from fine grain hard cast iron. The two cylinder holes must be ground in the correct relation to each other, and for this work a special fixture, as shown in Fig. 27, was designed. This is held on a Heald No. 70 internal grinding machine. The fixture comprises a faceplate *A*, screwed onto the nose of the spindle, which is machined out on the front end to fit a sliding member *B* provided with toe-clamps for holding the casting to be ground. For grinding hole *C*, pin *D* is placed as shown in the illustration, and for grinding hole *E* the pin is removed and inserted in hole *F*, the slide being moved up until this hole lines up with the one in the faceplate. The method of grinding these two cylinders is to first rough them out to within 0.001 inch of the finished size, using a Norton (vitrified) crystolon wheel, grain 46, grade I. The wheel for the roughing operation is operated at a surface speed of 4205 feet, and the work speed for roughing at 105 feet surface speed. For finishing, the work speed is reduced to 78 feet. For roughing, the power traverse is at the rate of 12 linear inches per minute, and this is reduced to 4 linear inches per minute for finishing. This method of handling the work is used because of the extreme accuracy and finish desired in this factory, which, however, is far beyond the requirements of ordinary commercial work of this character and thereby reduces by at least one-half the output usually obtained on such work.

Summary

The foregoing examples of internal grinding illustrate methods of handling various classes of work, as well as the wheel speeds, work speeds, and wheels used. Attention has also been directed to the method of holding the work while grinding, which, of course, has a considerable bearing on the results obtained. In looking over these examples, it will be found that there is a considerable difference in the wheel and work speeds used, and an endeavor in each case has been made to explain why such variance in practice existed. It is impossible, of course, to lay down any hard and fast rules for internal grinding, and in this respect the examples of work are expected to give data of value in doing a similar line of work.

* * *

FAST CONTINUOUS MILLING

An excellent example of the progress that is being made in continuous milling operations is illustrated in the milling of steel clutch shifter yoke forgings, like that shown in Fig. 1. The milling operation is performed on a Becker vertical milling machine and is illustrated in Fig. 2.

From Fig. 1, it will be seen that the yoke forging has two bosses that must be faced off on each side. The faces of these bosses are approximately 3/4 inch diameter, and about 3/16 inch of metal is removed from each face at the thickest portion. The heaviest cut is at the center of the boss on account of the draft given the forging by the dies used in producing the piece. The work was formerly done on a horizontal milling machine by clamping the pieces in a string fixture, loading at one end while the cutting was going on at the other end.

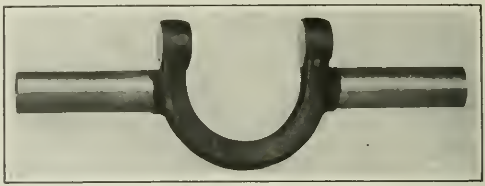

Fig. 1. Clutch Shifter Yoke Forging to be milled

On the Becker milling machine the cutter arbor is provided with four 6-inch face milling cutters, spaced the proper distances apart. The lower end of this arbor is piloted in a removable bracket that clamps within the ways used for the vertical travel of the milling machine table. The forgings, of course, the shanks of which have been previously rough-turned, are clamped in pairs in the rotary fixture. The fixture, when completely loaded, holds sixteen forgings. The ends of the forgings are located against stops for the milling operation. The straps or clamps that hold the work are of the three-point bearing type, two of the points being on the shanks of the yokes, while the third rests on the body of the fixture.

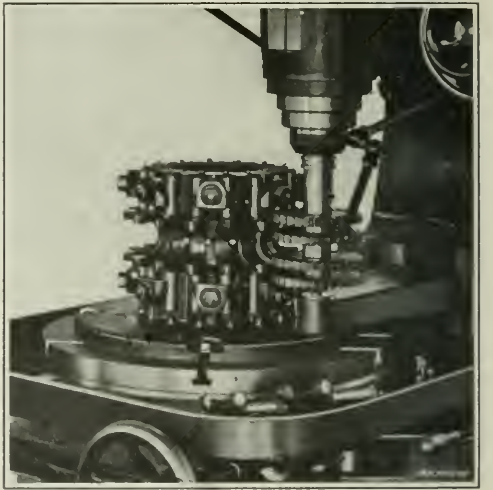

Fig. 2. Continuous Milling Fixture for Becker Vertical Miller

The work-holding fixture rotates continuously at a speed of ten inches per minute. This gives the operator ample time to remove the work and insert new pieces without stopping the machine. The cutters revolve at 110 revolutions per minute and the production is 195 completed pieces per hour, each milled on four faces.

* * *

A calculating machine that will figure in duodecillions, adding, subtracting, multiplying and dividing, is being exhibited at the Panama-Pacific Exposition by the Burroughs Adding Machine Co., of Detroit, Mich. It is known as a non-listing calculator and has forty rows of nine keys each and forty wheels in the mechanism. The utmost capacity of the machine is within one unit of ten duodecillions. Written down, its capacity is, 9,999,999,999,999,999,999,999,999,999,999,999,999,999. The practical use for such a machine will be in making a number of additions simultaneously. The wide keyboard enables an operator to add from six to ten different sets of numbers, each running from three to six columns, without taxing or interfering with each other in the adding mechanism. It thus will perform work that would otherwise require six to ten individual machines for certain kinds of work where several parallel sums on a single page can best be set down simultaneously.

HOW WE CAME TO HAVE THE SLOCOMB SHOP MICROMETER

BY J. T. SLOCOMB*

Luther D. Burlingame, writing in the June number of MACHINERY, undertakes to tell "How We Came to Have the Micrometer Caliper," but when he finally sums up at the end of his article he shows a diagram of the Brown & Sharpe micrometer and the article is really "How We Came to Have the Brown & Sharpe Micrometer." To avoid such criticism, I will call this, "How We Came to Have the Slocomb Micrometer."

The principle of the micrometer is very old. The particular reading as commonly used on the sleeve and thimble, as far as I know, came from the Palmer patent. Mr. Burlingame says that I gave the impression that micrometer calipers were not used extensively during the period between 1885 and 1890. This is the impression that I meant to convey, and I think is well borne out by facts. We will admit that Mr. Sharpe brought from France in 1867 a Palmer micrometer, but it was in 1877—or ten years later—that they made their first one-inch micrometer, which goes to show that his conception of the value of the micrometer for machine shop purposes was not great.

Horace Thurston, who had charge of the tool department at the Brown & Sharpe works, writes as follows: "I severed my connection with the Brown & Sharpe Mfg. Co. July, 1882. Up to that time the micrometer was in very little use, there being only two or three in the entire plant, I being the owner of one."

Henry Corp who was employed on the third floor where they made sewing machines and other small work and where I should expect to find micrometers in use, if anywhere, says, "I regret to say that I cannot give you any accurate information on that subject as I was at work on the third floor where there would not be much use for micrometers."

Charles Corp, Edward Parks and George Greene, who worked at the Brown & Sharpe plant at the time I was there, agree with me that micrometers were very little used and that perhaps half the men owned one-inch micrometers, but as far as they knew, there was not a two-inch tool in use anywhere except the one that belonged to Mr. Burnham and that I referred to in the article in the December number.

I have a letter from Thomas Craig in which he says, "I commenced work for the B. & S. Mfg. Co. Thursday, December 6, 1877, at 1 P. M. As near as I can remember they had just a few one-inch micrometers in use in the shop. Some time about 1880 they started to make a lot of fifty one-inch micrometers. They gave the contract to a fly-by-night machinist by the name of Smith, but he flew before the contract was finished. I can't remember fully who finished them—I do know that one of them was in the tool-room when I took charge. It was only partly finished, so out of it I made the first thread micrometer that was ever made, and it was in use in and out of the tool-room for many years before any were made for sale.

"Did I ever tell you of the joke that I played on George Richard, the inspector, with this old thread micrometer? You see I was the only one who knew how to read it, so once upon a time I was requested to make personally two studs somewhat like the enclosed sketch. The ½ by 13 thread I was told must be just standard, so I got all the parts the same as the sketch except the thread. I got the thread on the first one that I cut 0.001 inch small, so I made the other just the same; when they came to George for inspection he went to the tool-room for the thread micrometers and, of course, he had to come to me to tell him how to read them, so you can see the joke. They passed inspection O. K. I am very sure that Brown & Sharpe did not make any two-inch micrometers before Mr. Spalding came there from the Victor Sewing Machine Co. I think that the first one we ever had was a Victor—just when we got it I don't remember, but think it was somewhere about the time that you say—1884 or 1885."

I have lately visited A. W. Handy in Portland, Me. Mr. Handy worked for the Brown & Sharpe Mfg. Co., beginning in 1862 and leaving in 1880. He built many of the B. & S. machine tools by contract. He told me that while he was in the company's employ few micrometers were made, and these were made to fill orders, being used principally by the brass manufacturers in Connecticut for measuring sheet brass. The design apparently was something between the Palmer and a suggestion made by the brass manufacturers. Mr. Handy said that micrometers were not used then for machine shop purposes. Before the Victor Sewing Machine Co. was bought out by the Brown & Sharpe Mfg. Co., the latter made micrometers with a diagonal revolution line on the sleeve, so cut as to correct inaccuracy of the pitch of the screw; but with the goods purchased from the Victor Sewing Machine Co. there was a precision screw made by the Pratt & Whitney Co., Hartford, Conn., and this was afterwards used for making accurate micrometer screws.

The first micrometer I ever saw was one made by A. J. Wilkinson at Hyde Park, Mass. This was in 1884. It was a one-inch caliper and had a covered screw. Mr. Wilkinson was making them in a factory devoted to dental instruments. The machinist who showed me this caliper said, "It is a useful tool to gage wire with," and I believe that he expressed the general opinion of micrometers at that time. They were not machine shop measuring instruments.

During my stay in the Brown & Sharpe works—from 1885 to 1890—I thought I saw the possibility of micrometer calipers, although I did not at that time contemplate going into business. In 1893 I was in business and was looking about for something to manufacture. It occurred to me that the micrometer was something that could be developed into a valuable machine shop tool. I had had a good deal of experience in machine shops and thought I knew how to design a micrometer to cover machine shop requirements. It was practically the same problem as taking a lathe that was used for experimental purposes and improving upon it or redesigning it for heavy-duty machine shop service.

Perhaps there have been few tools gotten out that have been so much misunderstood as the Slocomb micrometer. Because we left off some of the metal polish on the frame, people thought this part cast iron and formed the impression that the rest of the tool was in keeping with it. A well-known maker of machine tools a good many years ago made screw machines with the bed planed and polished all over. The rest of the machine was of a type common to that period with short and small bearings and weak drive, and was what would be called today generally inefficient.

Now as a comparison with Slocomb micrometers, suppose at that time some one had designed a screw machine with all the modern features but left off the polish on the bed; would this new machine have been considered cheap or inferior? This was exactly the case with the Slocomb micrometer. I designed a form of bearing nuts that increased surface of thread contact about four times over what was common without increasing the size or weight materially. I put in an all tool steel screw considerably larger in diameter than the regular one without increasing the outside diameter of the tool materially. I put in a solid anvil and an improved form of adjustment that made these parts more substantial and more easily adjusted. I put a spring between the nuts arranged in such a way that there is a slight uniform friction throughout the range of the screw regardless of the wear of parts. This spring tension allows the micrometer to be screwed down upon the work, taken off and the measurement read without danger of the screw's turning of its own accord. I designed a new style of I-beam frame, providing for the greatest stiffness without increasing the weight. Altogether, I designed what others call now the heavy-type micrometer, but what I call the high-duty Slocomb micrometer, and put this into such shape that it is accurate, easy to handle, very durable and moderate in price. It is evident that this I-beam frame could not well be finished in bright metal. I could have sand-blasted and nickel-plated them, but nickel-plate was in disrepute in machine shops. The black enamel is a non-conductor of heat and for other reasons seemed the most appropriate finish.

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* General Manager, J. T. Slocomb Co., Providence, R. I.

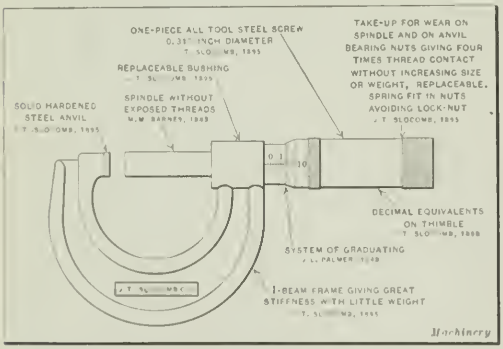
In 1894 I made a precision screw and designed and constructed a special lathe so made that the accuracy of this screw is surely duplicated in the work. The trouble in doing this with regular lathes is that the lead-screw is too far off one side of the cutting tool so that any irregularities in the smoothness of carriage is manifested in inaccurate work. With this new lathe and new large precision screw, I was able to cut accurate threads on tool steel, something that no one else has been able to do commercially so far as I know. This accurate tool steel screw was the greatest boost the micrometer ever had for machine shop requirements.

Mr. Burlingame mentions my design patent April 13, 1897, which covers the design of frame, but has neglected to mention my other patent which covers the important part of the construction. The screw thread micrometer referred to in Mr. Burlingame's article which he says Mr. Hiscox showed Mr. Whitehead is probably the micrometer referred to in Mr. Craig's letter.

Many attempts have been made to make micrometers with more than one-inch range of measurement. This I have always contended is on the wrong track. In a shop of more than one-man power, more than one micrometer is necessary and they may as well be of different sizes. A micrometer with attachments is unreliable. A micrometer of two- or three-inch capacity is too heavy to use on small work, and if well made a combination micrometer would cost as much as several separate tools. A set of micrometers will last longer than one and there are several other reasons for having the one-inch range only.

Mr. Burlingame says, "To illustrate from how many sources the features of the present-day micrometers have been derived, reference may be made to Fig. 25, where some of these features together with their inventors are indicated." The illustration referred to shows the Brown & Sharpe micrometer and ignores all others. According to my opinion of the requirements of a first-class micrometer, the diagram should be as shown in the accompanying illustration.

The locking device referred to by Mr. Burlingame is a device which converts the micrometer caliper into a snap gage. When used it destroys the best feature of the micrometer, and I cannot admit that it is a valuable improvement to the micrometer caliper.



Improvements in Micrometer Caliper made by J. T. Slocomb and others

* * *

One of our contemporaries advises its readers that the Canadian public has been warned by its government against dealing with German or Austrian firms, because this is an offense punishable by three to seven years of penal servitude. It is further mentioned that certain firms in the United States have been attempting to sell in Canada various lines of German or Austrian goods, in this case, paper and paper specialties, as well as a wide range of other goods, and that the department of customs in Canada has issued stringent instructions to custom officers to be on the lookout for goods of this character, and that all German made goods that pass the international boundary will be confiscated.

THE RELATION BETWEEN PRODUCTION AND COSTS*

Manufacturers in general recognize the vital importance of a knowledge of the cost of their product, but few of them have a cost system on which they are willing to rely under all conditions. While it is possible to record quite accurately the amount of material and labor used directly in the production of an article, and several systems have been devised which accomplish this result, there does not yet seem to have been devised any system of distributing that portion of the expense known variously as indirect expense, burden or overhead, in such a manner as to make us have any real confidence that it has been done properly.

There are in common use several methods of distributing this expense. One is to distribute the total indirect expense, including interest, taxes, insurance, etc., according to the direct labor. Another is to distribute a portion of this expense according to direct labor, and a portion according to machine hours. Other methods distribute a certain amount of this expense on the material used, etc. Most of these methods contemplate the distribution of *all* of the indirect expense of the manufacturing plant, however much it may be, on the output produced, no matter how small it is. If the factory is running at its full, or normal, capacity, this item of indirect expense per unit of product is usually small. If the factory is running at only a fraction of its capacity, say one-half, and turning out only one-half of its normal product, there is but little change in the total amount of this indirect expense, all of which must now be distributed over half as much product as previously, each unit of product thereby being obliged to bear approximately twice as much expense as previously.

When times are good, and there is plenty of business, this method of accounting indicates that costs are low; but when times become bad and business is slack, it indicates high costs due to the increased proportion of burden each unit has to bear. During good times, when there is a demand for all the product that can be made, it is usually sold at a high price and the element of cost is not an important factor. When business is dull, however, a high price for the product is not obtainable, and the question of how low a price the product may be sold at is of vital importance. Cost systems, as generally operated at present, show under such conditions that costs are high and, if business is very bad, they usually show a cost far greater than the amount obtainable for the goods. In other words, present systems of cost accounting go to pieces when they are most needed. This being the case, many have felt for a long time that there is something radically wrong with the present theories on the subject.

As an illustration, a man found that his cost on a certain article was 30 cents. When he found that he could buy it for 26 cents, he gave orders to stop manufacturing and to buy it, saying he did not understand how his competitor could sell at that price. He seemed to realize that there was a flaw somewhere, but he could not locate it. His expense consisted of labor 10 cents, material 8 cents, and overhead 12 cents. He was running his factory at less than half its capacity, possibly at one-third. The overhead on this article, if the factory were running full, would be about 5 cents; hence the cost would be only 23 cents. The possibility that his competitor was running his factory full suggests itself at once as an explanation.

The next question that suggested itself was how the 12 cents overhead, which was charged to this article, would be paid if the article was bought. The obvious answer was that it would have to be distributed over the product still being made, and would thereby increase its cost. In such a case it would probably be found that some other article was costing more than it could be bought for; and, if the same policy were pursued, the second article should be bought, which would cause the remaining product to bear a still higher expense rate. If this policy were carried to its logical conclusion, the manufacturer would be buying everything before long, and be obliged to give up manufacturing entirely.

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* Abstract of a paper by H. L. Gantt, read before the Buffalo meeting of the American Society of Mechanical Engineers, June, 1915.

The illustration cited is not an isolated case, but is representative of the problems before a large class of manufacturers, who believe that *all of the expense, however large, must be carried by the output produced, however small.* This theory of expense distribution is quite widespread, and clearly indicates a policy, which in dull times would, if followed logically, put many of our manufacturers out of business.

Most of the cost systems in use, and the theories on which they are based, have been devised by accountants for the benefit of financiers, whose aim has been to criticise the factory and make it responsible for all the shortcomings of the business. In this they have succeeded admirably, largely because the methods used are not so devised as to enable the superintendent to present his side of the case. The sound theory of cost keeping, however, is that one of its prime functions is to enable the superintendent to know whether or not he is doing the work he is responsible for as economically as possible, which function is ignored in the majority of the cost systems now in general use. Many accountants, who make an attempt to show it, are so long in getting their figures in shape that they are practically worthless for the purpose intended, the possibility of using them having past. In order to get a correct view of the subject, we must look at the matter from a different and broader standpoint. The following illustration seems to put the subject in its true light:

Suppose that a manufacturer owns three identical plants, of an economical operating size, manufacturing the same article—one located in Albany, one in Buffalo and one in Chicago—and that they are all running at their normal capacity and managed equally well. The amount of indirect expense per unit of product would be substantially the same in each of these factories, as would be the total cost. Now suppose that business suddenly falls off to one-third of its previous amount and that the manufacturer shuts down the plants in Albany and Buffalo, and continues to run the one in Chicago exactly as it has been run before. The product from the Chicago plant would have the same cost that it previously had, but the expense of carrying two idle factories might be so great as to take all the profits out of the business; in other words, the profit made from the Chicago plant might be offset entirely by the loss made by the Albany and Buffalo plants. If these plants, instead of being in different cities, were located in the same city, a similar condition might also exist, in which the expense of the two idle plants would be such a drain on the business that they would offset the profit made in the going plant.

Instead of considering these three factories to be in different parts of one city, they might be considered as being within the same yard, which would not change the conditions. Finally, we might consider that the walls between these factories were taken down and that the three factories were turned into one plant, the output of which had been reduced to one-third of its normal volume. Arguing as before, it would be proper to charge to this product only one-third of the indirect expense charged when the factory was running full. If the above argument is correct, we may state the following general principle: *The indirect expense chargeable to the output of a factory bears the same ratio to the indirect expense necessary to run the factory at normal capacity, as the output in question bears to the normal output of the factory.*

This theory of expense distribution explains many things which were inexplicable under the older theory, and gives the manufacturer uniform costs as long as the methods of manufacture do not change. Under this method of distributing expense there will be a certain amount of undistributed expense remaining whenever the factory runs below its normal capacity. A careful consideration of this item will show that it is not chargeable to the product made, but is a business expense incurred on account of maintaining a certain portion of the factory idle, and chargeable to profit and loss. Many manufacturers have made money in a small plant, then built a large plant and lost money for years afterwards, without quite understanding how it happened. This method of figuring gives a clear explanation of that fact, and warns us to do everything possible to increase the *efficiency* of the present plant, rather than to increase its *size.*

This theory explains clearly why some large combinations of manufacturing plants have not been as successful as was anticipated, and why the small, but newer plant, is able to compete successfully and make money, while the combinations are only just holding their own.

The idea so prevalent a few years ago, that in the industrial world money is the most powerful factor, and that if we only had enough money, nothing else would matter very much, is beginning to lose its force, for it is becoming clear that *the size of a business is not so important as the policy by which it is directed.* The view of costs so largely held, namely, that *the product of a factory, however small, must bear the total expense, however large,* is responsible for much of the confusion about costs and hence leads to unsound business policies.

If we accept the view that the article produced shall bear only that portion of the indirect expense needed to produce it, our costs will not only become lower, but relatively far more constant, for the most variable factor in the cost of an article under the usual system of accounting has been the "overhead," which has varied almost inversely as the amount of the product. This item becomes substantially constant if the "overhead" is figured on the normal capacity of the plant.

Of course a method of accounting does not diminish the expense, but it may show us where the expense properly belongs, and give us a more correct understanding of our business. In our illustration of the three factories, the cost in the Chicago factory remained constant, but the expense of supporting the Buffalo and Albany factories in idleness was a charge against the business, and properly chargeable to profit and loss. If we had loaded this expense on the product of the Chicago factory, the cost of the product would probably have been so great as to have prevented our selling it, and the total loss would have been greater still. When the factories are distinctly separate, few people make such a mistake, but where a single factory is three times as large as is needed for the output, the error is frequently made, with results that are just as misleading. As a matter of fact it seems that the attempt to make a product bear the expense of a plant not needed for its production is one of the most serious defects in our industrial system today, and farther reaching than the differences between employers and employes.

The problem that faces us is then first to find just what plant, or part of a plant, is needed to produce a given output, and to determine the "overhead" expense on operating that plant or portion of a plant. This is primarily the work of the manufacturer, or engineer, and only secondarily that of the accountant, who must, as far as costs are concerned, be the servant of the superintendent. In the past, in almost all cost systems the amount of "overhead" to be charged to the product, when it did not include *all* the "overhead," was more or less a matter of judgment. According to the theory now presented, it is not a matter of judgment, but can be determined with an accuracy depending upon the knowledge the manufacturer has of the business. Following this line of thought it should be possible for a manufacturer to calculate just what plant and equipment he ought to have, and what the staff of officers and workmen should be to turn out a given profit. If this can be correctly done, the exact cost of a product can be predicted. Such a problem cannot be solved by a cost accountant of the usual type, but is primarily a problem for an engineer, whose knowledge of materials and processes is essential for its solution. Having made an attempt to solve a problem of this type, one of the most important functions we need a cost system to perform, is to keep the superintendent continually advised as to how nearly he is realizing the ideal set, and to point out where the shortcomings are.

Many are accustomed to this view point when treating individual operations singly, but few have as yet made an attempt to consider that this idea might be applied to a plant as a whole, except when the processes of manufacture are simple and the products few in number. When, however, the processes become numerous or complicated, the necessity for such a check becomes more urgent, and the cost keeper who performs this function becomes an integral part of the manufacturing system, and acts for the superintendent, as an inspector, who keeps him advised at all times of the quality of his own work. This conception of the duties of a cost keeper does not at all interfere with his supplying the financier with the information he needs, but insures that information shall be correct, for the cost keeper is continually making a comparison for the benefit of the superintendent, of what has been done with what should have been done. Costs are valuable only as comparisons, and comparisons are of little value unless we have a standard, which it is the function of the engineer to set.

Lack of reliable cost methods has, in the past, been responsible for much of the uncertainty so prevalent in our industrial policies; but with a definite and reliable cost method, which enables us to differentiate between what is lost in manufacturing and what is lost in business, it will usually become easy to define the proper business policy.

* * *

TOOLS FOR MAKING LAMP WICK-TUBES AND BURNER CAPS

BY R. TOEPLITZ*

The use of an automatic press for making the wick-tube for a kerosene lamp is quite generally understood, but the dies used for this purpose are expensive, and unless there is a large amount of work to be done it would not pay to make them. Furthermore, the working of hard metal, in gages ranging from No. 26 up, will be found unsatisfactory when it is attempted to do the work in an automatic press. The dies which form the subject of this article may be used in a standard power press, and they produce a finished wick-tube of the form shown in Fig. 1 in three operations.

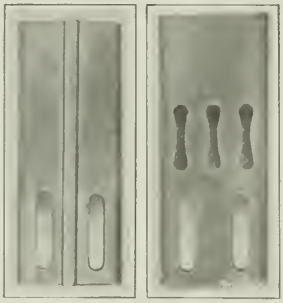

Fig. 1. Opposite Sides of Wick-tube to be made

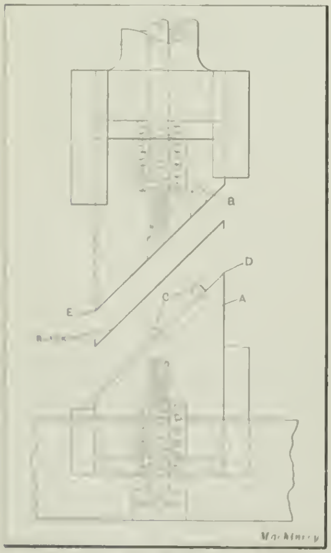

Fig. 2. Bending Die used to prepare Edges of Blank for making Seam

The first operation consists of perforating the blank and cutting it off from the stock; the finished blank is illustrated at the left-hand side of Fig. 3, and the punch and die for performing this operation is shown at the right-hand side of the same illustration. It will be seen that the punch is provided with a spring stripper which engages the stock and holds it down in place on the die. As the ram continues to descend, the perforating punches come into operation and cut the seven holes in the blank. Then the continued movement of the ram brings the shear blade *A* into operation, which cuts the finished blank from the stock. It will be evident that the shear blade carried by the punch-holder works in conjunction with the side of the die blank in cutting off the blank.

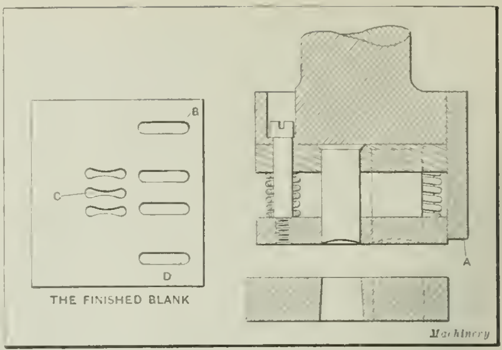

Fig. 3. Finished Blank and Punch and Die for producing it

The second operation consists of bending the edges of the blank preparatory to forming the seam in the third and final operation. The punch and die used for bending the edges, and the form to which the blank is bent, are illustrated in Fig. 2. It will be seen that the punch and die carry two steel blocks *A* and *B*, the faces of which are inclined at an angle of 45 degrees. These blocks slide in their holders, and they are supported by stiff compression springs. The work is located by means of pins *C* carried in the block *A*, which enter the holes *B*, *C*, and *D* in the blank (Fig. 3); and it will be seen that clearance spaces are provided to enable the pins *C* to enter the block *B*. When the press is tripped, the block *B* descends and the blank is securely held between the blocks *A* and *B;* then as the ram continues to descend the springs which support the blocks are compressed,

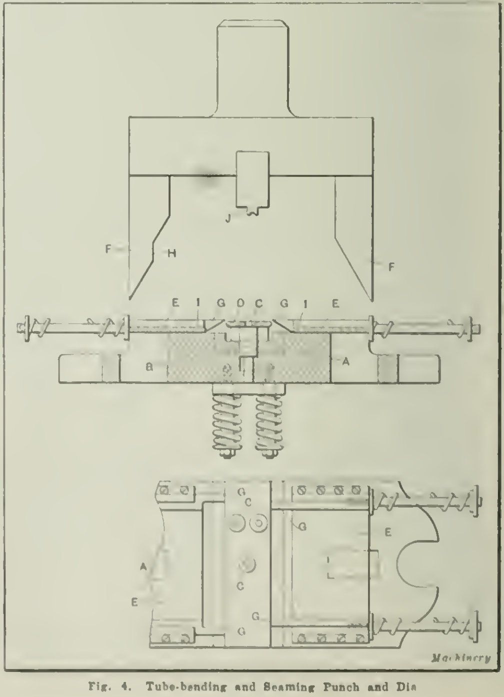

Fig. 4. Tube-bending and Seaming Punch and Die

causing the blocks to slide back into their holders. This results in bending one edge of the blank over the corner *D* of the block *A*, while the opposite edge of the blank is bent over the corner *E* of block *B*. After the stroke of the press has been completed, the blank has been brought to the form shown in the illustration.

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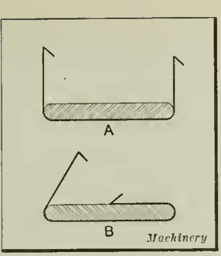

Fig. 5. Diagram showing Successive Steps in Tube-bending Operation

The third and final operation in the production of a lamp wick-tube according to this method is performed by the punch and die illustrated in Fig. 4, and consists of bending the tube to the required shape and closing in the seam on the side. It will be seen that a steel block *A* is fitted into the bolster and that this block has a groove cut in it, the width and depth of which is equal to the dimensions of the wick-tube which is to be made. A spring pad *B* is provided with three pins *C*, which enter holes in the blank for the purpose of locating it in the required position in the die. After the work has been set in place, the mandrel *D* is laid on top of it, the three pins *C* serving the additional purpose of holding the mandrel in place.

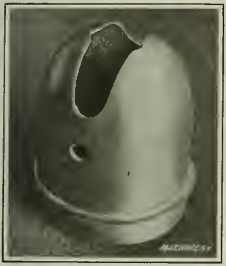

Fig. 6. Lamp Burner Cap to be pierced and slotted

It will be seen that two slides *E* are carried on the bolster. When the press is tripped, the ram descends and the cams *F* carried in the punch-holder engage these slides *E*, causing them to move in toward the center of the die. This results in the tapered ends *G* of the slides *E* engaging the mandrel *D* and pushing it down into the groove in the steel block *A*. The result of this movement is that the blank is bent up over the sides of the mandrel, bringing it to the form shown at *A* in Fig. 5. When the blank has been brought to this condition, the vertical surface *H* of the left-hand cam *F* comes into contact with the left-hand slide *E*, with the result that the movement of this slide is temporarily stopped. At the same time, the right-hand cam *F* imparts an uninterrupted movement to the slide *E* which it actuates, causing the flat end *I* of the finger to slide over the top of the mandrel *D* and bend the right-hand side of the blank down into the position shown at *B* in Fig. 5. By this time the upper inclined surface on the left-hand cam *F* has reached the slide *E* and causes the flat end *I* of this slide to pass over the top of the mandrel, which completes the bending operation. The ram of the press has now descended far enough to bring the seam closing punch *J* into operation, which closes the seam along the sides of the wick-tube. As the ram rises, the spring pad *B* lifts the finished tube from the die, after which it is merely necessary to knock out the mandrel.

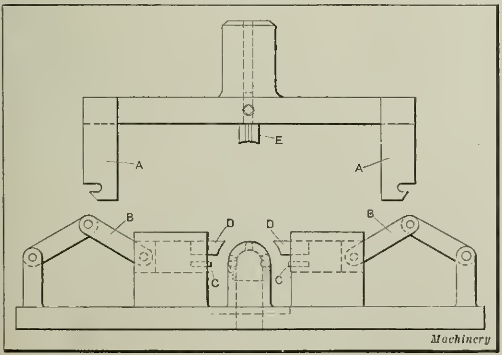

Fig. 7. Burner Cap Piercing and Slotting Punch and Die

Fig. 6 shows a lamp burner cap which has the final operation performed on it by the punch and die illustrated in Fig. 7. After the blanks which form the burner caps have been drawn up and trimmed, it is necessary to pierce the two holes in the sides and cut the slot in the top of the cap; and for this purpose the punch and die illustrated in Fig. 7 have been found to give very satisfactory results. When the punch descends, the arms *A* cause the links *B* to be straightened out to bring the piercing punches *C* and slot-cutting punches *D* into operation. Further movement of the ram causes the arms *A* to bend the links *B* down so that the punches *C* and *D* are withdrawn. The punch *E* then comes into operation and completes the cutting of the slot in the top of the cap. As the ram of the press rises the slots at the bottom of the arms *A* lift the links *B* back to the starting position shown in the illustration, after which the finished cap is removed from the die and a fresh shell subtituted in its place ready for the successive stroke of the press.

* * *

TUNGSTEN PRICES SOARING

At the outbreak of the European war the American tungsten market was very dull and prices were comparatively low, being about $6.50 per "unit" (20 pounds) or 32½ cents a pound. The ores mined in Burma, Australia and other countries came into competition with the American ores, and many of the prospects were unworked. Tungsten is used in high-speed steels, and the demand fluctuates with the steel trade. There is a smaller but growing demand for tungsten for incandescent electric lamp filaments, for electric contacts, for wire used in metal work, etc., but when the orders for shrapnel shells and other war materials began to be filled, the demand for high-speed steel for tools with which to turn and bore the shells became very great. Great Britain placed an embargo on the shipment of tungsten ores from every part of the British Empire, so that the Burmese, Australian and New Zealand supplies were cut off, and it is said that very little ore has come from Portugal. Following these events the price rose until $12.50 or more per unit has been paid for ores carrying 60 per cent and over of tungsten trioxide. The price of tungsten now is $2.25 a pound, and as there is approximately 18 per cent tungsten in most high-speed steels, the effect of the increase of its price on the cost of high-speed steels is considerable. High-speed steel makers probably will try to hold the price of tool steel as low as possible, but if tungsten continues to rise in price it will be out of the question to sell it at the prices heretofore obtained. The situation is grave, as tungsten is becoming very scarce and is hardly obtainable at any price.

* * *

The life of a big gun, taking its life to be that of the period when actually discharging projectiles, is very short indeed. This was brought out in striking fashion in a lecture recently delivered by Lieut.-Col. A. G. Hadcock before the Royal Institution in London. Lieut.-Col. Hadcock referred to the ephemeral life of the butterfly, which was stated to be only twenty-four hours, but its life is long compared with that of a 13½-inch gun. The time required to build a 13½-inch gun may be from ten to twelve months, but its actual life is almost an infinitesimal fraction of this period. The author pointed out that its life was equal only to the time that it was in use, and supposing that an incessant stream of projectiles should be fired from a gun as rapidly as the explosions could take place and deliver their energy, the actual life would be only twelve seconds!

* * *

The element selenium has the peculiar property of changing its electrical conductivity according to the conditions of light to which it is subjected. Different mechanical pressures also change the electrical conductivity of selenium. In fact, by applying great pressure it is claimed that the conductivity may be multiplied more than a thousand times.

AVOIDING HARD CAST IRON IN OXY-ACETYLENE WELDING[*]

BY M KEITH DUNHAM[†][‡]

Why is it that on a casting which has been welded you cannot mill down the surface, or that you break drill after drill in a single hole? Has this happened so often that you have lost faith in oxy-acetylene welding and condemn the process? If you have it is up to you to rearrange your ideas, for cast iron can be welded with 100 per cent efficiency. Yes, the weld can be made even softer and stronger than the casting, if the elementary principles governing the condition of the metal are understood and used by the operator. Welding a casting merely means that the break is fused together by heat—in other words, it is recast—but because the flame is concentrated and of an extremely high temperature, it is necessary only to recast a small portion of the metal. If the welder realizes that welding with the oxy-acetylene flame is simply a recasting process locally applied, he will recall that the foundryman has had practically the same experiences and found ways of producing a hard or a soft casting as desired.

It is well known that the foundry using scrap materials, *i. e.*, old castings, with the addition of no pig iron, makes hard, brittle castings. We may infer from this that the continued melting of cast iron causes it to become hard, so that if we weld the break, using a part of the same casting as a filler rod, the weld will be harder than the adjoining sections of the metal. The iron loses certain characteristics each time it is melted, *i. e.*, carbon passes off in the form of a gas, and iron oxide (rust) is deposited in the casting by the oxygen of the air (or of the welding flame) uniting with the iron. To overcome this, the welder must use a filler rod which will overcome the hardening action of melting by preventing decarbonization, and a flux that prevents the formation of iron oxide on the metal or removes it when formed.

Silicon is the element which tends to soften cast iron and manganese the one which hardens it. Therefore, the welding rod should be rich in silicon (about 4 per cent) and as low as possible in manganese. Naturally, it must be free from sand, dirt and rust. The purchase of such a rod is not at all difficult, but the ordinary foundry is not equipped to furnish it. Economy in the purchase of welding rods should not be too closely figured; from eight to twelve cents per pound, depending upon quantity, is a fair price. *Without a rod meeting these requirements, a soft weld on cast iron is impossible.* The flux used should have the quality of flowing the metal readily; but more than that, it must remove the iron oxide from the weld, and also form a film over the molten metal to protect it from oxidation. Equal proportions of carbonate and bicarbonate of soda is one of many combinations which will perform these functions satisfactorily. Ordinary borax or salt, which are in very common use, do not meet the requirements, although a small percentage of borax may be added to the soda flux.

Cast iron melts at about 2300 degrees F., while the oxy-acetylene flame has a temperature in excess of 6000 degrees F. Thus in the welding operation, the tip of the blue cone of the flame should be held a little distance from the surface of the weld, never in contact with it, as the force of the flame will break the protecting film of the flux and result in "burnt" metal, which is sometimes manifested in machining by hard spots. Too many operators have a tendency to use the force of the flame to burn into the break, rather than to properly prepare the metal for welding; and unless the burnt metal caused by this action is thoroughly scraped out by the welding rod, hard spots will be frequent in the line of the weld, and result in the strength being seriously reduced. The casting should always be properly prepared, the break ground or chiseled out in a wide vee and thoroughly cleaned, both in the vee and for a portion one or two inches wide on each side, to eliminate any possible danger of dirt getting into the weld. This also provides for the filling in of a better quality of cast iron (from the welding rod) and therefore producing a softer weld than would be the case if the old material of the casting were remelted and incorporated in the weld.

Nearly every mechanic knows the effect of chilling cast iron, *i. e.*, that it becomes hard and brittle. It is not necessary to dip the hot casting into water to accomplish this—allowing the weld to cool in the open air or having the casting in contact with a cool metal surface will do it just as well. Very often the welding is performed on a metal table in order to facilitate alignment of the broken pieces. Suppose the casting to be welded is a flat section; a very natural thing for the welder to do is to lay it on the welding table and by simply butting the edges of the break together, alignment is secured and the weld made. No thought is given to the conduction of heat from the weld by the cold table surface, with the result that the heat is carried away from the weld and at least the bottom part of the weld is chilled and made hard. It is also a fact that a casting, welded under these conditions may be warped, but that is another story.

If it is essential for a weld to be made under these conditions, use asbestos paper or fire-brick to prevent the conduction of heat; but wherever and whenever possible, make the weld in a forge, or use a charcoal fire, a gas torch or an oil torch, both to preheat and to effect slow cooling. The safe and economical way is to use one of these agencies to bring the line of welding up to the red heat, make the weld, then use the same agency to again bring the work slowly back to a red heat, and cover it with a good non-conductor such as asbestos, mica or ashes. When the casting is cold, it will sometimes be found that the surface is hard. This is merely the film formed by the flux and can be destroyed by using an old file while the casting is at a red heat, or it can be knocked off with a hammer or roughly ground. Securing a soft cast-iron weld is merely dependent upon the application of well-known metallurgical principles; there is nothing mysterious about it, and if these principles are employed, the resulting weld can be easily machined instead of constituting one of those jobs that all the machinists in the shop try to dodge.

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[*] For other articles on the subject of oxy-acetylene welding and cutting published in MACHINERY see also "Importance of the Purity of Oxygen used in Cutting Steel," June, 1914, "A New Field for the Oxy-acetylene Welding Torch," April, 1914, and other articles there referred to.

[†] M. Keith Dunham was born in Massachusetts in 1882. He was president and general manager of the Waterhouse Welding Co., Boston, Mass., from its organization in 1908 until selling out his interest in 1914. Mr. Dunham has made a special study of gases, and is now acting as a consulting engineer on the construction and use of oxy-acetylene apparatus.

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* * *

MOUNTING BLUEPRINTS

BY J. N. HOLLENBECK[*]

There are many objections to the use of loose blueprints in the shop, among which the following may be mentioned. The prints soon become soiled, they are easily torn, and loose prints are more likely to get lost. For this reason the practice of mounting blueprints is steadily increasing. For mounting a blueprint, any good grade of cardboard, or better still, a piece of sheet fiber about 1/16 inch in thickness and a little larger than the print, will be found satisfactory. The following method of mounting has been used by the writer and found to give good results. The first step is to give both sides of the sheet of fiber or cardboard a coat of orange shellac, and then set it up on edge to dry. After the shellac is thoroughly dry, a second coat should be applied to the side on which the blueprint is to be mounted. Then apply a similar coat of shellac to the back of the blueprint and allow the blueprint and mount to stand until the shellac is nearly dry, *i.e.*, until the surfaces are so sticky that when touched with the finger tip, the mount can almost be lifted from the table. The blueprint should then be placed upon the mount and thoroughly rubbed down first with the hands and then with the roller. After allowing the mounted print to stand for four or five hours to allow the shellac to set thoroughly, one or two coats of white shellac should be applied over the entire surface of the blueprint to give it a glossy appearance and to protect it from grease and dirt. The prints must be thoroughly dry before applying the white shellac.

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COMPOUND INDEXING ON THE MILLING MACHINE*

BY JOHN A. HINCKLEY†

In reading up on the subject of compound indexing on the milling machine, I was unable to find anything better than a "guess and guess again" method. After giving the subject some thought, I developed the following method which may prove of interest to readers of MACHINERY. Suppose it is desired to cut 77 teeth on a gear blank and that an index plate with a 77-hole circle is not available. The method of procedure would be as follows: We know that the ratio of the worm and worm wheel is 40 to 1; hence, in order to cut 77 teeth it is necessary to turn the worm through $\frac{40}{77}$ revolution at each setting. The factors of 77 are 7 and 11. Hence we have:

$$\frac{x}{7} + \frac{y}{11} = \frac{40}{77} \qquad (1)$$

Where $\frac{x}{7}$ = the fraction of a complete turn of the handle for the first setting;

$\frac{y}{11}$ = the fraction of a complete turn of the handle for the second setting.

The sum of the quantities $\frac{x}{7}$ and $\frac{y}{11}$ must, of course, equal $\frac{40}{77}$ of a complete turn of the handle. Clearing Formula (1) of fractions, we have:

$$11x + 7y = 40.$$

Then solving the preceding equation for the value of y gives:

$$y = \frac{40 - 11x}{7}.$$

We know that x and y must both be integral numbers, and hence we can assign to x various integral values, substitute these values in the preceding expression for the value of y, and solve for y, continuing this method of procedure until an integral value of y is found. A convenient way of arranging the work is shown in the following.

x	$y = \frac{40 - 11x}{7}$
1	Not integral
2	Not integral
3	1

Substituting the values of 1 and 2 for x results in non-integral values of y, but when the value 3 is substituted for x, the corresponding value of y is found to be 1. Thus:

$$\frac{x}{7} + \frac{y}{11} = \frac{40}{77};$$

$$\frac{3}{7} + \frac{1}{11} = \frac{40}{77}.$$

As applied to the milling machine index head, this means that the movement resulting from turning through 3 holes in a 7-hole circle plus the movement resulting from turning through one hole in a 11-hole circle will give the required setting. By multiplying both terms of either fraction by the same number, the value is not changed, and the denominator may be made to assume a value corresponding with the number of holes in a circle which is available on some index plate. Suppose, for instance, that we multiply both the numerator and denominator by 3. We then have:

$$\frac{3}{3} \times \frac{3}{7} + \frac{3}{3} \times \frac{1}{11} = \frac{40}{77}$$

$$\frac{9}{21} + \frac{3}{33} = \frac{40}{77}$$

It will, of course, be evident that the preceding equation means that the required setting may be obtained by first moving through 9 holes in a 21-hole circle, and then moving through 3 holes in a 33-hole circle.

With this method it will always be the sum of the two fractions that is employed, for if the correct setting should be obtained by taking the difference of the fractions, the computed integral value of y would be required to have a minus sign, which would show at once that the difference of the two fractions was required. For example, suppose it is required to cut 66 teeth in a gear blank. Using the factors 3 and 22, we have:

$$\frac{x}{3} + \frac{y}{22} = \frac{40}{66};$$

$$22x + 3y = 40;$$

$$y = \frac{40 - 22x}{3}.$$

x	$y = \frac{40 - 22x}{3}$
1	6
2	Not integral
3	Not integral
4	—16

Substituting the preceding value of x and y in the equation, we have:

$$\frac{1}{3} + \frac{6}{22} = \frac{40}{66};$$

$$\frac{11}{33} + \frac{6}{22} = \frac{40}{66}.$$

$$\frac{4}{3} - \frac{16}{22} = \frac{40}{66};$$

$$\frac{44}{33} - \frac{16}{22} = \frac{40}{66}.$$

It will be evident from the preceding formulas, which represent possible methods of obtaining the required setting, that there are two different settings available, *i.e.*, 11 holes forward in a 33-hole circle and 6 holes forward in a 22-hole circle; or 44 holes forward in a 33-hole circle and 16 holes backward in a 22-hole circle. It should be noted that if the number of teeth to be cut is a prime number, compound indexing cannot be used.

* * *

CLEARANCE DRILLS FOR COUNTERSINKING HOLES

BY JOSEPH M. STABEL*

In drilling holes that are to be countersunk for screw heads, it is desirable to use a drill the diameter of which is equal to or slightly larger than the diameter of the countersunk hole at the bottom. When countersinking holes in parts that are thinner than the head of the screw, if a standard size of clearance drill is used, the hole must be enlarged by the countersink in order that the screw head will be even with the top surface of the part which it holds in place. The difficulty is that when a countersink is used for enlarging a hole that has been drilled under size, a burr is formed on the under side of the hole which, in many cases, requires an extra operation to remove it.

Many a die has had to be annealed after being finished because it pierced holes that were too small and required enlarging by a countersink. It has also been necessary to replace jig bushings by larger sizes for the same reason. For instance, the draftsman might specify on the drawing a "countersink for a No. 4 screw"; consequently, the toolmaker would naturally use the standard No. 4 screw, clearance drill, instead of the larger size which should have been used, owing to the thinness of the part to be held by the screw head. To avoid trouble of this kind, the accompanying table was computed. This table gives the sizes of clearance drills for various screw sizes and thicknesses of stock, and covers both the Brown & Sharpe and U. S. standard sheet metal gages within a range of thicknesses which were considered of the most practical importance. (A regular clearance drill will answer the purpose for metal thicker than about No. 5 B. & S. or No. 7 U. S. standard gage.) The top horizontal line of the table gives the screw size numbers; the second line, the diameter at the top of the screw head; the vertical column to the left, sheet metal gage numbers and decimal equivalents. In the body of the table are listed the sizes of clearance drills to use, expressed by numbers, letters and fractions.

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* For additional information on the subject of indexing on the milling machine and allied subjects published in MACHINERY see also "Indexing Attachments for Rack Milling," October, 1914; "Indexing Movements for Small Angles on Milling Machine," by P. J. Ryan, August, 1914; "Automatic Indexing Fixture for Cutting Internal Ratchet Gears," by Alfred Spangenberg, May, 1914; "Machining Automatic Chucking Machine and Lathe Turrets," by C. M. Conradson, September, 1913; "A New System for Locating Holes to be Bored on the Milling Machine," by George J. Murdock, April, 1912;; "Making a Precision Dividing Wheel," March, 1910; "Differential Indexing," January, 1903; and other articles there referred to.

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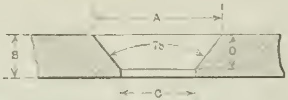
CLEARANCE DRILL SIZES FOR COUNTERSINKING HOLES



A = diameter screw head
B = thickness of metal
C = clearance hole
D = depth of countersink

Screw Size Numbers		1	2	3	4	5	6	7	8	9	10	12	14	16	18	20
Screw Head Sizes—A		0.149	0.176	0.204	0.229	0.256	0.283	0.312	0.340	0.364	0.387	0.439	0.492	0.545	0.597	0.650
B. & S. Gage, and Decimal Equivalents B																
5	0.1819	..	..	..	..	..	..	..	..	..	..	..	..	J	O	3/8
6	0.1620	..	..	..	..	..	..	..	..	..	..	..	1/4	19/64	S	Y
7	0.1442	..	..	..	..	..	..	..	..	..	..	1	I	21/64	V	Z
8	0.1284	..	..	..	..	..	..	..	..	13	8	D	N	S	Y	29/64
9	0.1144	..	..	..	..	..	..	22	17	10	7/32	H	P	3/8	27/64	31/64
10	0.1018	..	..	..	..	..	27	20	11	3	B	L	11/32	X	29/64	1/2
11	0.0907	..	..	..	..	30	25	15	4	A	F	5/16	T	Z	15/32	33/64
12	0.0808	..	..	..	31	29	19	9	2	1/4	I	P	3/8	27/64	31/64	17/32
13	0.0719	..	..	36	1/8	24	16	5	A	F	9/32	Q	W	7/16	31/64	35/64
14	0.0640	..	..	34	29	20	12	7/32	D	I	M	11/32	X	29/64	1/2	9/16
15	0.0570	..	42	31	27	17	8	1	F	9/32	N	T	13/32	29/64	33/64	9/16
16	0.0508	49	37	30	22	14	4	B	H	L	O	U	27/64	15/32	17/32	37/64
17	0.0452	45	34	28	19	11	7/32	D	I	19/64	P	3/8	27/64	31/64	17/32	37/64
18	0.0403	42	31	26	17	8	1	F	9/32	N	Q	W	7/16	31/64	35/64	19/32
19	0.0358	38	1/8	23	15	5	A	G	L	O	R	25/64	7/16	1/2	35/64	..
20	0.0319	37	30	21	14	4	B	H	M	O	R	X	29/64	1/2	35/64	..
21	0.0284	35	29	19	11	7/32	D	I	N	P	S	X	29/64	..	..	..
22	0.0253	33	28	18	10	2	1/4	J	N	21/64	S	Y	29/64	..	..	..
23	0.0225	32	27	17	8	1	1/4	9/32	5/16	Q	T	13/32	15/32	..	..	..
24	0.0201	31	25	16	7	1	F	9/32	5/16	R	23/64	Z	15/32	..	..	..
25	0.0179	1/8	24	15	6	A	F	L	O	R	23/64	..	..	..	..	..
26	0.0159	30	23	14	5	A	G	L	O	11/32	U	..	..	..	..	..
27	0.0141	30	22	13	4	B	G	M	P	11/32	U	..	..	..	..	..
28	0.0126	29	21	12	3	B	H	M	P	S	U	..	..	..	..	..
29	0.0112	29	20	12	3	C	H	19/64	21/64	S	3/8	..	..	..	..	..
30	0.0100	29	19	11	7/32	D	I	N	21/64	T	V	..	..	..	..	..

Screw Size Numbers		1	2	3	4	5	6	7	8	9	10	12	14	16	18	20
Screw Head Sizes—A		0.149	0.176	0.204	0.229	0.256	0.283	0.312	0.340	0.364	0.387	0.439	0.492	0.545	0.597	0.650
U. S. Standard Gage, and Decimal Equivalents B																
7	0.1875	..	..	..	..	..	..	..	..	..	..	..	..	J	5/16	23/64
8	0.1718	..	..	..	..	..	..	..	..	..	..	..	..	9/32	Q	25/64
9	0.1562	..	..	..	..	..	..	..	..	..	..	..	1/4	5/16	23/64	Z
10	0.1406	..	..	..	..	..	..	..	..	..	8	1	J	Q	W	7/16
11	0.1250	..	..	..	..	..	..	..	17	16	7	1/4	N	T	Z	29/64
12	0.1093	..	..	..	..	..	..	22	15	6	1	J	Q	W	7/16	31/64
13	0.0937	..	..	..	..	30	27	17	7	1	1/4	N	T	13/32	29/64	33/64
14	0.0781	..	..	..	31	29	19	9	2	D	I	P	3/8	27/64	31/64	17/32
15	0.0703	..	..	36	1/8	24	15	4	A	G	9/32	Q	W	7/16	31/64	35/64
16	0.0625	..	..	33	29	19	11	2	1/4	I	M	S	X	29/64	1/2	9/16
17	0.0562	..	42	31	26	17	7	1	F	9/32	N	T	13/32	15/32	33/64	9/16
18	0.0500	49	37	30	22	14	4	B	H	L	O	U	27/64	15/32	17/32	37/64
19	0.0437	44	33	28	19	10	2	1/4	J	N	P	V	27/64	31/64	17/32	19/32
20	0.0375	41	1/8	24	16	6	1	G	L	5/16	Q	W	7/16	31/64	35/64	..
21	0.0343	38	30	22	14	4	A	H	L	O	R	25/64	7/16	1/2	35/64	..
22	0.0312	36	30	20	13	3	C	H	M	P	R	X	29/64	1/2	35/64	..
23	0.0281	34	29	19	11	7/32	D	I	N	P	S	X	29/64	..	..	..
24	0.0250	33	28	18	10	2	1/4	J	N	21/64	S	Y	29/64	..	..	..
25	0.0218	31	26	17	8	1	1/4	9/32	5/16	Q	T	13/32	15/32	..	..	..
26	0.0187	1/8	25	16	7	1	F	L	5/16	R	23/64	..	..	..	..	..
27	0.0171	1/8	24	15	6	A	F	L	O	R	23/64	..	..	..	..	..
28	0.0156	30	23	14	5	A	G	L	O	11/32	U	..	..	..	..	..
29	0.0140	30	22	13	4	B	G	M	P	11/32	U	..	..	..	..	..
30	0.0125	29	21	12	3	B	H	M	P	S	U	..	..	..	..	..
31	0.0109	29	20	12	3	C	H	19/64	21/64	S	3/8	..	..	..	..	..
32	0.0101	29	19	11	7/32	D	I	N	21/64	T	V	..	..	..	..	..

Machinery

These drill sizes are such that a narrow flat or cylindrical edge about 0.005 inch wide will be left at the bottom of the countersunk hole. To illustrate the application of the table, suppose a die is to be made for perforating holes in a strap hinge made from No. 13 U. S. standard metal gage and that the drawing specifies countersinking for a No. 10 screw. No 13 U. S. standard gage is first located and this line followed across the table to the column headed by No. 10, which represents the screw size in this particular case. The table shows that a 1/4-inch drill should be used. Ordinarily a clearance drill of No. 8 or No. 9 size would be used (0.199 inch and 0.196 inch, respectively), which would mean that the countersink would have to remove about 1/16 inch surplus metal.

By referring to the illustration at the top of the table, it will be noted that it was computed for an included screw-head angle of 78 degrees, whereas the standard A. S. M. E. angle is 82 degrees. This change was made because it was found in practice that there is a variation in the angles of commercial screws amounting to about 3 degrees; consequently, to obtain a neat fit around the top of the screw head, the angle was made 78 degrees, thus allowing the screw to seat itself a little tighter around the large part of the head.

* * *

Reports from the U. S. Geological Survey show a great demand for metals and rapid rise in prices following the outbreak of the European war. Before the outbreak of the war, Cookson's, the leading brand of antimony, was quoted in New York at about 7 cents a pound, with other brands ranging from 5.30 cents upward. Following the outbreak of hostilities Cookson's antimony soon rose to about 20 cents and after some fluctuations the year closed with quotations at 15 to 15.50 cents a pound, and other brands at 13 to 14.40 cents. The British government placed an embargo on the shipment of antimony, and the price rose so that in May, Cookson's was listed at 40 cents or more a pound, but in a few days quotations ceased, because the stock in this country was sold. At the beginning of the year, 1915, most of the large copper producing companies of the United States had for nearly five months been operating on a 50 to 60 per cent basis. Copper was selling below 13 cents a pound, and had been considerably lower. Soon after the first of the year, the price steadily advanced from below 13 cents to about 20 cents a pound, the highest price reached since 1907.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

FLUXES FOR OXY-ACETYLENE WELDING

We have read the article "Fluxes for Oxy-acetylene Welding" in the June number, and wish to call attention to some inconsistencies in it. In the first paragraph Mr. Miller says, "It should be stated here that the manufacture of satisfactory fluxes requires considerable chemical knowledge, and in the majority of cases should not be undertaken by a welding shop," etc.

From the standpoint of the manufacturer, and one who has spent eight years in serious study of the industry, the author's statement, in our opinion, is absolutely correct, but under the very next heading "Cast Iron" he contradicts this flatly when he states that the fluxes on the market differ but little in efficiency, and that a mixture of equal parts of carbonate of soda and bicarbonate of soda makes a satisfactory flux. If these two chemicals make a satisfactory flux it most certainly does not require a chemist to mix them in equal parts.

We, like other reputable manufacturers, are striving to increase the efficiency of apparatus, and to make improvements all along the line that will assist the operator in making a better and more economical weld. We feel that a statement of the kind noted above injures us as manufacturers, because we sell fluxes, and also does injury to the art, because the fluxes recommended will not do first-class work. Our reason for the latter statement is as follows: Iron when heated has a great affinity for carbon; it seizes onto it very readily. This well-known fact is utilized extensively in casehardening when using either bone dust or the cyanide process. The carbon in bone dust and also in cyanide is taken up by the iron with the result that a thin casing, very hard, is formed in the metal as deep as the carbon has penetrated. Now the same thing happens when a flux high in carbon is used, such as carbonate of soda and bicarbonate of soda. One criticism of cast-iron welding has been directed against the hardness of the weld. The hardness is due to a number of causes, the inefficiency of the welder, poor apparatus, etc., but, in our opinion, another reason is the use of a flux such as is recommended in the article referred to.

St. Louis, Mo. P. F. WILLIS,
Henderson-Willis Welding & Cutting Co.

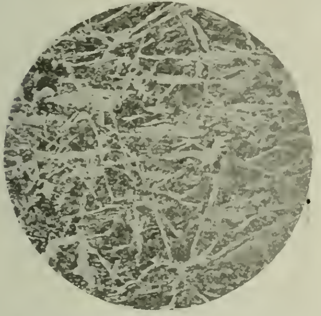


Fig. 1. Photomicrograph of Wrought Iron Welding Rod melted with an Excess Acetylene Welding Flame. Magnified 200 Diameters

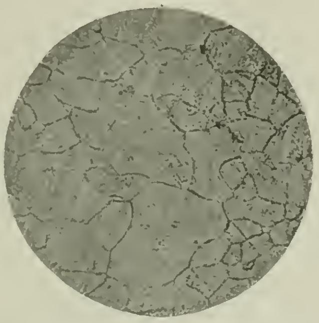


Fig. 2. Photomicrograph of Wrought Iron Welding Rod before melting in Excess Acetylene Welding Flame. Magnified 200 Diameters

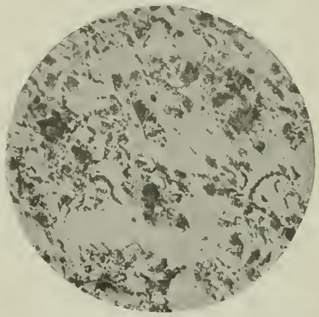


Fig. 3. Photomicrograph of Cast-iron Welding Rod as manufactured. Magnified 200 Diameters

I am glad that my contribution in the June number has raised some questions. It is impossible in an article of that length to cover all the points that might be mentioned. With regard to the criticism of the Henderson-Willis Welding & Cutting Co., I do not see that I contradicted myself because my statement is that in the *majority* of cases the manufacture of fluxes should not be undertaken in a welding shop. Under the heading "Cast Iron," I also stated that as far as my experience goes fluxes differ but little in efficiency. It is perfectly true that a mixture of equal parts of carbonate of soda and bicarbonate of soda makes a very satisfactory flux. I have used nothing else for five years. If the Henderson-Willis Welding & Cutting Co. desires, I will be very glad indeed to furnish them a sample of weld made with this material so that they can see for themselves that there are no hard spots or imperfections in the weld.

I would also be glad to make a test of their cast-iron flux. The matter of hard spots in castings is very simple. Except in a case where the flux produces a very thin, hard scale on the surface they are due to the chilling of the metal caused by the comparatively rapid cooling. These spots are generally noticed in thin sections, or where the piece is not preheated to a high degree, or where it is not cooled slowly. No flux will prevent this action and it is up to the welder to see that it does not occur. Hard spots can be produced at will with any flux, and on the other hand they may be avoided except as above stated, no matter what flux is used. We have had no trouble with hard spots for a long time. I found that the best way to avoid them was to make each welder finish up his welds, when he very soon found that it was easier for him to make the weld soft, than to waste time and energy in trying to file or machine the hard spots that he had produced.

The writer does not believe it possible to make a weld as soft as the original material unless by the use of welding rods excessively high in silicon; and even such rods would hardly produce as soft a material in the weld as in the original because the metal is added in small quantities and cools quickly compared with the rate of cooling of the original casting, but it would undoubtedly be possible to release more of the carbon in the shape of graphite than is actually released during the welding operation, by heating the iron long enough and to a sufficiently high temperature in the presence of sufficient silicon. Therefore, the weld in cast iron will always be closer grained and tougher than the original casting.

The writer believes that the action of carbonates in the case of cast iron has advantages when a proper welding rod is used, because the graphitic carbon tends to be burnt out under the heat which, of course, tends to make the metal hard. If some carbon from a carbonate flux is really absorbed by the iron, it would simply replace to some extent that which is burnt out, and in the presence of material added from a welding rod of proper composition, high in silicon, the carbon would tend to be retained by the cast iron in the graphitic form because of the presence of the silicon.

While it is generally believed that in the case of low-carbon steel or wrought iron, casehardening is caused by the absorption of carbon due to gases liberated by the casehardening material, the matter is still open for investigation. It is a fact that a piece of pure wrought iron can be so saturated with carbon in five minutes by an excess acetylene flame from a welding torch that it will contain over 4.8 per cent carbon. It is also true that this cannot be done with ordinary cast iron.

As a proof of this statement, five photomicrographs are reproduced herewith, taken from pieces which were made especially for the purpose. The magnification is 200 diameters in each case.

Fig. 1 shows a piece of ⅜-inch diameter wrought iron welding wire melted down by the action of an excess acetylene flame to which it was subjected for two minutes. The structure shown is that of steel containing a high percentage of carbon, as the white needles shown are of free cementite, which does not appear unless the steel contains at least 1 per cent carbon. Fig. 3 is a reproduction of a photomicrograph taken of a section of a ⅜-inch cast-iron welding rod as manufactured. It will be noted that the graphite flakes are quite small compared with those in ordinary casting, the reason being that the small size of rod permitted it to cool quickly. Of course, sufficiently rapid cooling will prevent the free formation of graphite, while slow cooling has the opposite effect.

Fig. 4 is a reproduction of another photomicrograph of a piece of the same cast-iron rod after being subjected to the action of the same excess acetylene flame used for melting the wrought iron welding wire, for a period of three minutes. There is little difference between the amount of graphite in this sample and in the sample shown in Fig. 3. Fig. 5 is a reproduction of a photomicrograph taken of a piece of ordinary cast iron of practically the same section and weight as the welding rod, subjected to the excess acetylene flame for three minutes. The graphite appears to be nearly the same as in Figs. 3 and 4. Fig. 2 shows a cross-section of ⅜-inch iron welding wire. It shows freedom from carbon, there being no pearlite visible. This was cut from the same piece as that shown in Fig. 1.

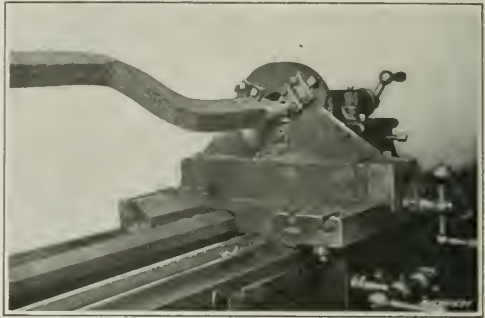
The writer knows of no way of casehardening wrought iron or steel as quickly as by subjecting it to the action of an excess acetylene flame. For many reasons, it is not at the present time a practical process, but the fact remains that the iron, at the temperature of melting and in the presence of gaseous carbon from the acetylene gas, absorbs very rapidly sufficient carbon to saturate the iron beyond the eutectic point.

As an illustration, Fig. 6 shows a photomicrograph, magnified 100 diameters, of a piece of steel, originally containing about 0.4 per cent carbon, which was subjected to the action of the excess acetylene flame for six minutes, and in this time absorbed sufficient carbon to produce a matrix of austenite-cementite eutectic, the austenite in the course of cooling being transformed into pearlite which is readily visible under high magnification; in this matrix are imbedded needles of free cementite, the structure indicating that the percentage of carbon is over 4.8, as otherwise the needles of cementite would not appear.

Rochester, N. Y. S. W. Miller,
Rochester Welding Works

TURNING A BENT SQUARE AXLE

We had a large number of bent square axles to turn on both ends and found it difficult to obtain a satisfactory rate of production on this work. The axles are 1¾ inch square and have to be turned to a diameter of 1½ inch for a length of 10 inches on both ends. The job was handled on a 16-inch lathe equipped with a single tool, and involved three roughing cuts and one finishing cut, as the machine was old and badly worn. In order to handle this work more efficiently, the fixture described in the following was made. This is provided with three tools which equalize the cutting strains to some extent and allow the roughing to be done in a single operation, instead of requiring three operations as was formerly the case. The same speed was employed, but the feed was increased so that the roughing time was cut down to about one-quarter that originally required. The total roughing and finishing time was reduced from 65 minutes to 30 minutes per axle, which includes setting up the work.



Lathe Fixture for Use in Turning a Bent Square Axle

We found that this tool would stand considerably higher speeds and feeds, but the machine was not capable of making an increase in this direction; in fact, we broke teeth out of the feed rack and gear until we reduced the speed and feed to the limits which we are now using. Reference to the illustration will show that the fixture replaces the cross-slide on the lathe carriage. This was necessary because, if the fixture was placed to the left of the cross-slide, it would require too great an extension of the tailstock spindle; if placed to the right of the cross-slide, the slide would interfere with the bend in the axle. We are using a similar tool for turning straight axles on a larger lathe, which is placed to the right of the cross-slide, thus avoiding the necessity of changing. This fixture takes axles up to 3½ inches square, and the saving in the machining time is proportionately as great as in the case of the small axles. The fixture shown in the illustration cost $12.63 to make and saved practically that amount in the cost of machining the first lot of 100 axles, this saving being on the productive labor without including overhead charges.

Fort Wayne, Ind. W. H. Butz

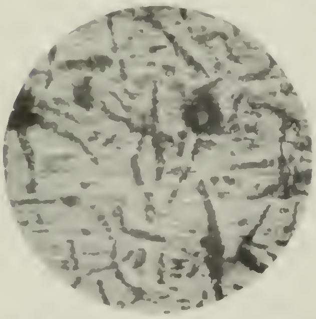


Fig. 4. Photomicrograph of Cast-iron Welding Rod after being subjected to Excess Acetylene Welding Flame. Magnified 200 Diameters

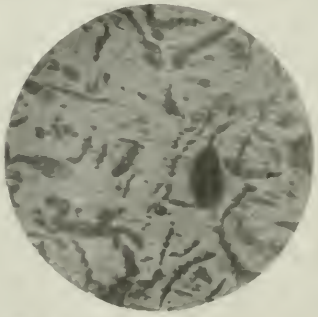


Fig. 5. Photomicrograph of Ordinary Cast Iron subjected to Excess Acetylene Welding Flame. Magnified 200 Diameters

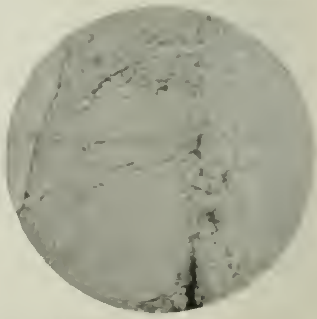


Fig. 6. Photomicrograph of Iron containing 4.8 per cent Carbon. Magnified 100 Diameters

SQUARE-END MILLING FIXTURE

It is the purpose of this article to describe a milling fixture which has been found very satisfactory for milling a square on each end of small cylindrical plugs. The fixture used for this purpose is shown in Fig. 1, and Fig. 2 illustrates the work to be milled. It will be noticed that the sides of the square at either end of the plug must be exactly parallel, and the jig was designed to assure the accuracy of this alignment.

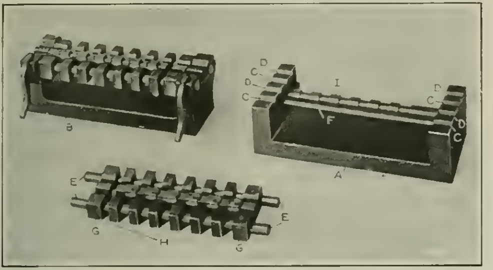


Fig. 1. Fixture for milling Square Ends on Cylindrical Plugs

The blanks are cut off from bar stock on a cold saw which cuts fifteen pieces at a time. After a sufficient supply of blanks has been provided, they are set up in the setting jig *A* which is merely used for locating the work between the V-blocks ready to be set up in the milling fixture which is shown at *B*. It will be seen that there are four grooves in the setting jig, the grooves marked *C* being employed while making the first setting and those marked *D* for making the second setting of the work. In making the first setting, the ends of the shafts *E* are placed in the grooves *C*, which brings the centers of the vees over the center of the shaft *F*. The blanks are now placed between the V-blocks and rest on the shaft *F*, which locates them at the required height. There is a set-screw between the movable jaws *H* and the fixed jaws *G* for the purpose of tightening the jaws and holding the work in place.

With the work clamped in place, the shafts *E* and the V-blocks which they sppport are transferred to the milling fixture *B* and the first cut is taken by straddle mills, which finish two sides of the square at the first traverse of the table. The V-blocks are then turned over to bring the opposite ends of the work into position, after which a second cut is taken which machines the corresponding sides of the squares at the opposite ends of the plugs. It will be evident from the preceding description that this method of procedure will insure having the sides of the squares at each end of the plugs exactly parallel.

The shafts *E*, carrying the V-blocks and work, are now removed from the milling fixture and once more placed in the setting jig, the shafts *E* being placed in the grooves *D* in order to center the work over the shaft *I*. The set-screws which hold the movable jaws *H* in place are now released and each of the plugs is turned through one-quarter revolution to allow the flats milled on them to drop into the grooves on the shaft *I*. The grooves are just wide enough to allow the ends of the plugs to enter and in this way the work is located at exactly 90 degrees from its former position. The set-screws are now tightened to lock the movable jaws and the work is again transferred to the milling fixture where two more cuts are taken, which completes the milling of the squares at either end of the plugs. It will be noticed that the milling fixture *B* is provided with quick-acting clamps of the cam-binder type which provides for securing or releasing the work very rapidly. Two sets of V-blocks and holders are provided with the setting jig *A* so that while the work is being set up in one set of blocks, the cut may be taken on the work held in the other set.

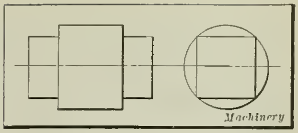


Fig. 2. Plug to be milled

Readville, Mass. O. A. Webster

TRUING FILES

In answer to the question asked by J. A. J. in the May number of Machinery, regarding a method of truing files, I would say that I have had no experience with the use of acid for this purpose, to which he refers. I have, however, found that very satisfactory results are obtained by taking a rather coarse oilstone with a perfectly true face, laying the file upon a bench, and rubbing the stone over the file against the cut, *i.e.*, toward the tang of the file. Two or three passes of the stone over the file are usually sufficient to reduce any high teeth to the required level. In this connection it is important to note that the stone should be passed over the file according to the preceding instruction; do not push the file over the stone.

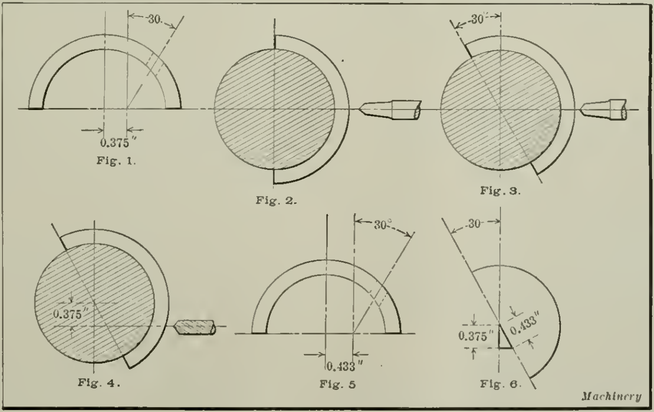
Stillwater, Minn. R. C. MacLachlan

MATHEMATICS IN THE TOOL-ROOM

When a mistake is made in the tool-room, the toolmaker is usually blamed; but there is a certain class of mistakes for which he is not entirely responsible. Such mistakes are due to the fact that the designer has failed to make a note on his drawing, instructing the toolmaker in regard to the method of making the angular setting of the work. In order to prove that this is the case, the writer will refer to a simple job which, nevertheless, caused a lot of worry in the shop; and this is a class of work that is quite likely to have mistakes made on it. Referring to the accompanying illustration, Fig. 1, it will be seen that it was required to make a half bushing which has a ¼-inch hole drilled in it at an angle of 30 degrees, the hole being 0.375 inch off center.

In handling this work, the half bushing was fastened on a suitable arbor and set up between centers on a milling machine. The center was lined up with a centering tool carried in the spindle of the milling machine, as shown in Fig. 2, after which the bushing was turned through an angle of 30 degrees by means of the dividing head to bring it into the position illustrated in Fig. 3. After this had been done the table was raised 0.375 inch and the hole drilled, the position of the work at this time being shown in Fig. 4.

When the finished bushing was sent to the inspection department, it was found that the hole was at the proper angle of 30 degrees, but that the hole was 0.433 inch off center instead of



Figs. 1 to 6. Diagrams showing Conditions in drilling an Off-set Angular Hole in a Half Bushing

0.375 inch as required. This condition is shown in Fig. 5. After this report had been made by the inspection department, we carefully repeated the entire operation, checking all of the movements; and we even went so far as to test the accuracy of the machine. But all of this work was in vain as we still obtained the same result. When we finally made a layout of the job, the source of difficulty became evident. Referring to Fig. 6, it will be seen that the table was raised through a vertical height of 0.375 inch, which made the offset on the diameter of the bushing equal to

$$\frac{0.375}{\cos 30 \text{ degrees}} = 0.433 \text{ inch.}$$

In order to obtain the required result, it was necessary to raise the table through a vertical height of $0.375 \times \cos 30$ degrees $= 0.375 \times 0.866 = 0.325$ inch.

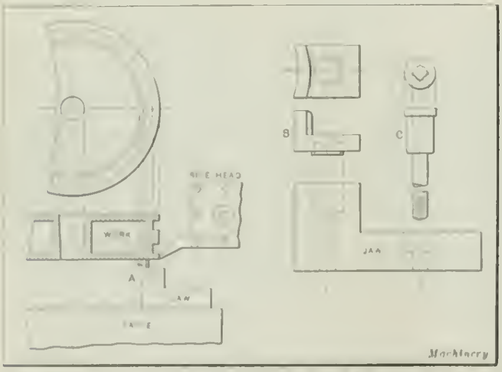
Detroit, Mich. L. C. HAFFNER

CHUCKING RING AND JAW EXTENSION FOR TURNING PISTONS

It is my purpose to describe the method we have adopted for turning pistons, which has resulted in a considerable saving of time. A chucking ring is cast on the piston, so that only one accurate setting of the work is necessary; and jaw extensions are provided to avoid the possibility of side cutting tools damaging the chuck-jaws. Referring to the illustration it will be seen that the chucking ring *A* is cast on the under side of the piston at a distance of about 1 inch from the outer edge, leaving ample room for the piston to rest on top of the jaw extension. It will be best to make the chucking ring about 3/8 inch high to afford sufficient bearing for the chuck; and the ring should be from 5/16 to 3/8 inch in thickness at the base to provide the necessary strength. The jaw extensions *B* are made of tool steel, and hardened to prevent being damaged. Extra screws *C* must also be made as the regular screws will be found too short for use when these extension jaws are employed.

With the aid of the extension on each jaw and the chucking ring on the piston, the workman can machine the entire height of the piston without having to turn it over in the chuck and spend time in truing the work up a second time. The possibility of completely finishing the turning and ring-grooves without resetting saves a considerable amount of time; and when the piston is ready to be turned over it does not have to be accurately trued up for the final operation. The chucking ring can be turned off or chipped off after which the piston is machined. This method is employed by a well-known firm of steam pump manufacturers.

Battle Creek, Mich. HENRY DOREN



Chucking Ring A cast on Piston and Extension Jaws B provided on Chuck

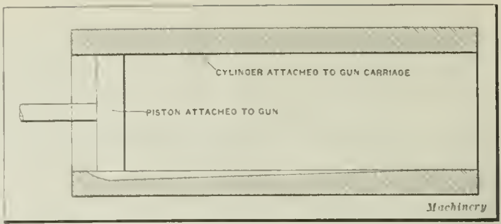


Fig. 1. Arrangement of Recoil Cylinder showing Piston in Firing Position

MACHINING RECOIL CYLINDERS FOR BIG GUNS

Modern field artillery of large calibre produces such a heavy recoil when fired that special means must be provided to absorb the shock. One of the simplest devices employed for this purpose consists of a recoil cylinder which is so designed that the gun can recoil somewhat freely at first, the freedom of recoil being steadily diminished until the gun is finally brought to rest. This result is obtained by the use of a steel cylinder and piston, the cylinder walls being provided with throttling grooves, as shown in Fig. 1, which permit the oil in the cylinder to by-pass the piston quite freely at first, but which automatically throttle the flow of the oil as the piston moves through the cylinder. At some point, either before or after the piston has passed the ends of the grooves, the recoil of the gun must be balanced by the pressure of the oil in the cylinder, thus bringing the gun to rest.

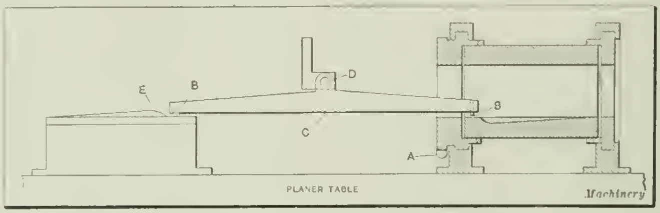
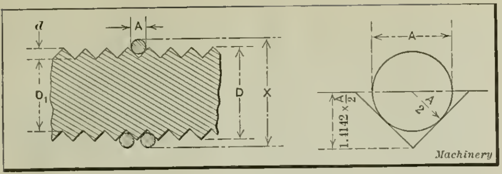


Fig. 2. Planer Fixture used for machining Throttling Grooves in Recoil Cylinders

The grooves in these recoil cylinders are often three in number, and they are equally distributed around the circumference of the cylinder at angles of 120 degrees. Each groove extends over an angle of approximately 45 degrees. The method by which these grooves are machined is quite interesting, and it is the purpose of this article to describe a method of handling this work which has been found very satisfactory. The cylinder is first bored out and then set up on an ordinary planer, the work being clamped in a fixture which provides for its rotation about the axis of the cylinder. A star feed attached to a worm and worm-wheel *A* revolves the fixture to provide the necessary rotary feed. Thus the work has a reciprocating motion provided by the planer table and a rotary feed motion. The tool *B* is carried in a long cast steel bar *C* which is attached to the planer head as shown in Fig. 2, the cam and roller arrangement providing the required vertical movement of the tool. The pivot *D* which supports the tool bar is carried by a bracket bolted to the tool head on the cross-rail of the planer, and the form or cam *E*, which is a reverse duplicate of the required groove, is bolted to the planer table. The bar *C* in which the tool is carried is made slightly heavier at the roller-end than it is at the tool-end, this is done for the purpose of keeping the roller constantly in contact with the cam. The way in which the desired form for the work is obtained will be seen by referring to the illustration, shown in Fig. 2, without requiring any further description.

The tool bar is lowered by means of the screw feed provided on the planer, until a sufficient depth of cut has been obtained; then the automatic feed is thrown in and the cylinder revolves through the prescribed angle of 45 degrees, which provides for planning the groove to the required width. The cylinder is then set back to its original position by operating the feed worm by hand, after which the tool is lowered to the proper depth for taking another cut, this operation being repeated until the groove has been machined to the required depth. The other two grooves in the cylinder are then machined in exactly the same manner. A slot machined



Diagrams showing Method of measuring Pitch Diameter of 90-degree Threads

at the tool-end of the bar *C* provides a permanent place in which a gage can be quickly attached for use in governing the exact setting of the tool point after the tool has been removed for grinding. In this way very little time is lost in re-setting the tool.

Cambridge, Mass. H. B. McDermid

PITCH DIAMETER OF 90-DEGREE THREADS

In certain lines of telephone work screw threads of 90-degree angle, of the form shown in the accompanying illustration, are found to give more satisfactory results than any other type of thread which has been tried. The writer has recently been conducting experiments with screws of this kind and with the taps used for machining the holes which they enter. In this connection it was necessary to obtain the pitch diameter of a number of different taps of this form. None of the handbooks or other sources of information gave a formula for this purpose and the writer finally developed the one here given. As it is quite possible that these taps will come into more or less general use, it is presented in the hope that it may prove of value to other readers of Machinery.

At the left of the illustration, is shown a cross-sectional view of the tap with wires of diameter *A* in place, a micrometer being used to measure the distance *X* over the outside of these wires. At the right is an enlarged view of one of the wires. Referring to this illustration:

Let $N =$ number of threads;

$P = \text{pitch} = \dfrac{1}{\text{threads per inch}}$;

$d = \text{depth of thread} = \dfrac{\text{pitch}}{2}$;

$D =$ diameter over tops of threads;

$D_1 = \text{root diameter} = D - 2d$;

$A =$ diameter of wire;

$X =$ distance over outside of wires.

It will be evident from the illustration that $\frac{1}{2} A$ equals the part of each wire which extends above the threads. Then, $\dfrac{A}{2} \times 1.4142$ equals the distance from the center of wire to root of thread; hence, the required distance *X* which is measured over the outside of the wires with a micrometer, is:

$$X = D_1 + A + 1.4142\,A.$$

Knowing this distance, the pitch diameter of the thread is obtained by subtracting $A + \dfrac{1.4142\,A}{2}$ from *X*. Presented in the form of a formula this will read:

$$\text{Pitch diameter} = X - A - \frac{1.4142\,A}{2}.$$

Montreal, Canada Hercules Smart

HIGH-SPEED STEEL TOOLS

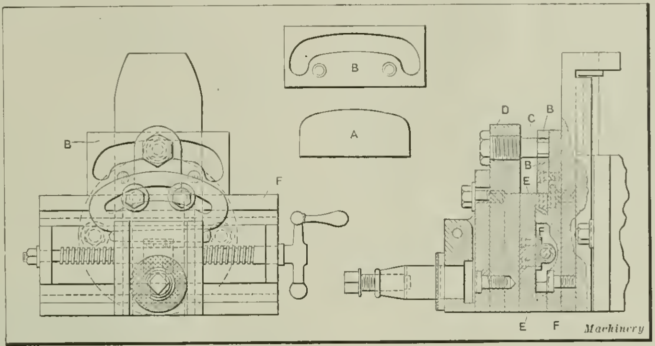
It is surprising to note how many shops are using reamers on very fine work, which are fitted with high-speed steel blades. A reamer need not have very much clearance and, therefore, the cutting edge can be well supported, which makes it possible for high-speed steel blades to be successfully used under such circumstances. Some engineers and superintendents have such faith in high-speed steel for all-around work that they specify its use for broaches. It is difficult to see how a broach could be operated in a manner to require it to be made of high-speed steel. A good grade of carbon steel will maintain a good cutting edge for a considerably longer time when working under the conditions which exist in broaching; and it is also easier to machine, less likely to be distorted in hardening and tempering, and thus a more economical material.

Boston, Mass. C. W. Thayer

RADIUS ATTACHMENT FOR THE SHAPER

The illustration presented in this connection shows a radius attachment fastened to a shaper head, and the same attachment can be used on the planer. It was designed for use in cutting the required profile on the work *A*, which is made of tool steel and ½ inch in thickness. A number of these pieces are set up in the vise and the tool is guided by the master form *B*. A hardened bushing carried on the stud *C* runs in this form, the stud on which the bushing is carried being screwed into the slide *D* which carries the tool. A master form of any shape could be used on the same attachment to machine similar work of various shapes. The slide *D* works freely in the slide *E* which is moved along the small cross-head by means of a screw, as shown in the illustration. The whole attachment can be secured to the shaper by merely tightening three screws.

Philadelphia, Pa. Peter Siebold



Radius Attachment for Use on Shaper

MAKING A SPIRAL CONVEYOR

The following description of a method of making a spiral conveyor will perhaps interest readers of Machinery. As there were only two conveyors to be made, a very simple and inexpensive method had to be adopted. The spiral, a small part of which is shown in Fig. 2, was to be used for conveying lime, and was formed of 1½ by 3/16 inch mild steel;

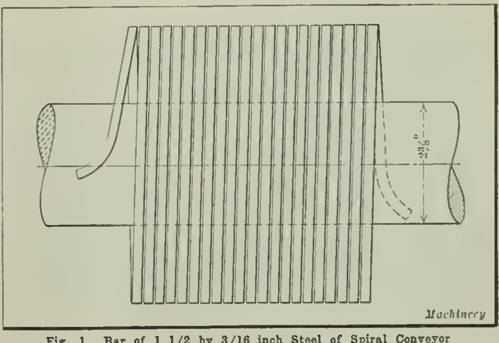


Fig. 1. Bar of 1 1/2 by 3/16 inch Steel of Spiral Conveyor wound close on Mandrel

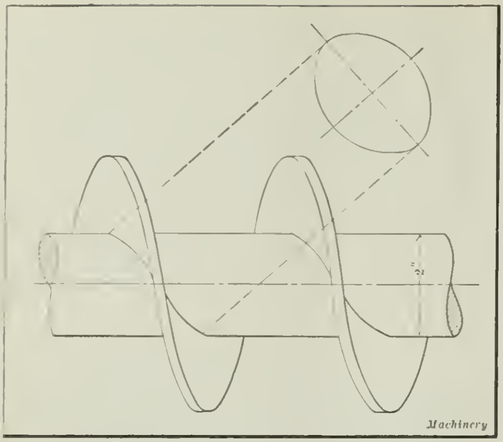


Fig. 2. Method of determining Required Size of Mandrel

the pitch was 3½ inches, the length 10 feet, and it was mounted on a 2-inch shaft. It was decided to make the spiral by winding the bar of steel edgewise around a shaft of suitable diameter, as shown in Fig. 1. As the inside diameter of a spiral decreases when it is opened out, a shaft larger than 2 inches in diameter had to be used. The method of finding the size of this shaft is explained in Fig. 2.

The inside of the spiral was developed, forming an ellipse, the circumference of which was measured, and the diameter corresponding to it is the size of the shaft required. This was found to be about 2⅜ inches. A 2-inch shaft was then procured and the close-wound spiral placed upon it. This was then placed in the fire and heated. On being taken out, a portion of the spiral was opened out to the correct pitch. This operation was continued until the length was finished.

Christchurch, New Zealand. J. H. Clarke

MACHINING BUSHINGS ON THE DRILL PRESS

An economical method of machining bushings on the drill press is illustrated in Fig. 1, and the bushings to be machined are shown in detail in Figs. 2 and 3. In handling this work, it is necessary to keep within a limit of 0.002 inch on both the diameter and length. The castings are first held in a quick-acting vise and reamed with a combination roughing and finishing reamer, the vise being held from turning or lifting, but free to line itself with the reamer. One motion of the lever releases the work and the reverse motion clamps the next casting so that very little of the operator's time is required for setting up the work or removing the finished product.

The second and third spindles of the machine are fitted with expanding chucks which hold the bushings by the reamed hole so that they may be turned by feeding them past a high-speed steel tool which is carried in a special holder. The automatic feed is tripped just before the bushing strikes the stationary counterboring tools, which will be seen in Fig. 1 directly beneath the second and third spindles. Hand feed is used for the facing operation and a positive stop is employed to govern the depth of cut. The bushing from the second spindle, which has from 0.012 to 0.018 inch left for the finishing operation, is placed on the chuck in the third spindle, where it is turned to size and the opposite end faced in the same manner that was employed under spindle No. 2. With a comparatively unskilled operator, this method enabled twenty-five of the smaller bushings shown in Fig. 2 to be machined per hour. The bushings are made of a hard and tough grade of bronze, which is very hard on the tools. The rate of production on the larger size of bushing shown in Fig. 3 is fifteen per hour.

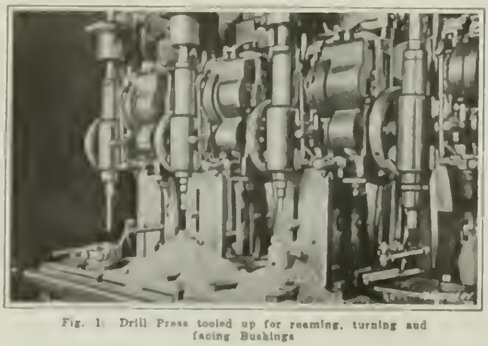


Fig. 1. Drill Press tooled up for reaming, turning and facing Bushings

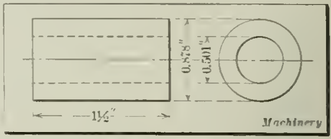


Fig. 2. Twenty-five Bushings of this Size machined per Hour

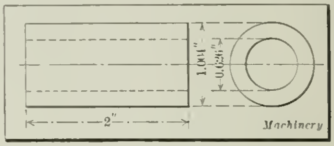


Fig. 3. Fifteen Bushings of this Size machined per Hour

Northampton, Mass. W. H. Sawtell

DRILLING A DEEP HOLE

We were recently called upon to manufacture 50,000 brass studs which were turned from a ⅜-inch square bar, with a short section of the original square bar left at the center of the finished stud. There was one operation that could not be conveniently done on the automatic screw machine, *i. e.*, the drilling of the 7/64 inch hole to a depth of 2¾ inches. For this purpose we designed a special fixture which it is the purpose of this article to illustrate and describe.

We decided to do the work on a Greenfield speed lathe. It will be remembered that this type of lathe is provided with both wheel and lever feed for the tailstock, and for handling the present work the tailstock spindle was removed and replaced by a special spindle which is shown at *A* in the cross sectional view, Fig. 2. Referring to this illustration it will be seen that the spindle is provided with a threaded nose onto which the bracket *B* is screwed. The spindle was bored out to such a size that the work holder *C* is a sliding fit in the spindle, the movement of the work holder being accomplished by means of the lever *D* which is pivoted on to the bracket *B*. The quadrant *E* is provided with teeth for the purpose of locking the lever in the closed position.

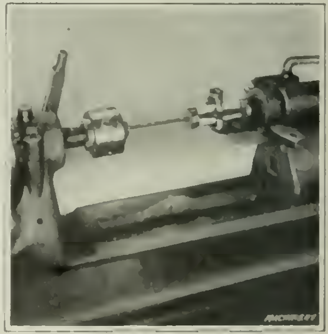


Fig. 1. Greenfield Speed Lathe equipped for drilling a Deep Hole

One of the studs to be drilled is shown in position at *F* in the work holder. It is accurately centered between the tapered drill bushing *G* at one end of the work holder and the tapered end of the rod *H* at the opposite end of the holder. The drill bushing is pressed into the end of the work holder; and the design of the work holder and the manner in which the rod *H* is threaded into the tailstock screw are all clearly shown in Fig. 2. In setting up a piece of work in the fixture,

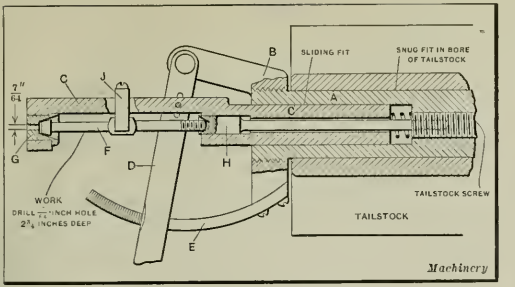

B
SLIDING FIT
SNUG FIT IN BORE OF TAILSTOCK
$\frac{7}{64}''$
C
J
A
C
G
F
D
H
WORK
DRILL $\frac{\ }{64}$-INCH HOLE $2\frac{3}{4}$ INCHES DEEP
TAILSTOCK SCREW
TAILSTOCK
E
Machinery

Fig. 2. Deep Hole Drill Jig used on Machine shown in Fig. 1

the rod *H* is held stationary by its threaded connection with the tailstock screw, and a movement of the lever *D* releases or re-centers the work by sliding the work holder *C* in the spindle *A*, the work holder being prevented from turning by means of a clamp *J* which engages the square which is left at the center of the stud.

The drills used for this operation were of exceptional length and made with an increase in the angle of twist. They were held in the lathe spindle and the work was fed up to the drill by means of the tailstock lever. The use of this lever feed made possible the quick return of the work, which enabled the work to be rapidly backed off. This was an advantage as it was necessary to back off the work several times in drilling each hole in order to clear the chips from the drill to prevent it's breaking. The average rate of production obtained with this fixture was one piece per minute, the time required for setting the work up in the fixture being not over three seconds. As this rate could be steadily maintained, and as perfect alignment was secured, this fixture and method of handling the work were considered very satisfactory.

Middletown, N. Y. DONALD A. HAMPSON

UNIVERSAL TOOLMAKERS' DRILL JIG

The accompanying illustrations show a handy form of toolmaker's universal drill jig which is used for accurately locating and drilling holes in jigs, dies and templets. Referring to Fig. 1, which shows a detail view of the tool, it will be seen to consist of a hardened and ground block *A*, four sliding pins *B*, a set of removable bushings *C* and eight headless set-screws. The bushings *C* are made up with various sized holes to provide for guiding different sizes of drills. Small slugs of brass or copper are used between the set-screws and the pins *B* so that adjusting the screws will not tend to move the position of the pins.

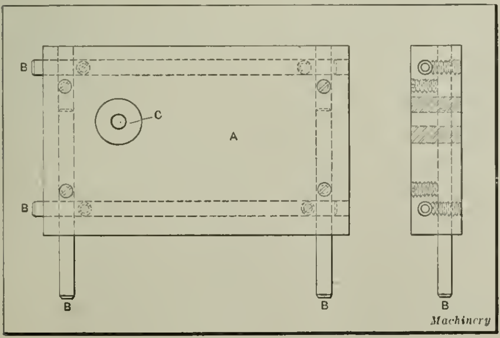


Fig. 1. Toolmakers' Universal Drill Jig

To explain the use of this jig we will assume that we have a die-block to lay out, in which there are a number of holes that must be accurately located, drilled and reamed. After the block has been planed up perfectly square, parallels are clamped to the edges so that they overhang in the manner shown in Fig. 2, allowing the pins *B* to engage with these parallels when the jig is laid flat against the die-block. The bushing *C* is located at a known distance from the edges of the jig, and by setting the pins *B* in the required position by means of a micrometer or micrometer depth gage, the bushing is located in position for drilling the hole in the die-block. For this purpose the jig is clamped to the die-block with a pair of parallel clamps, after which the hole is spotted, drilled and reamed in the usual way. It will, of course, be evident that any number of holes that come within the range of the jig can be located on the die-block in the same way. The usefulness of this tool will be apparent to any toolmaker, and many uses will be found for it that may not be seen at the first glance. One such purpose consists in using the block *A* which is perfectly square to clamp small pieces of work on preparatory to holding them on the magnetic chuck of a surface grinder.

Newark, N. J. DONALD BAKER

ORIGIN OF FORM GRINDING

Referring to the article, "Form Grinding," in the July number, I wish to make a correction in the statement regarding the development of form grinding.

It is true that comparatively little is known as to the origin of the use of the form grinding wheel for producing irregular or straight shaped surfaces. However, it is also true that the Norton Grinding Co. was recommending the form grinding process, using the wide wheel and a straight-in cut, fourteen years ago. Visitors from other plants were then spending time in the Norton Grinding Co.'s factory, investigating the grinding problem and receiving help. We were then recommending and suggesting to these visitors—among them a representative from the Singer Sewing Machine Co.—the straight-in cut or form grinding process, using a wide faced wheel. Charles H. Norton was advocating this very same process twenty-five years ago, but could not then get the users of grinding machines to even consider his suggestion. His plan was looked upon as being impractical and impossible. According to tradition it was not possible to get properly finished and accurate work when using a wide-faced wheel. It was believed that the work would not be straight and would not be round unless the wheel or the work were traversed. Even after repeated demonstrations of the possibilities of correctly finishing work to size had been made, it was still believed to be impossible to do this repeatedly, piece after piece, but the developments of today and the possibilities in form grinding have proved the tradition to be wrong.

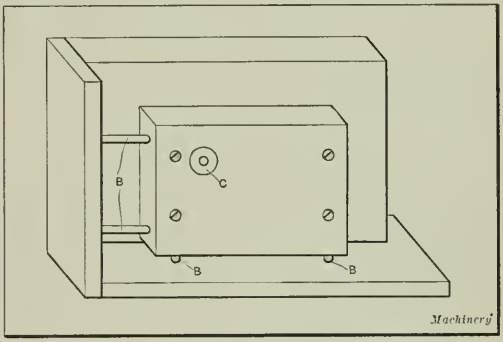


Fig. 2. Method of using Universal Drill Jig shown in Fig. 1

The first commercial application of form grinding in manufacturing was as stated in your article, the multiple-throw crankshafts for automobile engines.

Worcester, Mass. H. W. DUNBAR,
Norton Grinding Co.

* * *

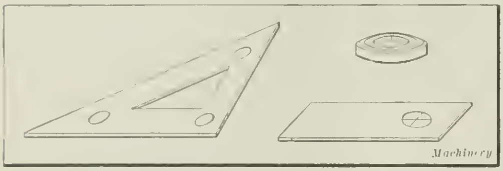
The temperature of oil baths for drawing the tempers of tools should be indicated by a thermometer rather than by a pyrometer, because most pyrometers are subject to considerable error at temperatures below 800 degrees F. Thermometers are simpler and not so likely to get out of order.

SHOP AND DRAFTING-ROOM KINKS

INGENIOUS MEANS AND SHORT CUTS FOR SAVING LABOR AND MATERIALS

USE OF RUBBER ON DRAFTING TOOLS

Where one triangle is used to guide a second triangle in drawing section lines, etc., trouble is sometimes experienced through the triangle slipping. This difficulty can be easily overcome by sticking three small circular disks made of dentist's "dam rubber" to the under side of one of the triangles. Shellac, varnish or good mucilage will be found satisfactory for sticking the disks in place.



Triangle with Rubber Disks to prevent it from slipping; Horn Center in a Metal Frame; and Center made of Mica

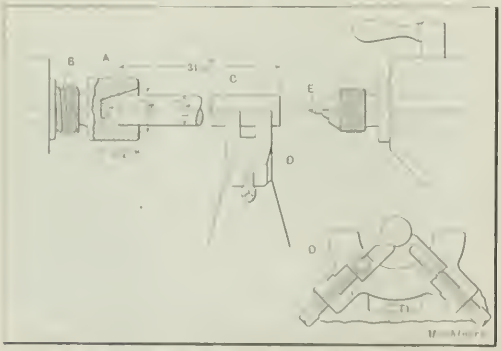
It used to be the custom for every draftsman to have a few horn centers in his instrument case. These were made of glass, mica or horn, and had two lines scribed on them at right angles. The transparent center was held in a metal frame on the under side of which there were three or more short needle points to hold the center in place over the point from which it was desired to draw one or more circles or arcs. The point of the compass rested on the horn center, thus protecting the drawing from damage. These centers were expensive and the writer has found that a very satisfactory substitute can be made from a piece of clear mica 1 by 3 inches in size, which has cross lines scribed near one end and a disk of dentist's dam rubber about ⅝ inch in diameter on the under side at the other end to prevent the center from slipping.

Birmingham, Ala. F. W. Salmon

CENTERING SHAFTS

In an automobile-axle plant, where there are large numbers of shafts to center at both ends, the method described in the following is used. The shafts come to the lathe from a screw machine with both ends turned for grinding, but owing to the heavy feed the shafts run out too much to be centered while turning. On the centering lathe a bell center *A* is provided to fit the lathe spindle *B*. The taper in the bell center where the shaft enters is ¾ inch in diameter at the small end and 2¼ inches at the large end, the depth of the socket being 2¼ inches. This bell center will drive all sizes of shafts from ⅞ inch up to 2 inches in diameter.

The shaft *C* to be centered is inserted in the bell center *A* and steadyrest *D* while the lathe is running, but the shaft does not start to revolve until the center drill *E* is fed up against it. The pressure exerted by the center drill causes the taper in the bell center to grip the shaft and start it revolving. The center drill cuts as long as the pressure is applied, and when the drill is withdrawn from the work the shaft stops, ready to be removed from the lathe. It is not necessary to use the top leaf of the steadyrest in this work, but if centering cold-rolled shafting, which is required to run within 0.002 inch of accurate, it will be necessary to use the top leaf of the rest. The shafts which are regularly centered by this method are 1¼ inch in diameter by 34½ inches long and will run within 0.006 inch of true. This operation can be completed on both ends of the shaft in 45 seconds, which means centering 800 shafts per day. The writer has seen an expert operator center a shaft in 28 seconds.

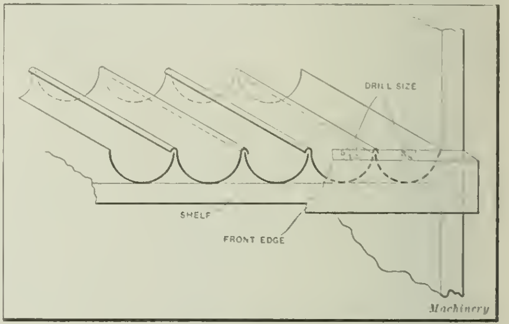


Lathe set up for centering Shafts from ⅞ to 2 inches in Diameter

Flint, Mich. C. E. Hendricks

DRILL HOLDER

A holder for drills and similar tools must meet the following conditions in order to be satisfactory. First, it must be easy to inspect all of the drills if several are held in the same compartment. Second, it must be easy to pick out either one or all of the drills held in a given compartment. Third, the drills should lie straight in the holder. Fourth, it must be easy to pick up the drills. Drills are returned to the toolroom more or less greasy and as a result, they are likely to accumulate dust and dirt as well as to cause any wood with which they come in contact to become soaked with oil. Bearing these facts in mind, in addition to the detailed requirements which have already been outlined, the drill holder shown in the accompanying illustration was designed, if the term "designing" can properly be applied to the making of such a simple thing as a drill holder.



Drill Holder made of Tinned Sheet Metal

The shelf on which these drill holders are placed should slope forward in order that a clear view of the drills may be obtained; and a wide shelf containing several rows of holders can be used, or a single row of holders may be placed on a narrow shelf, according to the requirements of different toolrooms. In connection with the accompanying illustration, it should be observed that the length of the holder does not necessarily have to be equal to the length of the drills. The holders are made of tinned sheet metal and each alternate section has turned over edges which are bent up tight over the edges of the intermediate sections. The joints can be soldered if it is desired to make a smoother or more permanent connection than it is possible to obtain by simply tightening the joint in a vise. The holders are fastened to the shelf by means of nails in the bottoms of the sections, one nail to a section being sufficient. A convenient method of forming the sections is to bend them over a piece of iron pipe of suitable size, if a machine for this purpose is not available.

Stockholm, Sweden. Ralph S. Forsstedt

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

BABBITT FOR SUB-PRESS SLIDES

H. M. Co.—Can you tell us what is the best kind of babbitt metal to use in sub-presses where the plunger slides up and down?

Answered by Sloan & Chase Mfg. Co., Ltd., Newark, N. J.

A.—We use babbitt for lining sub-press slides of the following constituents: lead, 66 per cent; antimony, 18 per cent; tin, 16 per cent.

POINTS ON MAKING AND USING THREADING CHASERS

H. R. N.—There are three general classes of threading chasers; namely, hand chasers, threading tool or fixed chasers of the type that is used like a lathe tool, and die chasers.

1. For what purpose are hand chasers and threading-tool chasers generally used?
2. What are the preferable forms of threading-tool chasers and the advantages of this type of threading tool?
3. What form of hob should be used for cutting hand chasers and threading-tool chasers?
4. What form of hob should be used for cutting the teeth of die chasers and what should be the relation between the size of the hob and the nominal size of the die?

Answered by A

1. Hand chasers are used especially in connection with brass work, for slightly reducing the size of a thread which has been cut either by a die or a threading tool. Hand chasers are also employed for truing up battered threads in repair work, and for similar purposes. For instance, if a thread needs to be slightly reduced in size or is battered, the defect can be quickly remedied, without gearing up a lathe for thread cutting, by the application of a hand chaser. The cutting end of the chaser, when in use, should be supported by a rest extending parallel with the thread, and at such a height as to locate the cutting face of the chaser at about the center of the work. Hand chasers have been used to a limited extent for cutting new threads, although such a thread is likely to be quite inaccurate, especially as to lead, and considerable experience is required in doing this work.

The threading-tool type of chaser is used quite extensively for roughing out threaded parts which have to be finished accurately afterward and which cannot be produced with sufficient accuracy or with the same degree of finish by the use of threading dies. It is common practice after roughing out work of this class with a threading chaser to finish it with a regular single-point threading tool. As the carriage to which the chaser is attached is actuated by a lead-screw, this insures a thread of accurate lead (assuming that the lead-screw is correct), and makes it possible to reduce the thread much closer to the finished size in the roughing operation than would be the case if a die were used for roughing; consequently, only a slight amount of stock needs to be left for the finishing operation. Threading-tool chasers are also used quite extensively for finishing threads completely and they produce threads which are accurate enough for most threaded work, excepting such work as taps, thread gages, etc. When chasers of this type are not ground in the thread, after hardening, they cannot be used for extremely accurate work because the pitch error caused by the hardening of the chaser naturally affects the accuracy of the work being threaded.

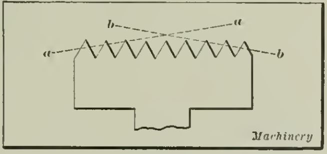


Fig. 1. Threading-tool Chaser is chamfered as indicated by Dotted Lines for cutting Right- and Left-hand Threads

2. A form of chaser for cutting U. S. standard threads, which has been used successfully, is shown at *A* in Fig. 2. As will be seen, the points of the teeth have flats corresponding in width to the pitch of the thread, but the bottoms of the grooves extend to a sharp V. This sharp V-shape is intended to provide clearance in order to prevent roughing or tearing of the thread when it is being cut. Thus, when using this form of chaser, the part to be threaded is turned to the correct outside diameter so that the top of the thread is not finished by the chaser; in this way, a smooth thread is obtained. To prevent any roughness when cutting a V-thread, the method illustrated at *B*, Fig. 2, would be employed. As will be seen, the chaser used has twice the pitch of the thread to be cut; that is, for cutting eight threads per inch a chaser having four threads per inch would be used so that the teeth engage every alternate thread on the work. As will be understood, the lathe is geared for the lead of the thread to be cut. This same method can also be employed for cutting U. S. standard threads, but evidently the flats at the points of the chaser teeth must correspond to the pitch of the thread to be cut, which necessitates making a special chaser, inasmuch as this width is less than it should be for the pitch of the chaser itself. As the illustration indicates, these chasers are of the inserted type, being held in a special tool-holder.

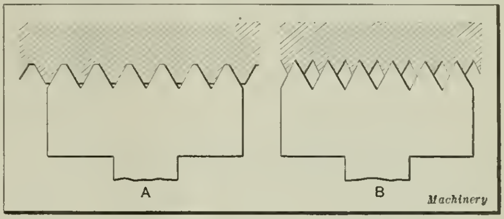


Fig. 2. Threading-tool Chasers for U. S. Standard and V-threads

A threading-tool chaser can be used for cutting either a right-hand or left-hand thread, the teeth being chamfered as indicated by line *a-a* Fig. 1) for a right-hand thread, and as at *b-b* for a left-hand thread. Sometimes these chasers are chamfered on both sides so that they can be used for cutting both right-hand and left-hand threads. A constant clearance angle of 15 degrees will be great enough to take care of the spiral angle of the thread for most work, but it is not so great as to appreciably weaken the cutting edges of the chaser. For the particular class of work mentioned in the foregoing, the threading-tool chaser is superior to a single-point tool simply because it has a number of cutting points, which enables the threading operation to be done much more quickly.

3. The hobs commonly used for cutting the teeth of hand and threading-tool chasers have annular teeth which instead of being helical are at right angles to the axis of the hob. The method of forming the chaser teeth is indicated by the diagram Fig. 3. The chaser *C* is held at the required clearance angle of 15 degrees, and the teeth are cut by feeding the hob *H*, or what is practically a milling cutter, horizontally. Evidently, the angle of the hob teeth must be varied to com-

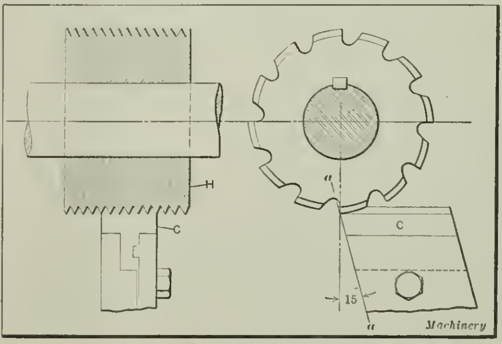


Fig. 3. Hobbing or Milling Teeth of Threading-tool Chaser

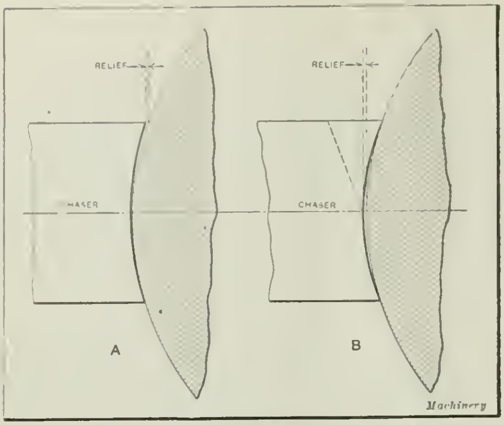


Fig. 4. Diagrams illustrating Two Methods of giving Die Chasers Relief or Clearance

pensate for the clearance angle at which the work is held; that is, if the angle of the chaser teeth in plane *a-a* is to be 60 degrees, the angle of the hob teeth must be somewhat greater than 60 degrees. Assuming that the clearance angle is 15 degrees, then for a 60-degree thread (U. S. standard or V-thread) the hob tooth angle would be 61 degrees 44 minutes; for a Whitworth standard thread, 56 degrees 40 minutes, and for a British Association standard, 49 degrees.

The teeth of threading chasers are also milled in some cases by using a single V-shaped cutter. This method is usually employed when a very accurate chaser is required. Inasmuch as one groove is milled at a time, the distance from one groove to another and, consequently, the pitch of the teeth, can be accurately gaged by means of the lead-screw on the milling machine; hence, as far as the pitch of the chaser teeth is concerned, there is only one error to be considered; namely, that produced by the hardening of the chaser, assuming that the lead-screw of the machine is accurate. On the other hand, when all the teeth are cut simultaneously by a hob of the type shown in Fig. 3, a lead error may be introduced by the inaccuracy of the hob as the result of its hardening, and this error will be increased by the hardening of the chaser. Moreover, the form of the thread can be made more accurate and a better finish obtained when using a single cutter. These hob cutters, however, are generally used because they enable the teeth of the chasers to be cut more rapidly, and inasmuch as chasers are ordinarily used as roughing tools the hob produces results which are sufficiently accurate.

4. The hobs used for cutting the teeth of die chasers have regular helical or "spiral" teeth and not annual teeth at right-angles to the axis, like the hob previously referred to. The exact methods of hobbing the teeth of die chasers vary somewhat. When chasers are being manufactured in a quantity they are held in a special fixture or head and the teeth are cut by a hob which is given a positive feeding movement by mans of an accurately cut lead-screw, a special machine being used. A method which has proved satisfactory is to hob one chaser at a time. For instance, if there are four chasers in a set, chaser No. 1 is hobbed first, then chaser No. 2, and so on, each succeeding chaser being advanced in a direction parallel to the cutting end, an amount equal to one-fourth of the pitch of the chaser teeth, so that these teeth, when the chasers are in position in the die-head, represent sections of a continuous thread. Uniformity of size is secured by gaging each chaser from the bottom or end opposite the cutting end.

When cutting or hobbing die chasers which are held in place in a die-head, a long tapered die tap (preferably fluted spirally) is a good form to use for roughing out the teeth. This tap is then followed by a hob (also preferably spirally fluted) which takes the finishing cut. Care should be taken that the number of flutes in the tap is not the same as the number of chasers in the die, the number of flutes preferably being greater. The relation between the diameter of the hob and the diameter the die is to cut, and the method of obtaining relief for the chaser cutting edges, are very important factors which materially affect the cutting qualities of the die. Evidently, if the hob is the same size as the die, the chaser teeth will not have relief or clearance when cutting a thread, assuming that the chasers are in a central position while being hobbed. However, if the chasers are set slightly above center (say about 0.005 inch), while being hobbed, the chaser teeth will have a slight clearance when they are placed in a central position. This method of obtaining relief, which is shown on an exaggerated scale by the diagram *A*, Fig. 4, has proved very satisfactory.

At times a hob that is slightly smaller than the size of the die may be used, the amount the chasers are set above the center, in this case, being very slight in order to prevent excessive clearance. When this method is employed, however, the cutting edges are somewhat weakened because the ends of the chasers are hobbed to a smaller radius than the die size or the size of the screws which the die is intended to cut. A hob that is larger than the size the die is to cut should not be used, because the amount the chasers would have to be set above the center in order to provide sufficient clearance and prevent a bearing and rubbing of the work in the center of the chaser would be so great as to materially weaken the cutting edges.

When recutting die chasers while they are held in place in a die-head, a hob that is slightly smaller in diameter than the size of the die is often used and the chasers are set in the central or normal position while the teeth are being hobbed. When the chaser teeth are formed in this way they have a bearing on the face and heel (as indicated by the diagram *B*, Fig. 4) unless altered. In order to obtain the required relief or clearance, the heel of each chaser is chamfered into the center line, as indicated by the dotted lines.

* * *

MACHINERY "PUT HIM WISE"

BY J. A. McG.

"Do you subscribe for MACHINERY?" was the question asked of a draftsman. His answer was, "No, neither do I read it; I cannot find anything in it to interest or teach me."

Later, the same draftsman was called upon to change a machine to do a special piece of war material, and there could be no guesswork or experimenting. The change had to be completed in a certain time. Another machine was to be changed along the same lines required in the other, but for a special piece smaller in size. This job was given to a young draftsman to work out. He was a subscriber to MACHINERY, who read and studied the articles found therein, and filed them away for future reference.

He remembered having seen an attachment of the kind required illustrated and described in a recent number. It was looked up in a quiet way without letting any other person know what he was doing, and was studied and found useful for the purpose required. *His* machine was finished within the time allowed, and it is working and giving good satisfaction. Later, the young draftsman was asked by the other fellow, "You made a good job on that machine—who put you wise?" The young man's answer was, "MACHINERY."

* * *

NUTS FOR SQUIRRELS, AND SQUIRRELS FOR NUTS

A veracious correspondent of the *Newark Evening News* writes that a motor van belonging to a warehouse in Newark, while returning from a trip to the southern part of New Jersey, was obliged to make a detour through a field at a point near Flemington, where repairs were being made to the road, and became so badly mired that the crew was compelled to abandon the car for the night. Upon returning in the morning it was found that during the night squirrels had eaten all the nuts off the machine! These squirrels evidently belong to a different tribe from those retained in the Ford service. According to the truthful press agent, two are now furnished with each new car, to run behind and retrieve the lost nuts.

WHY ACETYLENE IS THE COMBUSTIBLE GAS USED FOR AUTOGENOUS WELDING

REASONS WHY THE NUMBER OF BRITISH THERMAL UNITS IN A GAS IS NOT AN INDEX OF ITS WORTH IN WELDING

BY M. KEITH DUNHAM*

THE article in the July number by J. F. Springer entitled "A New Competitor of Acetylene" makes very interesting reading. If "Gasol" has all the advantages claimed for it, and if the table of costs as given is correct, the reader would naturally assume that this new gas would immediately supersede acetylene for autogenous welding. A careful reading, however, brings out some statements which evidently need additional explanation.

It is stated that two combustible gases are commonly employed in autogenous welding and cutting, acetylene and hydrogen. As a matter of fact, hydrogen is used very limitedly in welding for two reasons—the comparatively low temperature of the flame (about 4000 degrees F.), and the difficulty of adjusting the proportions of oxygen and hydrogen to secure anything but a flame of an oxidizing nature. If hydrogen were "commonly" used, as Mr. Springer states, those factories manufacturing oxygen by the electrolytic process, where hydrogen is the by-product, would not have to hunt for markets for this gas and to sell it for purposes other than welding at one-quarter to one-fifth of a cent per cubic foot (not one cent).

Many industrial concerns having electrolytic systems throw away the hydrogen and use acetylene for welding. They do this for the simple reason that acetylene at one or even two cents per cubic foot is cheaper than hydrogen which costs nothing, because acetylene and oxygen give the *right character of flame and the highest temperature of any combination of gases.*

Evidently then in the choice of the combustible gas for welding purposes, we have something else to consider beside the number of heat units in that gas, for strange as it may seem, there is a decided difference between heat units and flame temperature. We must also consider the character of the flame, since one of an oxidizing nature, for instance, would very seriously reduce the strength of the weld. And we must also bear in mind that the consumption of oxygen is of primary importance, since oxygen is as yet quite an expensive gas.

Mr. Springer states "the average cost of oxygen throughout the United States is probably not less than two and one-half cents." By referring to the foot note under the table of relative value of gases used in welding and cutting, we find that the figures are based on oxygen at one and one-half cents per foot. Why the inconsistency?

If the average price is two and one-half cents (I think this high), why is the table of costs made on a basis of one and one-half cents? Is it because of the fact that "Gasol" requires more oxygen for its combustion than acetylene and that to make "Gasol" appear competitive, the price of oxygen must be low? If we are merely trying to arrive at the cost of so many heat units, let us be consistent and use air, which costs nothing. Further, we can use natural gas or city gas or vaporized gasoline and so do away with acetylene or "Gasol."

But what we are really trying to do is to find out the relative cost of welding with "Gasol" and acetylene, using oxygen and paying for it the market price. We are not boiling water or making steam, and for welding purposes the cost of 1000 B. T. U.'s should not be of any particular interest. The cost of oxygen and the combustible gas per foot of welding, the strength of the weld, the time consumed in making the weld—these are the real facts to be determined in any comparison of gases.

The table of relative costs given by Mr. Springer then is misleading, since it does not state flame temperature, consumption of gas per foot of welding, quality of weld or time consumed. It does, however, lead the reader to believe that blaugas is cheaper for welding than acetylene and that "Gasol" is still cheaper than blaugas.

This table states that one and one-half cubic feet of oxygen are necessary to the complete combustion of one cubic foot of acetylene. As this table is made up on the basis of oxygen which must be paid for—that is commercially pure oxygen in cylinders and not meaning that in the atmosphere—Mr. Springer is in error, as only one cubic foot of oxygen is necessary. The early type of welding torches undoubtely consumed more oxygen than was necessary, but the modern torch uses equal proportions of oxygen and acetylene and there are a large number of manufacturers from whom welding apparatus may be purchased with this guarantee. Mr. Springer bases the price of acetylene at one cent per cubic foot and with oxygen at one and one-half cents; we find that the cost of 1000 B. T. U., using oxygen and acetylene, is $0.017 and not $0.0217, as given. [In the table this appears 0.00217, owing to typographical errors in the last column, each amount being one-tenth of what it should be.]

Mr. Springer states that "one quart of the liquid weighs one pound and produces approximately ten cubic feet of gas." His table is made up on the basis of "Gasol" at ten cents per pound. On this basis 1000 B. T. U., using "Gasol" and oxygen, would cost 0.017, or exactly the same as oxygen and acetylene—this on the acceptance of Mr. Springer's statement that only two cubic feet of oxygen are required for the combustion of one cubic foot of "Gasol." Looking at the two gases when used with oxygen merely from a heating standpoint, then, "Gasol" offers no price advantage. Why, then, use acetylene in preference to "Gasol"? Because the oxy-acetylene flame is considerably hotter and therefore much cheaper as a welding agent.

To understand better why acetylene with 1500 heat units gives a hotter flame than "Gasol" which claims 2300, we must understand that acetylene by weight contains over 92 per cent carbon and less than 8 per cent hydrogen. The combustion of this gaseous carbon is extremely rapid, the resulting temperature being very high—theoretically nearly 8000 degrees F., but practically, due to various reasons, probably between 6000 F. and 6500 degrees F. This temperature is estimated only, as no device has yet been made which will measure it. At this high temperature the hydrogen in the acetylene will not combine with oxygen, since water vapor (the combination of hydrogen and oxygen) cannot exist at temperatures beyond 4000 degrees F. The hydrogen, therefore, surrounds the welding cone, and to a greater or less extent perhaps acts as a protecting envelope around the welding flame, probably preventing undue oxidation of the metal welded by keeping the air away from the molten mass. The hydrogen later combines with oxygen from the air and burns, forming water vapors, a considerable distance from the welding cone.

It is the carbon in a gas, then, which produces the high temperature. The richer the gas in carbon, the hotter the flame. Hydrogen tends to lower the temperature, so the more hydrogen in a gas (in a broad sense) the lower must be the temperature of the flame. *Acetylene, having the highest percentage of carbon and the lowest percentage of hydrogen, necessarily produces the hottest flame when burnt with oxygen.*

Blaugas with 300 more heat units per foot than acetylene, and with an analysis of approximately 80 per cent carbon and 20 per cent hydrogen, when burned with oxygen gives a flame, the temperature of which is about 1000 degrees F. —less than oxygen and acetylene—yet the inference in Mr. Springer's table is that blaugas is a more valuable welding agent than acetylene.

What is "Gasol"? Natural gas from the Pittsburg district, with the lighter gases removed. Broadly speaking, it might be termed a very high-grade gasoline, since it liquefies at an ordinary temperature at a pressure of less than 1000 pounds. For all practical purposes, the same results would be obtained using a high-grade gasoline vaporized and burned with oxygen as with "Gasol." Gasoline with a specific gravity of 0.70 contains by weight about 84 per cent carbon and 16 per cent hydrogen and "Gasol" undoubtedly analyzes about this same percentage. A high-grade gasoline contains about 20,000 heat units per pound, while "Gasol," according to Mr. Springer, has 23,000, so that the similarity of "Gasol" and good gasoline may be noted.

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* Oxy-acetylene engineer. Address: Room 1375, 50 Church St., New York City.

Theoretically, then, the temperature of the flame of oxygen and "Gasol" would be about that of blaugas and oxygen (both gases having about the same percentage of carbon and hydrogen) or about 1000 degrees F. less than oxy-acetylene. It is probable, however, that it is considerably less than blaugas, due perhaps to impurities such as nitrogen and carbonic acid gas (from the gas well) which would very materially reduce the flame temperature.

To quote again from Mr. Springer's article. "At first thought, it may appear that the relatively higher consumption of oxygen will largely offset the advantage of the lower cost of the fuel gas. This is not the case, however, as less of the liquid gas ('Gasol') is used to do a given amount of work because its heat value is relatively higher than that of acetylene."

As a matter of fact, "Gasol" would be far more expensive, on account of the much lower temperature of the flame. It is this difference between heat value and flame temperature which must be clearly understood to get an idea of the relative values of the gases. Radiation and absorption of heat by the metal being welded, the effect of the products of combustion on the molten metal and the labor required should be as carefully looked into as flame temperature.

But to do all this, must we have a gas analysis, a meter test for consumption and a laboratory test of the weld? Not at all. The difference between the oxy-aceytene flame and other oxy-gas flames is such a big one that we can arrive at quite certain facts by welding a section of ordinary boiler plate, say, for instance, three-eighths inch thick.

With the oxy-acetylene flame, the adjustment of gases is quickly made by the *shape* of the welding cone, this cone becoming short, blunt and distinct at just the moment enough oxygen becomes mixed with the acetylene to form a neutral welding flame. Playing the flame in a circular motion for a few moments on the section immediately adjacent to the weld, the metal very quickly comes to the welding heat and the operator progresses at the rate of about a foot in fifteen minutes. By noting the oxygen tank pressure gage, we find that we have used about 11 feet of oxygen and if we are using a properly designed torch, about the same number of feet of acetylene to make twelve inches of welding three-eighths inch thick. Then we bend the metal backward and forward in a vise to see if it is brittle. No breaks developing, we cut through the weld and note that the metal looks right and if we further test it, we will find the tensile strength at least 90 per cent.

Then we take oxygen and one of the other gases—it makes little difference whether it is blaugas, "Gasol," Wolf gas, "Vulcan" gas, or plain gasoline vapor—and we find that when the oxygen is mixed a sharp, pointed cone begins to appear As we increase the oxygen this cone becomes shorter but there is no difference in shape; how long or how short this cone should be is solely a matter of guesswork on the part of the operator, yet it is of very vital importance that the mixture have just the right amount of oxygen to avoid oxidation on the one hand or carbonization on the other. Then we note that the color of the flame is much different than the oxy-acetylene. It is considerably darker than the white, brilliant cone of the oxy-acetylene and we here learn that we can in a general way determine temperature by color—by the luminosity or brightness of the flame.

If we are using a flame of the same size as we did with oxy-acetylene, we next discover that we are having great difficulty in getting the metal even to a red heat and here we ascertain the real difference between heat units and flame temperature. A flame of 5000 degrees F., for instance, should be about five-sixths as efficient as one of 6000 degrees F. if we consider theory only. Practically, however, the metal being welded is a very good conductor of heat and also must absorb considerable as well, so that with our flame of 5000 degrees F., we quickly find out that we are not progressing five-sixths as fast as with one of 6000 degrees F. In fact, we are not even welding at all, as the metal is radiating the heat as fast as it is applied.

So we change our welding tip or torch to one of double the size of the oxy-acetylene and finally we get the metal to the welding heat. Then we note that instead of the bright, clean appearance of the molten metal under the oxy-acetylene flame there is a scum having the appearance of soap-suds and we find out that we are oxidizing the weld—either from too much oxygen in the flame or from the product of combustion of the oxygen and hydrogen. If we succeed in welding the plate at all, we find it has taken us three or four times as long as with oxygen and acetylene, that the weld is burnt and low in strength and that our consumption of oxygen alone has cost us considerably more than the total cost of oxygen and acetylene.

Is this an exaggerated view? Not a bit. In theory, perhaps, one might weld steel with oxygen and an oil gas. In practice, I have found out by using several thousand feet of oxygen with all kinds of gases that acetylene is as yet the only combustible agent which can be considered for autogenous welding.

Are there exceptions? Personally I think not, yet I am aware of a manufacturer in the Pittsburg district, owning his own natural gas wells, who uses natural gas and oxygen for the welding of light gage metal. In this instance, the combustible gas costs nothing, yet I feel sure that acetylene at one cent per foot would in this instance even prove cheaper than the natural gas in the saving in labor, since an operator can weld quicker with a high temperature flame than he can with a low one, the quality of the weld must of necessity be better, since the products of combustion of an oxy-acetylene flame certainly are less harmful than those of oxygen and natural gas and finally the added cost of the acetylene I believe would be more than offset in the saving of oxygen.

These facts apply to welding only. For cutting, several combustible gases may be used, as in this case the flame is used merely as a heating agent and combustion is kept up by the oxygen. But the high temperature of the oxy-acetylene flame is even an advantage in many instances in cutting, notably in wrecking work, where the metal is rusted and where it is necessary to have a high heat to break through the foreign elements in order that the oxygen may attack the iron.

By all means, let us have at all times the fullest publicity about anything new, but let us keep to facts. Autogenous welding is as yet just an infant, not yet ten years old in this country, and many of the early prejudices, due to faulty apparatus, impure gases, bad welding materials and fluxes and last but not least unskilled workmen, are just beginning to be overcome. To the ordinary man, heat is heat and if he has never seen an oxy-acetylene flame in operation, it is just possible that he might condemn autogenous welding after seeing the results of welding with another combustible gas.

"Gasol" may have a very wonderful future, but unless it can change its composition that future does not lie in the field of autogenous welding.

• • •

Machine designers often specify "machine steel, case-hardened" instead of "tool steel, hardened" for small machine parts, their idea being that this is true economy, because machine steel is cheaper than tool steel. However, the cost of proper case-hardening is higher than that of hardening high-carbon tool steel. In fact, the cost of case-hardening when properly done, is from 3 to 4 cents per pound more than the cost of the hardening of high-carbon steel. This applies particularly to gears made from these materials.

NEW MACHINERY AND TOOLS

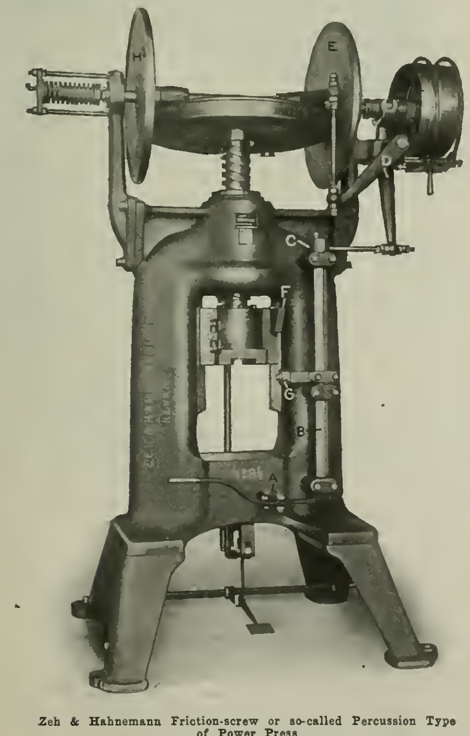
THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

ZEH & HAHNEMANN PERCUSSION PRESS

The friction-screw or so-called percussion type of power press has been used in Germany for a number of years, where it is successfully employed in handling those classes of work for which drop hammers or toggle embossing presses are generally used. For certain classes of work, the principle on which the percussion press operates enables it to give better results than are obtained with other types of presses. Until recently the percussion press has been practically unknown in this country, but the Zeh & Hahnemann Co., Avenue A and Vanderpool St., Newark, N. J., is now manufacturing machines of this type.

As the percussion type of press is not generally employed in this country, it will not be out of place to give a brief description of the manner in which it operates. Reference to the accompanying illustration will show that the ram is secured to the lower end of a vertical driving screw and that the flywheel is carried at the upper end of the same screw. The face of the flywheel is covered with leather which affords a good friction surface to be engaged by the disks which are keyed to the horizontal driving shaft. The machine may be tripped by means of a foot treadle or hand lever, which causes the ram to descend to deliver its working stroke and then return to the starting point where it stops until the machine is again tripped.

This movement of the ram is obtained by the following mechanism: When the operator pushes down the treadle, it causes the link *A* to be drawn in with the result that the square shaft *B* is rotated. The motion resulting from the rotation of shaft *B* is transmitted through the bell-crank *C* to yoke *D*, which results in sliding the horizontal driving shaft to the left and engaging the disk *E* with the flywheel to drive the ram down. When the ram has descended to the required point, the dog *F* engages the stop *G* on shaft *B* with the result that this shaft is rotated in the opposite direction to that which results from depressing the treadle. This causes the horizontal driving shaft to be moved to the right, and the disk *H* comes into engagement with the friction surface of the flywheel, reversing the direction of rotation of the screw and returning the ram to the starting point. The press is equipped with ball bearings, and a brake quickly stops the flywheel when the ram has reached the top of its stroke. An automatic knockout ejects the work from the die on the up stroke of the ram.

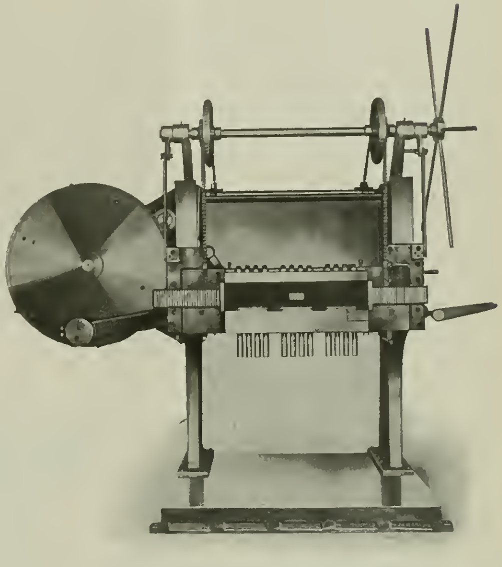


Zeh & Hahnemann Friction-screw or so-called Percussion Type of Power Press

In the operation of this type of press several noteworthy advantages are obtained through the application of the friction and screw drive. The driving screw is the means of enabling very high pressures to be obtained, and this pressure is of uniform intensity, even if the blanks vary considerably. Should it happen that something gets into the die that prevents the press from completing its cycle, the friction drive will slip before damage is done to the machine. Further provision against spring or breakage is made by making the frame of the press of cast steel and the driving screw of tool steel, so that the maximum strength is obtained. The Zeh & Hahnemann Co. is building a line of these presses which are made in six different sizes with capacities of 9, 25, 50, 75, 100, and 150 tons pressure, respectively.

MOLINE MULTIPLE TAPPING MACHINE

The No. 2 multiple tapping machine which is illustrated and described herewith is a recent product of the Moline Tool Co., Moline, Ill. This machine was developed to meet the requirements of multiple tapping operations on automobile cylinders which are cast *en bloc*, and a variety of work on which tapping operations of a similar character have to be performed. The machine is built in either the floor type as shown in the illustration, or with an adjustable table.



Moline No. 2 Multiple-spindle Tapping Machine

The upper end of each spindle is provided with a shell lead-screw of the same pitch as the tap, and the spindles are driven by spur gears which are cut from the solid steel. These gears mesh with a steel rack which is reciprocated by a large crank gear, this crank gear being driven by a train of spur and spiral gears and a shifting belt. The spindles are mounted in a counterbalanced rail, which is readily raised or lowered by the pilot wheel.

In operating the machine the work is placed in position, either on a wheeled jig or on the table, and the rail is then brought down against a positive stop which locates the ends of the taps in position ready to enter the holes in the work. The machine is then started by the lever at the right-hand end and the crank makes one complete revolution, running the taps down a predetermined distance and then withdrawing them. The machine is stopped after the completion of this cycle by a brake on the tight pulley. Different positions of the crankpins can be furnished to provide for tapping holes of different depths. After the work has been tapped in the manner just described, the rail is raised out of the way so that the work can be removed. The crank and rack control is used only when it is necessary to tap to an exact depth or to a shoulder.

The machine can be furnished with a fixed distance between spindles, as shown in the accompanying illustration, or with an adjustable head if the center distance is not less than 3 inches. As a rule a machine of this type would have to be built to order as the requirements of different classes of work would necessitate certain modifications of the design. The weight of the machine is about 9000 pounds.

COPPER BAND CUTTING-OFF MACHINE

The Automatic Machine Co., Bridgeport, Conn., has recently developed a machine which is particularly adapted for cutting off copper bands from tubing, for use on shrapnel and high explosive shells. The machine is shown in Fig. 1, and Fig. 2 shows the construction of spindles used for cutting off rings and for turning bands. The large hollow cast-iron spindle, which runs in cast-iron bearings bolted to a substantial base, is one of the features of the machine. The base itself is mounted in an oil pan, and the machine is designed with a reservoir, pump and piping to deliver a liberal amount of lubricant to the cutting tools. The spindle has a spring collet chuck with spring feeding fingers which reach close up to the back of the tube-holding chuck, the general arrangement being shown in Fig. 2.

The operation of the machine is controlled by the two hand levers shown over the headstock, and the pilot wheel on the cross-feed slide. The tailstock or stop has a releasing device which prevents the revolving tube coming into contact with the stop while it is being cut off. The stop is adjustable on the bed for any length up to the capacity of the machine. The long lever over the headstock provides for feeding the tube, and the short lever is employed to open and close the chuck. The cross-feed is hand-operated, and the tool-slide is fitted with a multiple tool-holder, so that from three to six rings are cut off at a time. The actual time required to feed up the tube, secure it in the chuck, and cut off from three to six bands is only ½ minute.

While this machine is particularly suited to the requirements of cutting off the copper bands for explosive shells, it could be built with certain modifications to suit it for use in trimming either end of shrapnel or high explosive shells, for finish-turning the copper bands, for cutting off steel tubing and for numerous other classes of work where a machine equipped with a large hollow spindle with a spring collet chuck could be used to advantage. These machines are made in two different sizes, one of which has a capacity of 6¾ inches in diameter through the feed fingers and collet chuck, and 7¼ inches in diameter through the collet chuck with the feed fingers removed. On the smaller machine the capacity is 3¾ inches in diameter through the feed fingers and collet chuck, and 4¼ inches in diameter through the collet chuck with the feed fingers removed. On this machine the maximum distance from the face of the chuck to the stop is also 18 inches. The equipment of either size of machine includes one collet and a set of push fingers, one tool-post fitted with multiple cutting-off tools for cutting from three to six rings according to width, a countershaft, oil pump, pan, and necessary piping and guards.

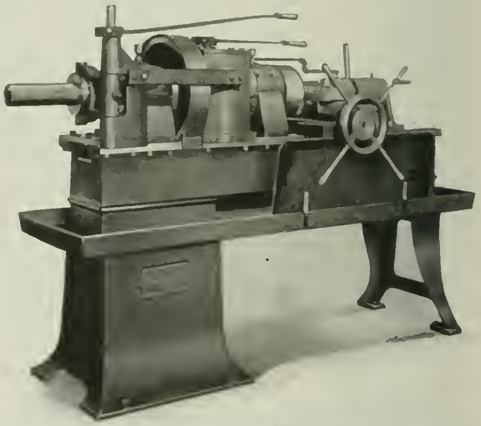


Fig. 1. Machine built by Automatic Machine Co. for cutting off Copper Bands for Shrapnel Shells

LANDIS PIPE MACHINE

The Landis Machine Co., Inc., Waynesboro, Pa, is now manufacturing a line of pipe machines which provide for performing the threading, reaming and cutting-off operations. These machines are designed to use the Landis stationary type of die-head which covers a wide range of sizes with a

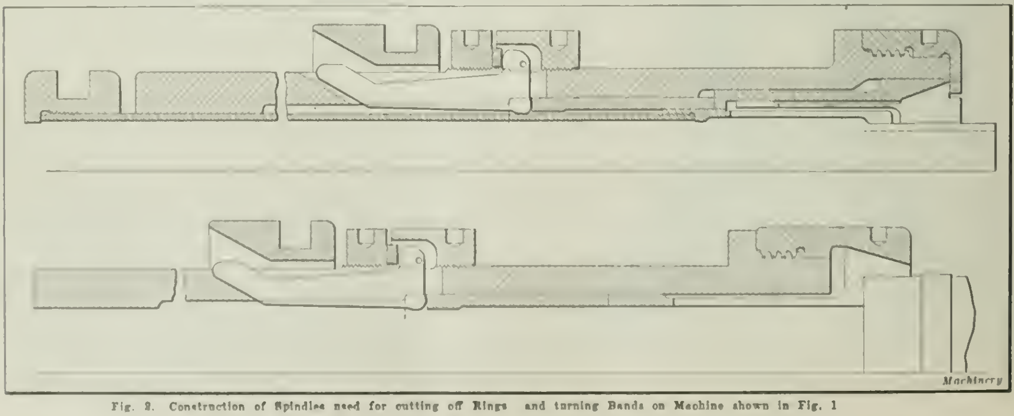
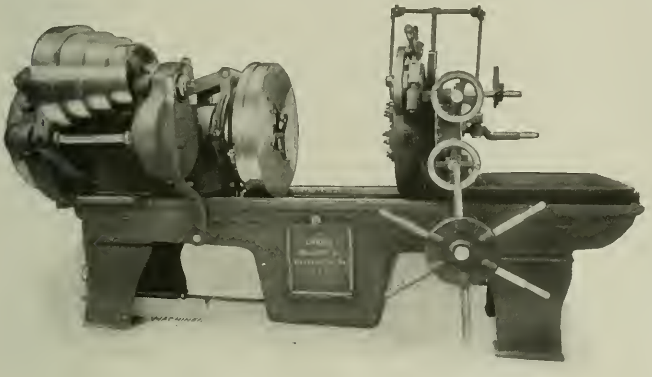


Fig. 2. Construction of Spindles used for cutting off Rings and turning Bands on Machine shown in Fig. 1

single set of chasers. The machines themselves are of massive construction and equipped with the latest types of mechanical and safety attachments. The gripping chucks have universal adjustment and on the 4- and 6-inch machines the chucks are lever-operated.

The most noteworthy feature of this type of machine is the ease with which it can be adjusted for working on different sizes of pipe. This is due to the fact that the die-head and gripping chuck have universal adjustment for different diameters, and also that only one set of chasers is required to cover the range of each die-head. A reaming attachment and cutting-off tools are provided, so that the machine is capable of threading, reaming, and cutting off a piece of pipe in one continuous operation.

The machines are made in three sizes with capacities for pipe of from 1 to 4 inches, 1 to 6 inches, and 2½ to 8 inches in diameter, respectively. The standard equipment of each machine includes two sets of chasers. On the two smaller sized machines these are of 11½ pitch and 8 pitch, respectively, while on the largest machine both sets of chasers are of 8 pitch, one set being for pipe from 2½ to 4 inches in diameter and the other for pipe from 4 to 8 inches in diameter.



Landis Pipe Machine equipped with Landis Stationary Die-head that Covers a Wide Range of Sizes with a Single Set of Chasers

KEMPSMITH SPINDLE NOSE CONSTRUCTION

In driving face milling cutters and cutter arbors on a milling machine, it is important for the spindle nose to be so designed that the face milling cutters can be driven either right-hand or left-hand; and easy means should be provided for quickly removing the cutter. These requirements are well taken care of by a patented spindle nose construction which has been developed by the Kempsmith Mfg. Co., Milwaukee, Wis., for use on the milling machines of its manufacture. The parts of this device are shown in Fig. 2, and Fig. 1 shows a cross-sectional view from which the method of operation will be readily understood. The spindle nose is threaded right-hand at *A*, and the body of the cutter is threaded left-hand at *B*. The hardened steel collar *C* is threaded right-hand for half its width, and left-hand for the other half. When using a cutter arbor, the threaded collar *A* remains on the spindle nose where it serves as a guard. When it is desired to attach a face milling cutter to the spindle, the collar *A* is unscrewed from the spindle until it holds only by one thread. The thread on the hub of the cutter is then engaged by the internal thread of the collar, and when the collar is screwed back onto the spindle nose, it draws the cutter back so that it takes a firm seat at the points *D* and *E*. It will be seen that the spindle nose is tapered at *E* and this taper serves to center the cutter. The actual driving of the cutter is done by the hardened steel key *F* which, for convenience, is held in the cutter by means of cap-screws.

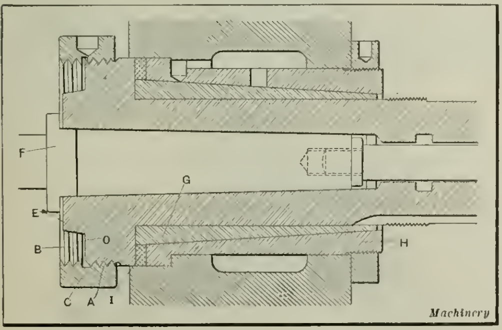


Fig. 1. Cross-sectional View showing Construction of Spindle Nose and Front Spindle Bearing Box

A small spanner wrench is provided for use in operating the hardened collar *C*. With this construction it is impossible for the cutter to become jammed on the spindle nose and as a result, it is always easy to remove the cutter no matter how long it has been attached to the spindle or under what severe service conditions it has been working. The advantage of this construction is particularly noticeable in the case of a vertical milling machine or vertical milling attachment. In such cases the entire operation of attaching the cutter to the spindle is performed from above the cutter. There are no cap-screws to be driven home from underneath and no loose centering plug is employed. In addition to showing the design of the spindle nose, Fig. 1 also illustrates the improved front spindle bearing box construction which has been developed by the Kempsmith Mfg. Co. A hardened steel sleeve *G* is shrunk onto the spindle and ground in position. This sleeve runs in a special phosphor-bronze box *H* in which ample provision is made for lubrication. The end thrust of the spindle is taken by the babbitt collar *I*.

SIMPLEX PARALLEL ATTACHMENT

In the parallel attachment which has recently been placed upon the market by the Simplex Drafting Appliance Co., 39 Auburn St., Malden, Mass., a special straightedge and drawing-board are unnecessary as the attachment can be used on any drawing-board that is large enough for the requirements of the work, and the blade of an old T-square will be found entirely satisfactory for use as a straightedge. The attachment itself is of a simple design so that it is relatively inexpensive to make, and it will be obvious that the possibility of utilizing an old T-square and drawing-board is the means of effecting a further economy.

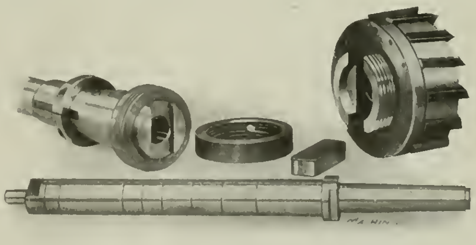


Fig. 2. Parts of Improved Spindle Nose applied to Kempsmith Milling Machines

The same attachment will fit any size of drawing-board, and after the attachment has once been set up it is impossible for it to come unstrung. Another important feature of this device is that a continuous drawing can be made either way of the drawing-board. The ends of the straightedge do not project beyond the edge of the board, and as a result they are not in an exposed position where they are likely to be knocked against by persons moving about the drafting-room. If so desired, a guard can be placed over the cord that passes over the straightedge, and this may also be made to serve as a rack for holding the drafting instruments, pencils, etc., which will be found a convenience.

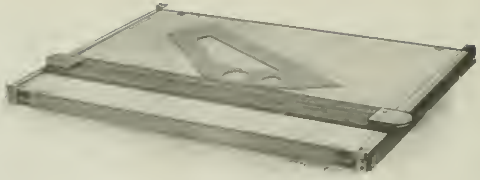


Fig. 1. Simplex Parallel Attachment for the Drawing Board

In preparing a straightedge for use in connection with this attachment, its length should be made 1/16 inch less than the length of the drawing board. A hole 1/16 inch in diameter is bored ½ inch from each end on the centerline of the straightedge, and countersunk on the under side to receive the head of the screw in the casing. Referring to Fig. 2, the upper left-hand corner of the board is shown at *A*, and the upper right-hand corner is arranged in the same way except that it is of the opposite hand. The arrangement of the lower left-hand corner of the board is shown at *B*, and the lower right-hand corner at *C*.

Parts which project over the surface of the drawing-board should be high enough to allow the straightedge to pass under with a little clearance. The dotted lines show the course of the cord, and the pulleys are numbered in the order in which the cord passes around them. The two ends of the cord are fastened at the lower left-hand corner which is marked *B*, and by loosening the screws sufficiently to allow the two ends of the cord to slip between the post and special washer, the cord may be pulled taut and the screws retightened. After the board has been strung up in this way, the angle of the straightedge can be varied. In order to keep it at any desired angle, the cord is passed over the ears on the bracket at the lower right-hand corner of the board *C*, which will keep the cord from slipping and the angle of the straightedge from varying. When it is desired to change the angle, the cord is removed from the ears and the straightedge set at the required angle, after which the cord is once more slipped over the ears to maintain the angle of the straightedge constant.

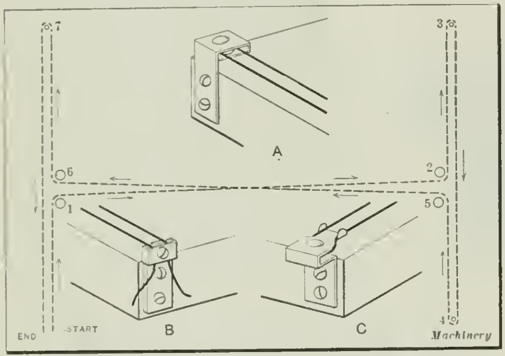


Fig. 2. Diagram showing Arrangement of Cord on Parallel Attachment

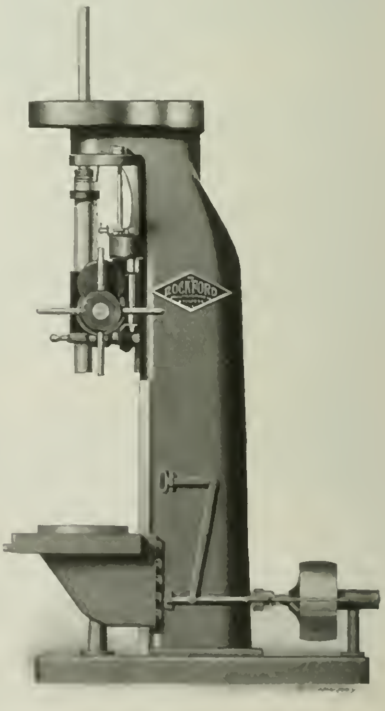
ROCKFORD BOX-COLUMN DRILLING MACHINE

The heavy-duty, box-column type of drilling machine illustrated herewith, which is a recent product of the Rockford Drilling Machine Co., Rockford, Ill., has a capacity for driving high-speed drills up to 2½ inches in diameter when working in steel. The machine is made in three different styles. Style No. 1 is equipped with a pulley which gives only one speed, and has a friction for starting and stopping the machine. Style No. 2 has a two-step back-geared cone pulley, which is driven by a double friction pulley countershaft. This arrangement gives four speeds forward and four reverse, or eight forward speeds. Style No. 3 is driven by either a direct-connected variable speed or constant speed motor.

Only one set of bevel gears is used in the drive, and these gears run at high speed. At the top of the machine the power is transmitted to the spindle through three spur gears which give a reduction of five to one. All of the gears are made of steel with the exception of the large driving gear on the spindle, this gear being made of semi-steel. The spindle is made of a special high-carbon steel, and the feed rack of chrome-nickel steel. The feed motion is taken from the spindle and transmitted through a gear-box which provides four changes of feed, any one of which is instantly obtained by turning a small lever up or down as the case may be.

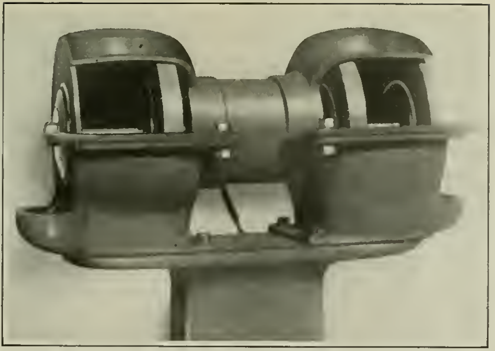
The hand feed is obtained through the pilot wheel which can be set in either of two positions. In one position the wheel is direct-connected to the cross-shaft and gives a quick approach or return of the spindle; in the other position, the drive is through reduction gears which afford a very powerful feed for hand facing or drilling. Provision is made for tripping the feed at any desired point by means of a dial that is graduated to correspond with the graduations on the spindle sleeve, and is equipped with a trip lock that can be set to automatically throw out the feed at any required point. The worm-wheel is made of bronze and the worm runs in an oil bath. The table has three T-slots which are planed from the solid, and is surrounded by an oil trough 4 inches wide by 3 inches deep.

The principal dimensions of this machine are as follows: distance from center of spindle to face of column, 10 inches; distance from end of spindle to table, 32 inches; distance from end of spindle to base, 50 inches; maximum feed motion, 20 inches; minimum diameter of spindle, 2 inches; taper



Rockford Heavy-duty Box-column Type of Drilling Machine hole in spindle, No. 5 Morse taper; size of working surface of table, 16 by 16 inches; vertical adjustment of table, 18 inches, available feed changes, 0.010, 0.015, 0.022, and 0.030 inch per revolution. Capacity for driving high-speed drills up to 2½ inches in diameter when working in steel; floor space occupied by machine, 25 by 59 inches; and net weight, 3000 pounds.

FORBES & MYERS GRINDER


Forbes & Myers Four-wheel Grinding Machine for sharpening Wood-workers' Tools

The grinder shown in the accompanying illustration has recently been placed upon the market by the Forbes & Myers Co., 178 Union St., Worcester, Mass., to meet the requirements of tool grinding in pattern and other wood-working shops. This machine is made in both bench and floor types. The accompanying illustration shows the upper part of the floor type machine. These machines are equipped with four wheels of the following sizes: one, 10 by 1 inch wheel with a flat face for use in grinding chisels and other plain cutters; three wheels, 10 inches in diameter by 1 inch, ½ inch and ¼ inch face width, respectively, with round faces for use in grinding gages and special cutters. Wheels of other shapes can be furnished to meet the requirements in grinding special tools.

The wheel guards are made of heavy malleable iron and the tool-rests are adjustable in two directions. The spindle is carried by ball bearings which are carefully protected against damage from dirt and grit. Provision is made for packing the bearings with a sufficient amount of grease to last for one year under ordinary working conditions. The motor is of the squirrel cage induction type and is adapted for use on two- or three-phase alternating current circuits. When operating on 60-cycle current, the speed is 1800 revolutions per minute, and when operating on 25- or 50-cycle current, the speed is 1500 revolutions per minute. The motor develops ½ horsepower, which is ample for grinding all kinds of wood-working tools; and as the motor is fully enclosed, adequate protection is provided against the entrance of dirt into the motor or the injury of its parts.

INGERSOLL-RAND PNEUMATIC DRILL

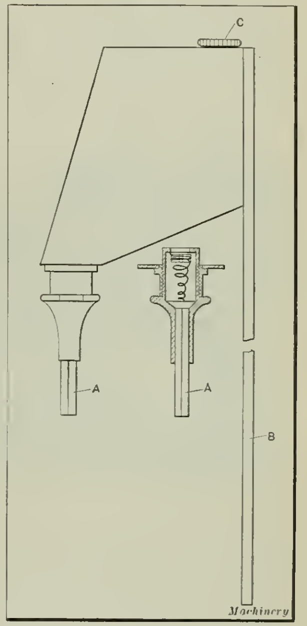
The pneumatic drill shown in the accompanying illustration is a recent product of the Ingersoll-Rand Co., 11 Broadway, New York City, and is known as the "Little David" close quarters drill. This tool is particularly adapted for working in confined positions where the regular type of four piston reciprocating drill of this company's manufacture could not be used. The distance from the end of the casing to the center of the spindle is only 1 5/16 inch on the close quarters drill, and the motor is of the 3-cylinder type. The valve is of the rotary type which is a form of construction that experience has shown to be very satisfactory on the standard "Little David" drills The crankshank is operated by three ratcheted levers which form a direct connection between the pistons and the drill spindle.

Ingersoll-Rand "Little David" Drill for use in Close Quarters

One of the important features of this tool is that there is practically no strain on the crankshaft, as the power is transmitted direct from the pistons through the levers to the ratchet spindle. Another important feature is that with the triple ratchet arrangement on the spindle, one of the ratchets is engaged at all times. It is claimed that this construction is the means of developing more power and a more constant pull on the spindle than would otherwise be obtained. Owing to the extreme simplicity of the design, it is estimated that this tool can be dismantled and completely reassembled in 30 minutes. The spindle is fitted with a No. 4 Morse taper socket and the tool is rated for drilling holes up to 3 inches and for reaming and tapping holes up to 2 inches.

OIL-RIGHT OVERHEAD OIL-CAN

Convenience of manipulation and complete safety to the operator are features of the oil-can for lubricating overhead bearings, which has been placed upon the market by the Oil-Right Overhead Oil-Can Co., 3501 Florissant Ave., St. Louis, Mo. This can, which is shown in the accompanying illustration, is made of 24 gage tin and holds one quart of oil. The can is mounted on a stick 8 feet in length which provides for reaching up to the bearings without requiring the operator to climb a ladder. As a result, the danger of accidents resulting from the oiler being caught by the shafting is eliminated; and as he is not required to carry the ladder about with him, it will be evident that he can work very much faster.



Oil-right Overhead Oil-can for lubricating Lineshaft Bearings without climbing a Ladder

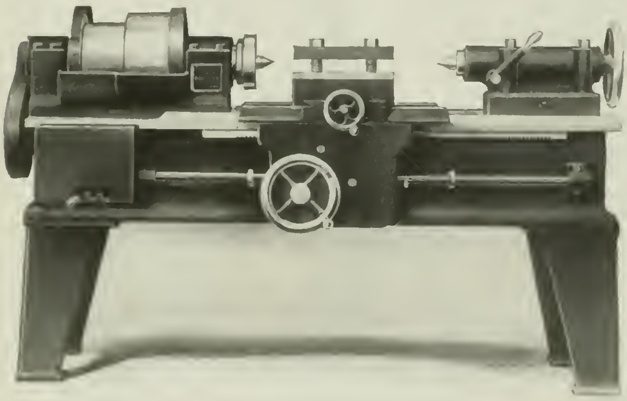
In using this oil-can, the valve stem *A* is placed in the oil cup or reservoir, and the oiler then pulls down on the staff *B*. This results in raising the valve stem and opening the valve in the oil-can so that the oil can flow down into the bearing. In order to fill the can the air vent *C* at the top is screwed down until it is tightly closed. The can is then turned over and the valve compartment unscrewed to allow the can to be filled with oil. The valve compartment is then screwed back into place, the can turned over, and the air vent once more opened, after which the can is ready for use.

FAIRBANKS-MORSE MANUFACTURING LATHE

The machine which forms the subject of this article was designed by the Fairbanks-Morse Co., 30 Church St., New

York City, to meet the demand for a plain heavy-duty standard lathe on which all useless finish was dispensed with, and which is of such simple design that it can be operated by unskilled labor. The machine is particularly suitable for performing the turning and boring operations on projectiles of sizes ranging from 3 to 6 inches in diameter. To make the machine capable of standing up under the most severe service, all of the gearing is of steel and the headstock bearings are chambered to hold a liberal quantity of oil, the bearings being lubricated by a ring-oiling system. The spindle runs in special bronze bushings which may be easily renewed; and the spindle is bored for a No. 5 Morse taper center. It is made solid unless otherwise specified, and can be furnished bored ready to take a 3-inch shell. By making the front end of the spindle slightly tapered, the lathe can be fitted with an expanding arbor.

The drive is from a double friction countershaft, which should be arranged to run at 110 revolutions per minute to obtain a cutting speed of 68 feet per minute. Three changes of feed are obtained by means of a shifting lever in the gear-box; and unless otherwise specified, the feeds provided are 1/8, 1/16, and 1/32 inch. The carriage is provided with an automatic stop in either direction. The cross-feed is by hand. When so desired, the lathe can be equipped with a special turret on the carriage, an oil pan and pump, and forming attachments. The principal dimensions of this machine are as follows: swing over bed, 16 inches; swing over carriage, 10 inches; distance between centers on a lathe with a 7-foot bed, 28 inches; width of driving belt, 6 inches; ratio of back gears, 6.25 to 1; and travel of tailstock spindle, 8 inches.



Fairbanks-Morse 16-inch Manufacturing Lathe for turning and boring Projectiles

AMERICAN LINESHAFT HANGER BEARING

In the lineshaft hanger bearing which has recently been placed upon the market by the American Roller Bearing Co., Pittsburg, Pa., there are four principal parts, consisting of the inner sleeve, the load rollers, the spacing rollers, and the outer sleeve or housing. These four parts form a simple self-contained unit which may be conveniently handled. The load rollers are held absolutely parallel at all times by means of intermediate spacing rollers which turn in the opposite direction to the load rollers. These spacing rollers prevent contact between the load rollers and eliminate any sliding contact, the result being a free rolling motion.

One of the complete assembled bearings for a lineshaft hanger is shown in Fig 2 with the roller unit partially removed The larger sized rollers are the load rollers which travel in a race or track on the inner sleeve. This sleeve is hardened and ground to insure perfect accuracy and the reduction of wear to a minimum. The smaller rollers are the spacing rollers which are supported by the race flanges or tracks on the inner sleeve. One of the retaining collars which are employed to insure holding the spacing rollers in the required position is also shown in this illustration. These collars are pressed onto the inner sleeve and do not receive any of the load.

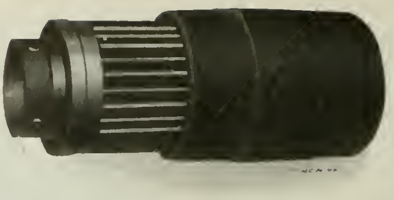


Fig. 1. American Roller Bearing for Lineshaft Hanger.

These bearings do not require lubrication, so that in addition to the saving of power resulting from the application of anti-friction bearings, a further economy is obtained by the elimination of a large part of the labor costs incident to the care and maintenance of plain bearings. Furthermore, the bearings are extremely long lived and danger of their heating due to the lack of attention is practically eliminated. The shaft hanger bearings made by the American Roller Bearing Co. are furnished for all standard types of hangers, the housings of the bearings being designed to receive the set-screws, balls and sockets or other holding device employed in such hangers. In addition to producing roller bearings for power transmission equipments, this company specializes in the manufacture of bearings for heavy machinery.

WESTINGHOUSE MAGNETIC BRAKE

Readers of MACHINERY will be interested in the following description of an alternating-current magnetic brake which has been designed especially for use with induction motors operating cranes, hoists, and many different classes of mill machinery. It is applicable wherever frequent stops and reversals are necessary; and as the operating magnet is single-phase, this brake may be used on polyphase circuits. The action of the brake is simple. When the controller is thrown to the off position, two brake shoes are forced by means of springs against a cast-iron brake-wheel which is keyed to the motor shaft. When the motor is started, the magnet coil is energized and the action of the magnet, operating through a lever and a toggle, forces the shoes apart and releases the brake.

In the design of this brake, the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has embodied several improvements. It is a complete self-contained unit that can be mounted directly beside the motor or on a special sole-plate. Since the application of its braking action is not dependent upon gravity, it can be mounted in any position, from the horizontal to 90 degrees in such a direction that the movable magnet lever has no tendency to fall away from the stationary magnet core. This makes this brake especially desirable for applica-

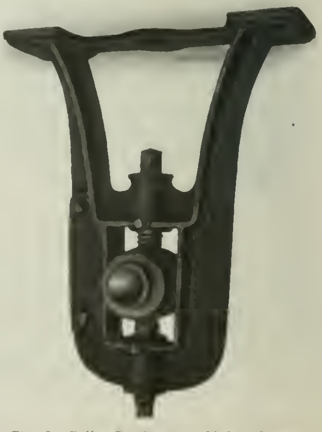


Fig. 2. Roller Bearing assembled in Hanger

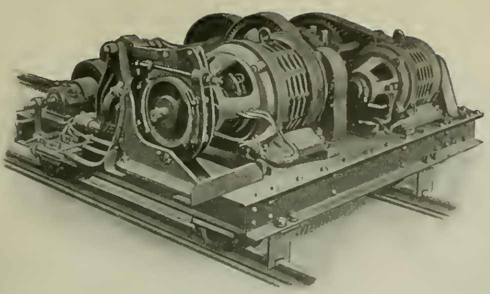


Fig. 1. Application of Magnetic Brake on Motor of a Crane Trolley

tions where the position of the motor changes during the operation, as on a roller lift-bridge. The over-all height has been reduced to a minimum so that it can be used in places where head room is limited, as, for instance, in crane service. The insulation is such that the brake is adaptable for use outdoors, and it can withstand exposure to the weather without any modification whatever. No dashpots are used, thus all possibility of trouble due to sticking is eliminated. The brake shoes are made of cast iron to which are fastened woven asbestos fabric linings. The wheel is made of cast iron, and the coefficient of friction between the brake wheel and shoes is not materially affected by oil, grease or water.

The pressure on the brake shoes can be varied by means of nuts on the spring rods, and wear on the shoes can be taken up by means of an adjusting screw. Two springs are used and only two adjustment points are necessary. If the operator fails to take care of the adjustment which compensates for wear on the shoes, the result will not be a failure of the brake to set; it will only mean that the machine cannot be started, as the brake will not release. With a view to facilitating repairs, axle steel pins held in place by cotter pins have been used wherever possible. A pair of pliers and a screwdriver are the only tools required to completely dismantle or assemble the brake. This brake, known as Type A, is made in sizes ranging from 5 to 100 horsepower for 25 and 60 cycle, 220, 440 and 550 volt circuits.

FOSDICK 3-FOOT RADIAL DRILL

In the June, 1914, and August, 1913, numbers of Machinery, descriptions were published of 5-foot and 3-foot radial drills manufactured by the Fosdick Machine Tool Co., Cincinnati, Ohio. Recently this company has added to its line another type of machine built in a 3-foot size, which is known as the Fosdick 3-foot heavy-duty round column radial drill. In its essential features the design of this machine combines the features of the two Fosdick radial drills previously referred to. The base is surrounded by an oil channel which runs completely around the column in order to avoid weakening the cross-section of the base immediately in front of the column where great rigidity is required. The flange around the channel is flush with the working surface of the base, so that the base may be embedded in the concrete to the floor level if so desired. Another valuable feature is that the high point in the channel is at the extreme outer end of the base so that the oil drains on both sides to the rear of the column. The table is of exceptionally rigid construction and provided with channels for the lubricant which lead to a pocket at one corner from which it may be drained into a receptacle placed to receive it. The table is a separate unit bolted to the base of the machine, and the adoption of this form of construction in place of the swinging table made it possible to greatly reinforce the lower end of the column. Swinging or tilting tables of various types may be supplied with the machine if so desired.

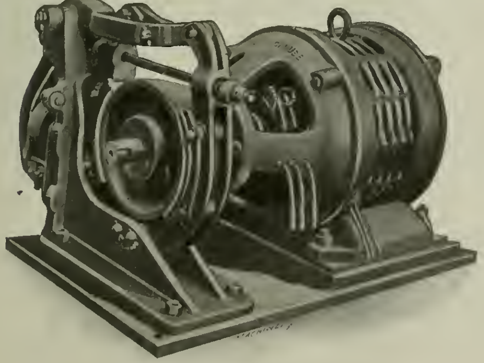
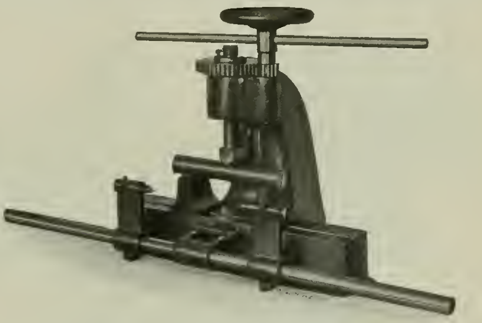


Fig. 2. Westinghouse Motor equipped with new Magnetic Brake

GEIER NO. 3A STRAIGHTENING PRESS

In the November, 1910, number of Machinery, a description was published of the No. 1 straightening press manufactured by the P. A. Geier Co., St. Clair Ave. and 51st St., Cleveland, Ohio. This company has now placed upon the market the No. 3A straightening press which is illustrated herewith. The design of this machine is essentially the same as that of the preceding type with the exception of the fact that a geared drive has been applied between the hand lever and screw. This drive, in conjunction with the ball thrust bearings which reduce friction to a minimum, enables the operator to develop a very high pressure on the thrust block through the expenditure of a reasonable effort. The ratio is such that a force of 100 pounds at the end of the hand lever will create a pressure of 50 tons at the thrust block. The centers will take stock up to 52 inches in length, and any crankshaft not over 52 inches long, that will rotate within a 10-inch circle, can be straightened. The weight of the press is 725 pounds.



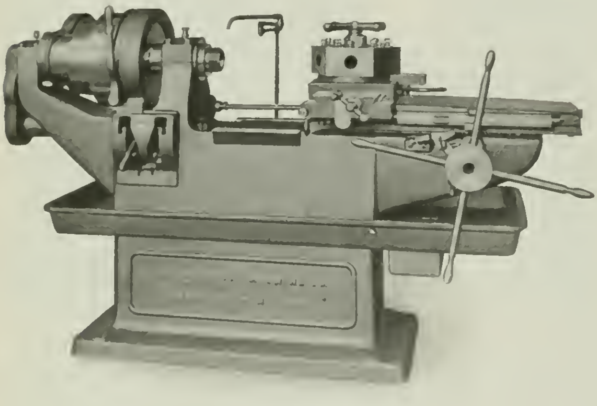
P. A. Geier No. 3A Straightening Press with Geared Drive

W. P. DAVIS TURRET LATHE

The W. P. Davis Machine Co., 305 St. Paul St., Rochester, N. Y., has redesigned its 24-inch turret lathe to make a modern and powerfully constructed tool. The machine is built in two styles. One is a plain head boring and chucking lathe, with the turret mounted on a cross-slide, and provided with power cross-feed. The other machine is for boring, forming and chucking operations, being suitable for a wider range of work than the plain machine. In order to obtain the utmost strength and rigidity, the head and bed are cast in one piece. The head of the new machine has been shortened, and is built with a three-step cone pulley of large diameter and wide face. The cone is made to run free on the spindle, and a friction clutch operated by a hand lever secures the pulley to the spindle when required. The back gears are thrown in by a positive jaw clutch built into the face gear, thus eliminating the possibility of belt-slip under heavy cuts.

The spindle is made of hammered crucible steel, and runs in bearings made of babbitt metal. A hole 2⅛ inches in diameter runs through the spindle, allowing an opportunity to use a draw-in chuck and collets. The nose of the spindle is bored for No. 6 Morse taper. In order to facilitate the operation of the machine, a gear box has been placed just below the head, containing six changes of positive feed ranging from 0.008 to 0.100 inch. The turret is six-sided and measures 12 inches across the faces. As shown, it is mounted on a cross-slide, and is operated across the saddle ways by power feed obtained by means of a roller chain and sprocket with an adjustable automatic stop. The saddle is fitted with independent automatic stops for each face of the turret, which are positive in action, permitting shoulder work to be done. An oil pan and pump are part of the regular equipment of the machine, and a number of adjustments have been provided, which are calculated to add to its efficiency and convenience of operation.

The principal dimensions of the machine are as follows: Back gear ratio, 7⅜ to 1; twelve available speed changes, 7 to 265 revolutions per minute; six available feeds, 0.008 to 0.100 inch; width of driving belt, 4 inches; diameter of hole in spindle, 2⅛ inches; maximum cross-feed of turret, 9¾ inches; swing over bed, 24 inches; floor space occupied, 36 by 120 inches; and weight of machine, 4000 pounds.



Redesigned W. P. Davis 24-inch Turret Lathe

STOLP POWER PRESSES

About two years ago a movement was started in England to Americanize automobile manufacturing methods and at that time the Coventry Motor Fittings Co., which is a leading radiator manufacturing concern, sent a representative to this country to investigate methods and machinery used in American automobile factories. This led to the placing of an order for the machines which form the subject of this article with F. H. Stolp, 92 Brook St., Geneva, N. Y. The tube drawing machine shown in Fig. 1 works automatically and will draw up enough tubes to make 200 automobile radiators a day. The machine is adapted for drawing tubing or molding of any form from flat ribbon stock of any metal. It will draw tubing with a plain or lock seam as desired. In additon to drawing, the machine automatically cuts off the tube to any desired length. Fig. 2 shows a self-feeding press designed for use in making fins or plates for automobile radiators, the capacity of the machine being enough fins for making 50 radiators a day. It will be seen that the machine is an automatic self-feeding punch press which takes the place of an ordinary press equipped with a roll feed. The machine makes the fins complete, folding over the edge, perforating and cutting off to a predetemined length in a single operation.

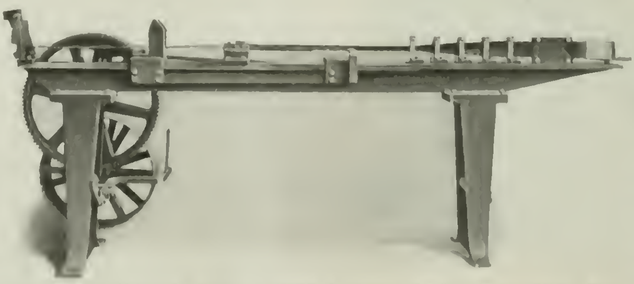


Fig. 1. Stolp Machine for drawing and cutting off Tubing or Molding from Flat Ribbon Stock

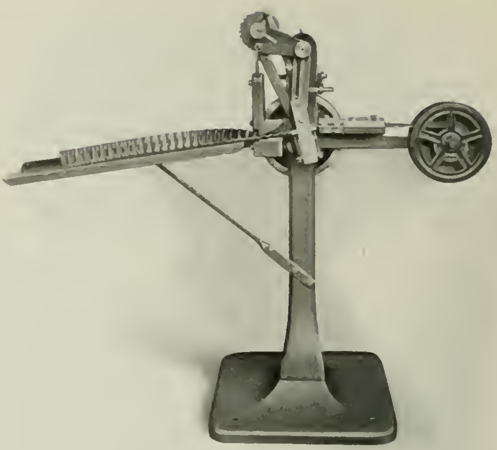


Fig. 2. Stolp Automatic Self-Feeding Punch Press for making Automobile Radiator Fins

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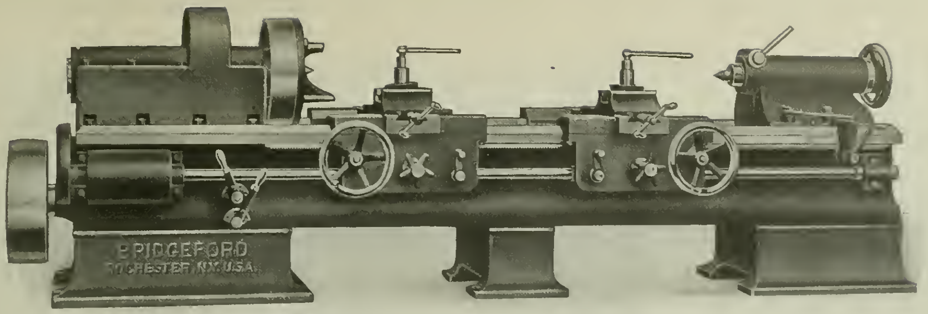
BRIDGEFORD PLAIN TURNING MACHINE

To meet the present demand for a simple and convenient machine particularly adapted to the requirements of plain turning, the Bridgeford Machine Tool Works, Rochester, N. Y., have developed the lathe which is illustrated and described herewith. This machine has fewer parts than an engine lathe, is powerfully constructed, and convenient to operate. Three mechanical speed-changes are provided through heavy cut steel gears, and the use of a two-speed countershaft which is furnished with the machine increases the number of available speeds to six. The feed-box provides four changes of feed for each change of gears at the end of the lathe.

All gearing used on the machine is made of steel and the speed and feed gears run in oil. The main driving gears is 6½ inches wide and 3 pitch; all other gears are made proportionally strong, according to the severity of the service to which they are subjected. When the machine is equipped with individual motor drive, the use of a 25-horsepower motor is recommended. The drive is through a constant speed pulley and two levers at the front of the machine control all changes of speeds and feeds. The lathe swings 27 inches over the ways, 13½ inches over the carriage, and takes 8 feet between centers with the standard length of bed. The machine can be furnished with one or two carriages, as desired, and is built strong enough to work high-speed steel tools to the limit of their capacity. The provision of two carriages on this machine adds greatly to the rapidity with which it is able to handle turning operations on classes of work which come within its range.



Bridgeford Plain Turning Lathe which swings 13½ inches over Carriage and 27 inches over Ways

LINCOLN ARC WELDING MACHINE

The Lincoln Electric Co., East 38th St. and Kelley Ave., Cleveland, Ohio, has recently placed upon the market an electric arc welding machine which combines the features of economy in power consumption, simplicity of operation, and reliability of service. This welder is so constructed that it always generates exactly the voltage which is required at the arc, and at the same time the current is maintained practically constant. On this account it is unnecessary to employ a rheostat or other means for adjusting the resistance of the circuit, and as a result no power is wasted in this way. This feature is made possible by the special windings of the generator.

The method of control has been simplified by eliminating the necessity of employing a resistance device in the circuit, and the operation of the machine is said to be so simple that any reasonably intelligent man can learn to run it. Emergency service is frequently demanded of arc welding machines, and for that reason the new Lincoln arc welder has been designed to give satisfactory service during long periods of heavy duty and to carry over loads without damage to the machine.

NEW MACHINERY AND TOOLS NOTES

Cutting-off Machine: Etna Machine Co., Toledo, Ohio. This machine, which has a capacity for stock up to 4 inches in diameter, represents the addition of a larger sized machine to the line of cutting-off machines of this company's manufacture.

Spot Welding Machine: National Electric Welder Co., Warren, Ohio. A power-driven spot welding machine intended for the rapid production of duplicate parts from light gage sheet steel. The machine is known as the "National Jr. Automatic Welder."

Water Cooler: L. G. Stebbins, New London, Conn. A sanitary water cooler especially adapted for shop use. The cooler is designed with an air chamber in the ice container, which is said to retard melting, thus making the cooler economical in the use of ice.

Universal Counter: New Haven Trolley Supply Co., New Haven, Conn. A counter in which the distinctive feature consists of operation by either a rotary or a reciprocating motion, so that the counter may be employed for recording either revolutions or strokes.

Air Pump: Hartford Machine Screw Co., Hartford, Conn. Two types of air pump for use in the garages of industrial plants employing motor trucks for transporting their product. One pump is mounted on a truck for portable service, while the other is a stationary unit.

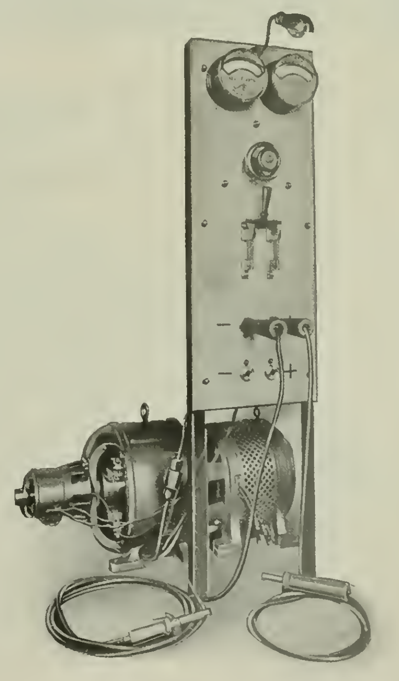
Automobile Trailer: Erie Trailer Mfg. Co., Erie, Pa. A "trailer" which can be coupled to any type of automobile for use in rapidly transporting material for a considerable distance. Such a trailer would doubtless be found very valuable by numerous manufacturing plants.

Tool-Holder: Keystone Equipment Co., Philadelphia, Pa. A tool-holder for high-speed cutters, which is designed in such a way that the cutting edge of the tool is protected from both vertical and lateral stresses. The holder is made of cold-drawn steel, and is casehardened.

Self-opening Die-head: Eastern Machine Screw Corporation, New Haven, Conn. This die-head is suitable for use on both automatic and hand screw machines. The chasers are held firmly over the cutting edge and cannot tip, so that the possibility of producing tapered blades is avoided.

Cutting-off Chuck: Westcott Chuck Co., Oneida, N. Y. A geared scroll cutting-off chuck especially adapted to the requirements of explosive shell work. The jaws are adjustable through spur gears and are designed to afford a powerful grip. Both independent and universal control of the jaws is provided.

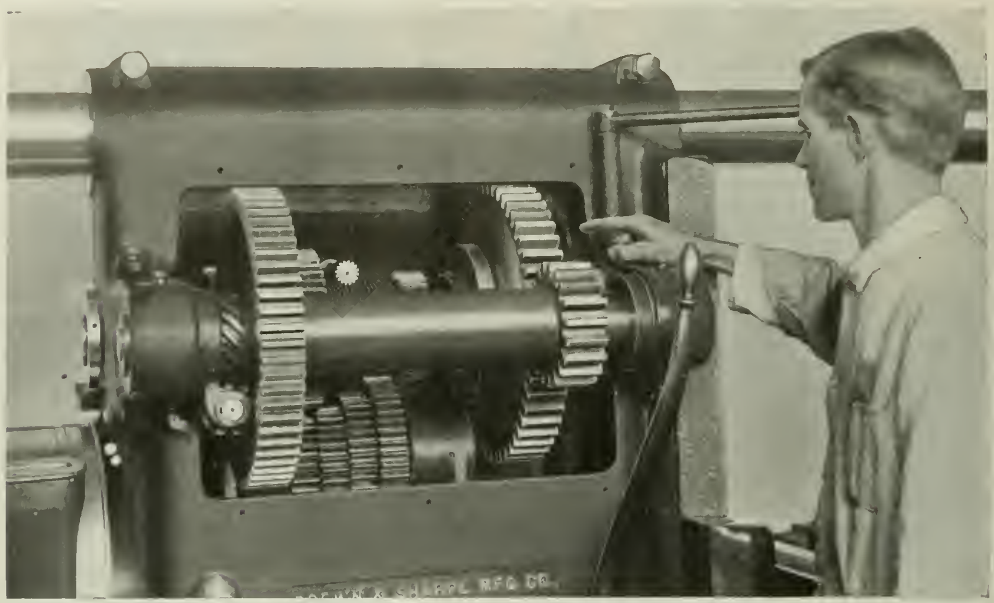
Compound Cross-feed Handles: Porter Cable Machine Co., Syracuse, N. Y. To overcome trouble experienced by lathe hands in having cross-feed handles so located that they interfere in certain positions, this company has redesigned the feed works on its 12-inch lathe, so that the handles cannot interfere in any position.



Lincoln Arc Welding Machine in which Voltage is held Constant

Four-Head Planing Machine: Betts Machine Co., Wilmington, Del. This machine has a capacity for handling work 16 feet wide, 10 feet high and 30 feet long. The machine was built for the League Island Navy Yard, Philadelphia, Pa.; it is motor driven and designed to provide for the rapid manipulation of all moving parts.

Rotary Cutting-off Machine: Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa. A high-duty 6-inch rotary cutting-off machine particularly adapted for use in connection with the manufacture of high explosive shells. The hourly capacity of the machine is 20 pieces of 0.50 per cent carbon steel, 6 inches in diameter.



The Power You Get from Those Rugged Back Gears

Look at their size. Notice their large diameters, wide faces and coarse pitch. These features mean smooth, even, and very powerful driving action. The power delivered to the large constant speed driving pulley by the wide belt is transmitted through a powerful train of hardened gears to the back gears and the large driving gear at the front of the spindle. By this means the drive is always directly to the front of the spindle, thus eliminating possibility of spindle torsion.

All gears run smoothly, the teeth being carefully cut and the supporting shafts housed in massive bearings close to the points of drive. Note how this is done in connection with the bearings of the back gear shaft shown above. The large size of the back gear sleeve is also shown. Such proportions overcome the vibrations due to torsion. A lever on the side of the machine controls the back gears and when they are thrown in or out of engagement, automatic locking pins secure or disengage the large driving gear at the front of the spindle.

The ample power furnished at all times is one of the main reasons why those big jobs can be mounted on the table and deep, result-producing cuts can be taken at coarse feeds.

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B. & S. No. 5B Heavy Plain Milling Machine

The largest and most powerful of our line of plain milling machines is shown below equipped with motor drive, milling a steel test block. For the shop demanding definite results on heavy work this is the machine to consider. With power to spare for work within its capacity; an efficient feed mechanism for driving a heavily loaded table against deep cuts; independent spindle speed and table feed change mechanisms to give a wide and flexible range of speeds and feeds; and a general handy arrangement of all operating parts, it is a machine at once productive and easy to operate.

Another point to remember. The sturdy design and the careful construction of these machines mean real and continuous service.

If you have heavy milling, this particular machine will be of interest. Or if you don't need this particular machine there may be another in our line of 40 sizes and styles that you do need. Better write for descriptive literature and see.

You Do Milling? Well, Read This

How often in a day's work do you encounter a troublesome problem in milling? It may be something unusual, a point about which you may feel that your solution is correct but still you would like to be certain. That is the time when a book like our "Practical Treatise on Milling and Milling Machines" is invaluable. This book is new and contains a readable, up-to-date fund of information about milling in general. Why not order a copy now?

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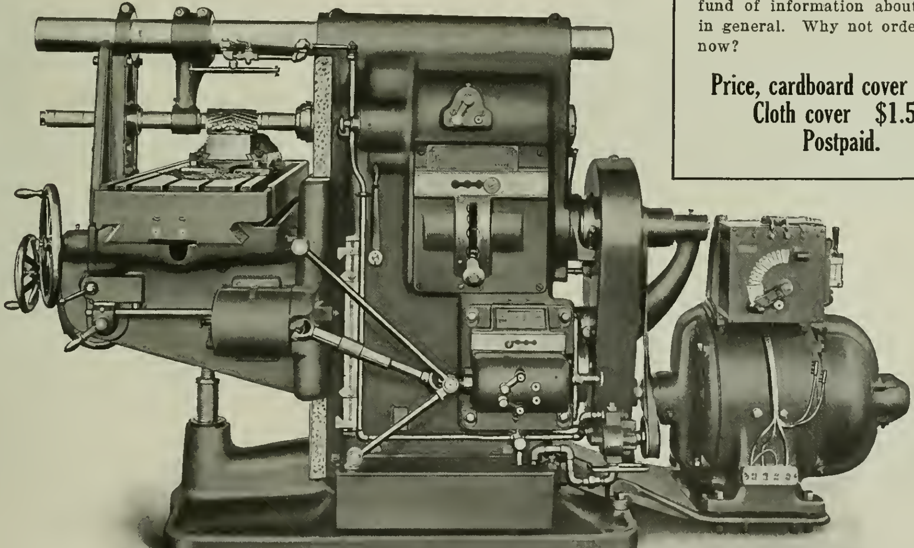


Providence, Rhode Island, U.S.A.

CANADIAN: The Canadian Fairbanks-Morse Co., Ltd., Montreal, Toronto, Winnipeg, Calgary, Vancouver, St. John, Saskatoon.

FOREIGN: Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow; F. G. Kretschmer & Co., Frankfurt, a/M., Germany; V. Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway; Schuchardt & Schutte, Petrograd, Russia; Fenwick, Freres & Co., Paris, France; Liege, Belgium, Turin, Italy, Zurich, Switzerland, Barcelona, Spain; F. W. Horne Co., Tokio, Japan; L. A. Vail, Melbourne, Australia; F. L. Strong, Manila, P. I.

READ PAGE 71

Turning Machine: Brightman Mfg. Co., Columbus, Ohio. This is a special machine for turning vanadium or other alloy steel from the rough bar ready for use in automatic machines employed in the manufacture of shrapnel and other explosive shells. The machine will turn all sizes of rounds from 1 to 6 inches in diameter, inclusive.

Yoke Riveting and Punching Machine: Hanna Engineering Works, 2059 Elston Ave., Chicago, Ill. In this combination machine the riveter is of the same design as that of the 100-ton lever and toggle machine of this company's manufacture. An auxiliary dash or mechanism has been added which absorbs the shock when the punch passes through the work.

Adjustable Boring Bar: Madison Mfg. Co., Muskegon, Mich. An adjustable cutter and bar for use in automatic machines, turret lathes, boring mills, and other machines. These cutters are intended to take the place of reamers and to insure obtaining absolutely straight holes of any size. It is claimed that the cutter can be set to within 0.00025 inch of the required size.

Combination Drafting Instrument: 3-in-1 Co., Hartford, Conn. A combination instrument developed as a substitute for drafting machines, triangles and protractors. The three instruments referred to are combined in the new combination instrument which consists of a 90-degree protractor and two adjustable transparent blades. Either blade can be used against a T-square or straightedge.

Die and Shell Hardening Furnaces: Tate, Jones & Co., Inc., Empire Building, Pittsburg, Pa. One of these furnaces is built with three independently heated chambers and is intended for use in hardening dies. The other furnace referred to is of the lead bath type, and is intended for use in connection with the manufacture of shrapnel shells of the type used by the Russian Government.

Portable Pneumatic Grinder: Ingersoll-Rand Co., 11 Broadway, New York City. In designing this tool particular attention was paid to developing a simple construction in which all parts are readily accessible. The grinder is adapted for using wheels up to 8 inches in diameter at 3400 R. P. M.; and is particularly suitable for grinding, buffing, and polishing operations, and for cleaning castings.

Blower and Compressor: DeLaval Steam Turbine Co., Trenton, N. J. A line of centrifugal blowers and compressors which can be operated at peripheral velocities of from 450 to 600 feet per second. It is possible in practically all cases to connect the blower or compressor directly to the DeLaval steam turbine. A pressure of from 3 to 4 pounds per square inch can be generated in a single-stage blower.

Single-Purpose Lathe: Cleveland Machinery & Supply Co., Cleveland, Ohio. A lathe particularly designed to meet the requirements of shell work, but which can also be employed in general manufacture. The machine may be provided with an open belt drive or with a geared head. It is of simple construction, and as a result it is claimed that an unskilled workman can readily be taught to operate it.

Projectile Lathe: Pittsburg Machine Tool Co., Braddock, Pa. This lathe is adapted for heavy projectile boring through the provision of an extra heavy carriage and a large saddle to hold an 8-inch boring bar. An oil tube delivers lubricant to the tool and the bed is furnished with an oil pan. A forming attachment at the back of the lathe provides for shaping the interior of the shell as required.

Lathe Turret and Diameter Stops: Fay & Scott, Dexter, Maine. The turret referred to is virtually a multiple tool arranged in such a manner that any number of tools up to six can be brought into operation successively. The diameter stop is automatic in its operation, the motion being taken from the revolving turret head. This device provides a positive independent feed stop for each face of the turret.

Stud-bolt Grip: E. Spring, 226 Northwestern Ave., Detroit, Mich. A device which takes the place of a cap nut for tightening or a pipe wrench for loosening studs. It consists of a block with a cylindrical opening to receive the stud and a knurled eccentric disk which engages the stud. The device is dropped over the stud and turned with an ordinary wrench, the grip on the stud being obtained by the eccentric knurled disk.

Elevating Trucks: Stuebing Truck Co., Cincinnati, Ohio. Elevating trucks of the type used in connection with loading platforms. The trucks are made in two styles. One of these trucks is provided with three wheels and the load is both lifted and lowered by means of the handle. The other one is of the 4-wheel type, and on this one the load is lifted by means of a handle but released by means of a foot lever and hydraulic check.

Rim Friction Clutch: The Lehigh Clutch Co., Camden, N. J. This clutch is of the opposite jaw type, and each jaw is operated by an independent lever which is connected with the spool by turn buckles. These turn buckles serve to adjust the clutch when the shoes begin to wear, as the wooden shoe or friction block on either jaw can be shifted without disturbing the other jaws, and without requiring the removal of the clutch from the shaft.

Portable Electric Drill: Standard Electric Tool Co., Cincinnati, Ohio. This company has added three new sizes to its line of portable electric drills; the new tools have capacities of ⅜, ½ and ⅝ inch, respectively. In all essential features the design follows that of other portable electric drills of this company's manufacture. They have weights of 17, 24, and 26 pounds, respectively, and are furnished with motors for operation on 110 or 220 volt current.

Universal Grinder: Thompson Grinder Co., Springfield, Ohio. This machine has a capacity for grinding cylindrical work up to 10 inches in diameter by 36 inches long; and for surface grinding it will handle work up to 8 inches wide by 48 inches long. An internal grinding attachment can be supplied which adapts the machine for grinding holes up to 12 inches in depth. Milling cutters up to 20 inches in diameter and knives up to 48 inches in length can be sharpened.

Steam-hydraulic Press: Mesta Machine Co., Pittsburg, Pa. A line of steam-hydraulic presses which are made in various sizes and in two general types. One of these is the 4-column type, while the other is of the single frame type, the latter being the latest product of the Mesta Machine Co. Presses of this type are built with capacities up to 500 tons. The machine is entirely self-contained, the steam and hydraulic cylinders being direct connected, so that the water does not have to be forced through pipes when the press is in operation.

Double Lever Bar Bender: Wallace Supplies Mfg. Co., Chicago, Ill. An adjustable machine adaptable for making two bends—one right-hand and the other left-hand—without resetting the bending device and without removing the stock from the machine. In cold-bending, the machine will handle flat stock up to ¼ by 2 inches, rounds up to ⅝ inch in diameter, and square stock up to ½ inch. In hot bending, the capacity is for flat stock up to ½ by 2 inches, rounds up to ⅞ inch in diameter, and square stock up to ¾ inch.

* * *

BAINES "KEYSTONE" RUST-PROOFING PROCESS

A process of rust-proofing steel and iron is being promoted by Henry C. Baines, engineer and metallurgical chemist of Baines' Metallurgical-Chemical Laboratories, 411 First St., Jackson, Mich. The process was developed in 1903, and several English factories were equipped for treating metal parts by it. The treatment consists of boiling the parts to be rust-proofed in a combination of chemicals for from fifty minutes to two hours, depending on the depth of rust-proof coating required and the size and bulk of the articles to be treated. The equipment required is simple, consisting of an iron tank of a size necessary to accommodate the products to be treated, and a few utensils. The tank may be heated by steam or by any other heat. The cost of the treatment, including chemicals, heat and labor, is less than one cent a pound for small articles, averaging five to the pound, and the cost decreases in proportion to the increase of weight and bulk of the material treated. It is claimed that iron and steel, both wrought and cast, can be rendered permanently rust-resisting and that it imparts a black mat-finish to the metal, thus providing an attractive coloring and rust-proofing in one process. The treatment is well suited for articles to be painted, as it furnishes a ground impervious to rust and chemical action, and effectually prevents peeling of paint due to these causes.

* * *

SHAPING TOOTH ENDS FOR CLASH GEARS

The Rockford Milling Machine Co. employs a simple method for shaping the ends of gear teeth of clash gears used in the speed-changing mechanism of the Rockford milling machine, which is simpler and cheaper to effect than the tooth rounding commonly resorted to for facilitating the changing of speeds. The alternate teeth are shortened with a small end-mill, the mill being sunk about 1/16 inch below the side faces of the gear. When a gear thus treated is brought laterally into contact with another in order to change the speed, the teeth slip by until one drops into the space at the end of a short tooth, and then full engagement is easily accomplished by the operator. The gear train is not moved forward or backward by engagement, as is usually necessary with the rounded tooth ends; hence, less effort is required of the operator to change speeds.

A CUTTER GRINDER THAT IS ALSO

a Cylindrical Grinder
a Surface Grinder
an Internal Grinder

A Cutter Grinder that is also a Cylindrical Grinder, a Surface Grinder and an Internal Grinder—that's the "Cincinnati" No. 2 Universal Cutter and Tool Grinder. It is **complete** toolroom machine; sharpens all sorts of cutters, including large face mills. Overhead works are simple, only one belt from the line shaft; can be furnished as a self-contained motor-driven machine if desired; many more advantages we'd like to tell about.

The special catalog giving full details sent upon request.

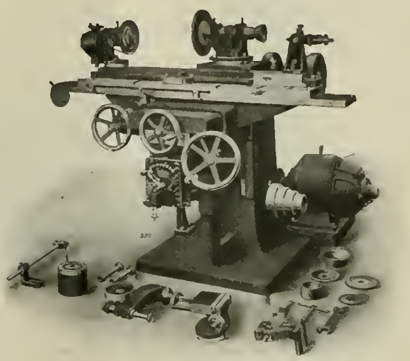
¶ Large face mills are always awkward to handle. Sharpening them is easy on this machine, because they are held on a revolving spindle just as on the Milling Machine. **And the clearance dials insure accuracy.**

¶ For spiral mills and similar work it has a graduated dial from which the desired clearance angle is read direct, and getting the correct clearance is the most important thing about cutter sharpening. With this machine it is easy.

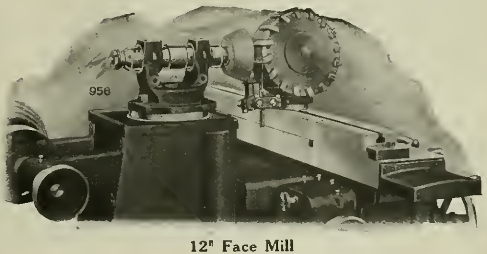
¶ The **AUTOMATIC TABLE MOVEMENT** enables you to do Cylindrical Grinding, and with the Internal Grinding Attachment you can grind the holes in jig bushings and small machine parts, such as gears, clutches, etc.

**THE CINCINNATI
MILLING MACHINE
COMPANY**

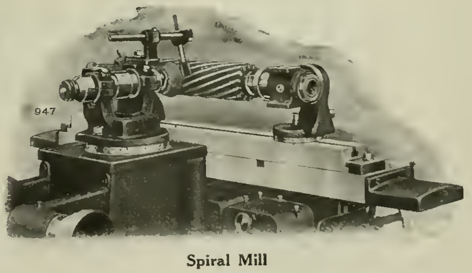
CINCINNATI OHIO, U. S. A.



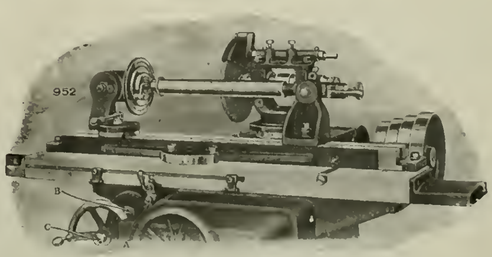
No. 2 Grinder Motor-Driven



12" Face Mill



Spiral Mill



Circular Grinding Attachment
Automatic Feed

S. A. E. STANDARD COTTER PINS

A committee of the Society of Automobile Engineers has worked out a table of standard cotter pins, showing 41 recommended standard sizes. These are to take the place of between 250 and 300 different sizes now in common use. Table I shows the range of sizes, while Table II shows where they may be applied. Table I, showing the sizes in a convenient form, may be developed from Table II. The sizes marked "x" are the ones in the short series of Table I, those marked "x¹" are the sizes required to complete the long series, and those indicated by "A" are extra sizes not called for on Table II, which seem desirable in order to fill out the line. There are 23 different sizes in the short series, 13 in the long, and 5 inserted to fill out the table, making a total of 41.

TABLE I S. A. E. STANDARD SIZES OF COTTER PINS

B. W. Gage		13	12	11	10	8	6
Nominal Diameter	1/16	3/32	7/64	1/8	9/64	11/64	13/64
No. Drill for Hole	48	36	30	28	21	11	2
Length of Shank							
5/16	x	..	..	..	..	..	..
7/16	x	..	..	..	..	..	.
1/2	x	x	..	..	..	..	..
5/8	x	x	..	..	..	..	..
3/4	x¹	x	..	..	..	..	..
7/8	..	x	A	x	..	..	..
1	..	x¹	x	x	..	..	..
1 1/8	..	x¹	x	x	..	..	..
1 1/4	..	..	x¹	x	A	..	..
1 3/8	..	..	x¹	x	x	..	..
1 1/2	..	..	..	x	A	..	..
1 5/8	..	..	..	A	x	x	..
1 3/4	..	..	..	x¹	x¹	x	..
2	..	..	..	..	x¹	x	x
2 1/4	..	..	..	..	A	x¹	x
2 1/2	..	..	..	..	..	x¹	x¹
2 3/4	..	..	..	..	..	..	x¹
3	..	..	..	..	..	..	x¹

Machinery

NOTE.—x, short series; x¹, long series; A, arbitrary sizes.

TABLE II. APPLICATIONS OF STANDARD COTTER PINS

Body Size of Bolt or Pin	Cotter Pins for Yoke and Rod Ends				Cotter Pins for S. A. E. Bolts				Cotter Pins for U. S. S. Bolts			
	Pin Dia.	Pin Length		Drill No.	Pin Dia.	Pin Length		Drill No.	Pin Dia.	Pin Length		Drill No.
		Sh'rt	Long			Sh'rt	Long			Sh'rt	Long	
3/16	1/16	5/16	1/2	48	..	..	..	..	..	..	..	..
1/4	1/16	7/16	5/8	48	1/16	1/2	5/8	48	1/16	1/2	5/8	48
5/16	3/32	1/2	5/8	36	1/16	5/8	3/4	48	1/16	5/8	3/4	48
3/8	3/32	5/8	3/4	36	3/32	5/8	3/4	36	3/32	3/4	7/8	36
7/16	3/32	3/4	7/8	36	3/32	5/8	3/4	36	3/32	3/4	1	36
1/2	3/32	7/8	1	36	3/32	3/4	7/8	36	3/32	7/8	1 1/8	36
9/16	..	..	..	..	1/8	7/8	1 1/8	28	7/64	1	1 1/4	30
5/8	..	..	..	..	1/8	1	1 1/4	28	7/64	1 1/8	1 3/8	30
11/16	..	..	..	..	..	..	..	..	7/64	1 1/8	1 3/8	30
3/4	..	..	..	..	1/8	1 1/8	1 3/8	28	1/8	1 1/4	1 1/2	28
7/8	..	..	..	..	1/8	1 1/4	1 1/2	28	9/64	1 3/8	1 3/4	21
1	..	..	..	..	1/8	1 1/2	1 3/4	28	9/64	1 5/8	2	21
1 1/8	..	..	..	..	11/64	1 5/8	2	11	11/64	1 3/4	2 1/4	11
1 1/4	..	..	..	..	11/64	1 3/4	2 1/4	11	11/64	2	2 1/2	11
1 3/8	..	..	..	..	13/64	2	2 1/2	2	13/64	2 1/4	2 3/4	2
1 1/2	.	..	..	..	13/64	2 1/4	2 3/4	2	13/64	2 1/4	3	2

Machinery

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PERSONALS

Harry R. Snyder, formerly of the Williamson Heater Co., Cincinnati, Ohio, has been made business manager of the Wrought Iron Heater Co., Des Moines, Iowa.

George E. Neil, formerly manager of the Neil Machinery Co., New York City, has taken the management of the machine tool department of Fairbanks, Morse & Co., New York City.

J. M. Toppin, who for several years has been connected with the General Electric Co., Pittsfield, Mass., has been appointed general manager of the Rhodes Mfg. Co., Hartford, Conn.

Donald B. Howard, general manager of the Wrought Iron Heater Co., Des Moines, Iowa, has been elected a member of the American Society of Heating and Ventilating Engineers.

R. W. Ellingham, formerly general factory manager of the Hendee Mfg. Co.'s plant at Springfield, Mass., is no longer connected with the company, having entered the employ of a Bridgeport, Conn., concern.

L. S. Love, formerly head of the L. S. Love Machinery Co., has joined the Sherritt & Stoer Co., Inc., 603 Finance Building, Philadelphia, Pa., dealers in machine tools, railway and machine shop equipment.

W. B. Gould, for many years with the Jones & Lamson Machine Co., Springfield, Vt., and well known to the machinery trade, has joined the machine tool department of Fairbanks, Morse & Co., New York City.

Roy C. McKenna, of the McKenna Bros. Co., Pittsburg, Pa., was recently elected president of the Vanadium-Alloys Steel Co., Pittsburg, succeeding E. T. Edwards, who resigned to become president of the Latrobe Electric Steel Co.

W. Spencer Robertson was appointed secretary of the American Locomotive Co. at a meeting of the board of directors, July 14, in New York City. Mr. Robertson was appointed to fill the vacancy caused by the resignation of C. B. Denny.

William T. Dunn, formerly tool steel expert for the Carpenter Steel Co. in Boston and New England, has been appointed district sales agent for New England and Eastern Canada, by the International High Speed Steel Co. of New York City.

C. D. Wheeler, for the past six years advertising manager of the Fort Wayne Electric Works of the General Electric Co., Fort Wayne, Ind., resigned the position July 17, to go with the Santo Mfg. Co., Philadelphia, Pa., as advertising and assistant sales manager.

J. E. Ruth, who has for some time been at the home office of the Gisholt Machine Co., Madison, Wis., preparing himself for work in the sales organization of the Gisholt periodograph department, is now located at the New York office of the company, 50 Church St. Mr. Ruth will look after Gisholt periodograph interests in the New York and metropolitan territory.

Arthur K. Ingraham, seventy-eight years old, and for forty-five years a salesman in the employ of the Joseph Dixon Crucible Co., Jersey City, N. J., is conceded to be the dean of traveling salesmen, claim to which distinction was relinquished by George Olney formerly of the Irving-Pitt Mfg. Co., Brooklyn, N. Y., who retired from active service over a year ago. Mr. and Mrs. Ingraham celebrated their golden wedding at their home in Mount Vernon, N. Y., seven years ago.

H. M. Montgomery, chairman of the Chicago section of the American Society of Mechanical Engineers, has been elected vice-president and director of the Powdered Coal Engineering & Equipment Co. of Chicago. This company is preparing elaborate plans for the construction and equipment of a large demonstration plant and research laboratory in Chicago where working demonstrations of the adaptation of powdered coal to all forms of furnace heat production will be carried on under engineering observation, aided by every influence that scientific research can bring to bear on the production of perfect combustion.

* * *

OBITUARIES

Thomas D. West, a well-known writer on foundry topics and author of several books on foundry practice, died in Cleveland, Ohio, June 17, following an automobile accident. Mr. West was the first one to subscribe to MACHINERY when it was started in 1894.

Charles H. Hunt, for forty years an armorer in the United States Armory at Springfield, Mass., died July 8, aged eighty-four years. Mr. Hunt was born in Springfield and lived there practically all his life. He entered the employ of the armory in 1861 and retired about fifteen years ago.

COMING EVENTS

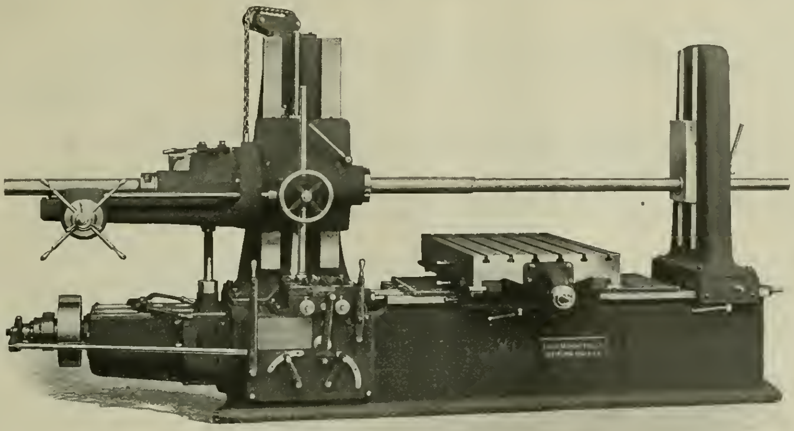
August 17.—Annual meeting of the International Railroad Blacksmiths' Association, Philadelphia, Pa. A. L. Woodworth, secretary-treasurer, C. H. & D. Railway, Lima, Ohio.

September 7-10.—Twenty-third annual convention of the Traveling Engineers' Association, Hotel Sherman, Chicago, Ill. W. O. Thompson, secretary, East Buffalo, N. Y.

September 9-11.—Swedish engineering convention in the United States; meeting in Chicago. Secretary, Eastern organization committee, E. Oberg, 183 68th St., Brooklyn, N. Y.; secretary Western organization committee, C. G. Axell, 601 City Hall Square Bldg., Chicago, Ill.

September 25-October 2.—Annual exhibit of the Foundry & Machine Exhibition Co., Atlantic City, N. J., in conjunction with the American Foundrymen's Association convention. Foundry & Machine Exhibition Co., 1049 W. Madison St., Chicago, Ill.

September 27-October 1.—Annual convention of the American Foundrymen's Association, Atlantic City, N. J.



Do you keep a record of the performance of every tool in your shop; how much work it does; how good work it does; how long it takes to "break in" a new man on the machine; how much it stands idle for repairs, and how much the repairs cost? If you do, you are just the kind of a customer we want for the

"PRECISION"

BORING, DRILLING AND MILLING MACHINE

THE

ORIGINAL "LUCAS TYPE"

Power feeds in every direction. QUICK POWER RETURN to every feed. THE SAME LEVER FOR ALL.

LUCAS MACHINE TOOL CO., NOW AND ALWAYS OF **CLEVELAND, O., U.S.A.**

SOCIETIES, SCHOOLS AND COLLEGES

Michigan College of Mines, Houghton, Mich. Year book for 1914-1915, and announcement of courses for 1915-1916.

University of Nebraska, Lincoln, Neb. Forty-fifth annual general catalogue containing record for 1914-1915 and announcements for 1915-1916.

Clarkson College of Technology, Potsdam, N. Y. Bulletin of the Clarkson College of Technology, showing the equipment of the shops and laboratories, etc.

Pennsylvania State College, State College, Pa., will conduct a summer school of scientific management during the two weeks beginning August 9. This summer season is planned for the accommodation of works managers; superintendents; heads of cost, stores, purchasing, planning and production departments; and members of such departments. The fee for this course is $15. Application should be made to J. A. Moyer, director, State College, Pa.

NEW BOOKS AND PAMPHLETS

Safety and Short Trains. By Marcus A. Dow. 30 pages, 5 by 7¼ inches. Published by the New York Central Lines, New York City.

Cost Reduction America's Only Salvation. By Dr. Robert Grimshaw. 14 pages, 6 by 9 inches.

This is a reprint of an address delivered by Dr. Grimshaw before the American Supply & Machinery Manufacturers' Association convention, held in Philadelphia, June 4, 1915. Dr. Grimshaw compared prices of European and American labor and products, and endeavored to show how necessary it is that these costs be reduced if we ever hope to obtain a secure foothold in foreign markets.

The Slide Rule. By Charles N. Pickworth. 122 pages, 5 by 7 inches. Published by the Van Nostrand Co., New York City. Price, $1.00.

This is the thirteenth edition of a practical manual relating to the use of the slide rule, revised and extended to include descriptions of various new slide rules and calculators. A brief reference to the extraction of fifth roots has been added. The book covers the subject thoroughly and should be useful to those who wish to make a complete study of the various applications of the slide rule to engineering calculations.

Purchasing. By C. S. Rindfoos. 165 pages, 6 by 9 inches. Published by the McGraw-Hill Book Co., New York City. Price, $2.

Recognizing the lack of literature on the subject of purchasing, this book has been prepared to meet the general requirements for information of this kind. The book covers a wide range as indicated by the chapter heads, which are as follows: How to Obtain the Right Article; How to Obtain the Lowest Price; How to Obtain Prompt Delivery; Making the Purchase Conform to Fixed Policy; How to Obtain Favorable Terms; Personal Characteristics and Qualifications; Strategy; Some of the Legal Aspects of Purchasing; Departmental Organization; Forms.

The Coking of Coal at Low Temperatures with Special Reference to the Properties and Composition of the Products. By S. W. Parr and H. L. Olin. 39 pages, 6 by 9 inches. Illustrated. Published by the University of Illinois, Engineering Experiment Station, as Bulletin 79. Price, 25 cents.

Coke produced by the low temperature process contains from 18 to 22 per cent of volatile matter and retains none of the tar-forming constituents. In domestic use, it kindles readily and burns with a bright smokeless flame. Results of the study show that the coke, tar and gas have specific properties of special value, and they indicate that the process of coking at low temperature could be established successfully and on a commercial basis.

Practical Shop Mechanics and Mathematics. By James F. Johnson. 130 pages, 5 by 7 inches. 81 illustrations. Published by John Wiley & Sons, New York City. Price, $1.

The author, who is superintendent of the State Trade School in Bridgeport, Conn., has collected in this book a great amount of material based upon his teaching experience and upon a shop practice covering a period of nine years. The subject is presented in a clear and simple style, and only the fundamental principles of each subject are presented. The book is divided into eight chapters, dealing with materials; measures and weights; measuring instruments; pulleys and belting; toothed gearing; force and its relation to work; forces; stress and strain; and angle measurements.

The 1915 U. S. Standard Schedule of Flanged Fittings and Flanges. Chart issued by the National Association of Master Steam and Hot Water Fitters, 260 West Broadway, New York City. Price, $1.00.

The standard types and dimensions of flanged fittings illustrated and tabulated on this chart were adopted March 20, 1914, by a joint committee of the National Association of Master Steam and Hot Water Fitters, the American Society of Mechanical Engineers, and the Committee of Manufacturers on Standardization of Fittings and Valves, and comprises the same sizes and dimensions which had previously been adopted by the Committee of Manufacturers on Standardization of Fittings and Valves, and which, by this committee, is termed the "American standard," and which became effective January 1, 1914.

The Design of Drill Jigs. By Andrew N. Haddow. [illegible] pages, 6¼ by 8¼ inches. 142 illustrations. Published by Emmott & Co., Ltd., Manchester, England. Price, 2 shillings, 6 pence (60 cents).

In this book the author has endeavored to give the result of his own experience in the hope that it may be helpful to those intending to devote their attention to the design of jigs and fixtures. The book comprises ten chapters dealing first with jig and fixture details, and then with special examples of jig design. The method of arrangement and the material contained resemble, in a general way, a number of series of articles that have appeared in the mechanical press here and abroad, and the book is, in fact, made up from a series of articles that have been published from time to time in the "Mechanical World." The chapters are headed as follows: Introduction—Jigs and Fixtures—Thumbscrews—Standard Parts—Selection of Type, with Examples—Drill Jigs—Drilling, Tapping, and Studding Tools—Fixtures for Drilling, etc.—Special Jigs.

Purchasing. By H. B. Twyford. 236 pages, 6 by 9 inches. Numerous illustrations, charts, diagrams and forms. Published by D. Van Nostrand Co., New York City. Price, $3.

While purchasing is one of the primary functions in the activities of business, the literature relating to the subject is meager. The reason for this is probably the difficulty of giving specific directions and the great differences that exist in different kinds of business. The author of the book under review, however, has endeavored to generalize the subject, and has placed on record a valuable collection of directions for those who have to do the purchasing for a business. The book is divided into four main parts entitled Purchasing, Purchasing Organization, Operation of Purchasing Department, and Purchasing as Practiced. Each of these main divisions is divided into chapters, the chapter headings being as follows: Principles of Purchasing, General Considerations; Functional Position of Purchasing Considered; Ethics of Buying; The Purchasing Agent; The Purchasing Department; Organization of the Department; System of Procedure; Obtaining and Tabulating Proper Records; Work Connected with Requisition and Order; Invoices and Method of Handling; Operation of Stores; Purchasing for Railroad Construction Work and for Operation of Electric Railroads; Purchasing for a Manufacturing and Construction Company; Purchasing for Construction and Operation in Widely Separated Localities; Purchasing for a Small Manufacturing Establishment.

Grinding Machinery. By James J. Guest. 444 pages, 5½ by 8½ inches. 200 illustrations. Published by Longmans, Green & Co., New York City. Price, $4.20.

This is one of the most complete books on grinding machinery that has been published, and it deals with the subject in a logical manner. It gives a great deal of attention to the different kinds of grinding machines and the appliances and attachments used in connection with them; but the practical requirements in grinding are perhaps not dealt with quite as completely as might be desired. The first chapter contains a general introduction, indicating the relation of grinding to manufacturing. The second chapter deals with the abrasives and the wheels, briefly reviewing the different kinds of abrasives and bonds, and entering somewhat upon the theory and the strength of wheels and their mounting and truing. The next chapter deals with the relation of the wheel to the work, wheel speeds, and work speeds. Much of this material is devoted to theoretical considerations which may be of considerable interest to the student of abstract theories, but which are of somewhat doubtful practical value. In the following chapters, plain, internal, and surface grinding machines, together with their various details, are fully illustrated and described. A practical chapter on the sharpening of cutters and tools in general is included. Even here, however, the author has entered somewhat upon mathematical considerations that are of no practical importance. The last chapter relating to grinding covers form grinding. A chapter on polishing and lapping and another on measuring instruments and gages are included. The latter does not seem to be required in a book dealing with grinding, although it contains some interesting information relating to standard measuring methods and instruments.

NEW CATALOGUES AND CIRCULARS

Lagonda Mfg. Co., Springfield, Ohio. Circular of the Lagonda vibrator cleaners for return tubular boilers.

Simplex Drafting Appliance Co., Malden, Mass. Circular of the "Simplex" parallel attachment for drawing boards.

Eastern Machine Screw Corp., New Haven, Conn. Circular of the H & G automatic self-opening die head for screw machines.

George P. Clark Co., Windsor Locks, Conn. Bulletin M illustrating and describing trucks for dry goods, dye houses, laundries, factories, etc.

Rigid Tool Holder Co., Baltimore, Md. Circular of the "Rigid" tool-holders for lathes illustrating construction and application for turning and boring.

Bay State Stamping Co., 380 Chandler Street, Worcester, Mass. Circular of self-closing oil hole covers, horizontal oilers, wick feed oilers, grease cups, emery wheel dressers, ferrules, etc.

National Machinery Co., Tiffin, Ohio. Tapper Talk No. 6, continuing the discussion of the bent tap principle as exemplified in the National Machinery Co.'s automatic bent tap nut tapper.

Society for Electrical Development, Inc., 29 West 39th St., New York City. Booklet outlining the plans for the Electrical Prosperity Week to be observed November 29 to December 4, 1915, under its auspices.

American Roller Bearing Co., 416-420 Melwood Ave., Pittsburg, Pa. Bulletin 1002 of roller bearing lineshaft hangers. These are furnished for regular shaft sizes from 1 7/16 to 5 15/16 inches diameter, inclusive.

F. H. Stolp, 92 Brook St., Geneva, N. Y. Circulars of an automatic self-feeding punch press adapted to make radiator fins complete, and a machine for drawing tubing or molding to any form from flat metal ribbon.

Stark Tool Co., Waltham, Mass. Catalogue of precision bench lathes, compound slide rests, cutting-off and forming rests, collets and other accessories. The catalogue is printed in English, German, French and Spanish.

Hunter Pressed Steel Co., Orthodox and Horrocks Sts., Philadelphia, Pa. Circular of the "Airspring" automatic grease cups in which a disk is pressed down on the grease by compressed air, assisted by a light coil spring.

Gisholt Machine Co., Madison, Wis. Looseleaf catalogue of Gisholt vertical boring and turning mills, showing 30-inch, 36-inch, 42-inch, 48-inch, 52-inch, 60-inch, and 72-inch sizes, and illustrating methods of mounting motors for driving same.

Lincoln Electric Co., East 38th St. and Kelley Ave., Cleveland, Ohio. Booklet on welding with the electric arc, illustrating the apparatus and describing the principles of practice. Numerous examples of broken machine parts repaired by electric arc welding are shown.

L. G. Stebbins, New London, Conn. Circular of "Crystal" sanitary water cooler for shops, mills, factories, etc. The ice is placed in a separate compartment on top and the drinking water underneath, the arrangement being such that the ice and drinking water do not come together.

Whitney Metal Tool Co., Rockford, Ill. Circulars of ball bearing punches in three sizes, the smallest having a capacity for punching a ⅝-inch hole through ¼-inch iron, and the largest for a ¾-inch hole through ¾-inch iron. These hand-operated punches are used successfully for riveting also.

Boston Gear Works, Norfolk Downs, Mass. Circular of hobs made of carbon steel and high-speed steel, unground and ground after hardening. Hobs with side clearance to teeth are also furnished to order. A list of unground high-speed steel hobs ranging from 48 to 6 diametral pitch is included.

Gardner Governor Co., Quincy, Ill. Booklet on the Gardner air-lift containing suggestions for the installation of the air-lift system of water pumping, tables of efficiency and data of various types of Gardner air compressors. The air-lift is suitable for deep wells in which it would be difficult, if not impossible, to install a regular piston pump.

Horsburgh & Scott Co., 5114 Hamilton Ave., N. E., Cleveland, Ohio. "Blue Book on Gearing," listing rawhide gears, cut metal gears, planed bevel gears, herringbone gears, spiral gears, racks, worms and worm gears. The company also does gear cutting to order. The book contains tables and gear data generally useful to draftsmen, designers, engineers, etc.

J. G. Blount Co., Everett, Mass. Catalogue No. 17 of grinding and polishing machinery and speed lathes. The line comprises bench and floor grinding machines with self-oiling bearings; wet tool grinders; combination grinding, polishing, buffing machines; speed lathes with accessories and equipment especially suited for manual training schools, etc.

Keystone Blue Paper Co., 910-912 Filbert St., Philadelphia, Pa. Circular containing samples of blue process papers made by the company. Attention is called to the fact that the company has a supply of red prussiate of potash, on the exportation of which an embargo has been laid by Germany and Austria, sufficient to supply its factory until peace is declared, probably.

New Departure Mfg. Co., Bristol, Conn. Ball bearing application sheets Nos. 35 FE, 36 FE, 37 FE and 38 FE, illustrating ball bearing blower mounting to replace plain babbitt boxes; ball bearings in vacuum cleaning and draft producing blowers; ball bearings for twin blower drive shaft support; and ball bearings for clutch and spindle support on special cutting-off machine, respectively.

Gisholt Machine Co., Madison, Wis. Catalogue K3 on the universal tool grinder, illustrating the machine, and showing the economies that result from the use of a tool grinder in manufacturing plants. The very practical feature of the catalogue is a list of tool shapes, including all the more common forms of lathe tools and giving the angles of clearance, front rake, top rake, and side rake.

Colonial Steel Co., 324 Fourth Ave., Pittsburg, Pa. Catalogue 11-B containing information on the use of "Colonial" high-speed steel in lathe and planer tools, disks and dies, and including description of its No. 7 tool steel. Much useful information is included on annealing, hardening and tempering carbon steels, the selection of tool steel, etc., also tables of information of value to steel users in general.

Titanium Alloy Mfg. Co., Niagara Falls, N. Y. Booklet on titanium aluminum and other bronze castings, giving the approximate composition of the various alloys with photomicrographs. The alloys described have been selected after careful

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research, followed by extended service trials in an effort to cover broadly the range of engineering specifications. The booklet should be of much interest to metallurgists and users of alloys generally.

Cameragraph Co., Kansas City, Mo. Catalogue of the "Cameragraph" duplex and "Cameragraph" simplex. The cameragraph is a photographic apparatus designed to economically reproduce drawings, blueprints, letters, fabrics, etc. It exposes, develops and fixes the prints entirely within the machine, without the use of a dark room, plate, or film. The duplex machine makes prints on both sides of the paper, and the simplex machine on one side only.

Chicago Pneumatic Tool Co., 1010 Fisher Bldg., Chicago, Ill. Bulletin E-36 superseding E-29 on electric grinders of the heavy duty portable type for foundries, machine shops, structural shops, grinding street railway rails, etc.; universal portable grinders for direct or single phase alternating current; universal portable surface grinder for structural work, castings, etc.; electrical tool-post grinder for direct current, No. 10 pedestal grinder; No. 6 external and internal precision grinder; etc.

Walworth Mfg. Co., Boston, Mass. General catalogue, 486 pages, 5 by 7¼ inches, listing the complete line of brass and iron goods and tools made by this company. The product includes screw fittings, malleable iron fittings, flanged fittings, pipe joints, pipe bends, gate valves, safety valves, globe and angle valves, check valves, swivel joints, reducing valves, steam and water gages, oil cups, oilers, wrenches, die-plates, vises, glass cutters, radiators, steam traps, thermometers, water and pressure piping, etc.

De Laval Steam Turbine Co., Trenton, N. J. Catalogue of De Laval centrifugal blowers and compressors designed for compressing air at all pressures from five inches water column to 125 pounds per square inch. With proper design and the use of good materials and workmanship, it is possible to run the blower and compressor wheels at peripheral velocities of 450 to 600 feet per second, thus making it possible to develop pressures of three to four pounds per square inch in single-stage blowers. The company's construction of single-stage and multi-stage blowers is illustrated. Numerous charts are also shown giving curves for the isothermal, adiabatic and actual compression of air and characteristic curves of single-stage and multi-stage blowers and compressors.

TRADE NOTES

Hurlbut-Rogers Machine Co., South Sudbury, Mass., makers of cutting-off and centering machines, has changed its corporate name to Hurlbut-Rogers Machinery Co.

Universal Electric Welding Co., 42d St. Bldg., 30 E. 42d St., New York City, has moved its welding plant from 47 West St. to the Russell Bldg., 67-79 Sixth St., Long Island City, N. Y.

Van Norman Machine Tool Co., Waltham Ave., Springfield, Mass., has recently completed the following additions to its factory: one three-story brick building, 50 by 90 feet; one three-story brick building, 32 by 25 feet; and a one-story brick building, 30 by 32 feet.

J. W. Fiske Iron Works, 78 Park Place, New York City, has been awarded the contract for a non-climbable chain link fence eight feet high, to surround the large new plant of the Nixon Nitration Works at New Brunswick, N. J., recently organized to manufacture explosives.

Brown & Sharpe Mfg. Co., Providence, R. I., will close its works from August 7 to 16 for the annual vacation. During this time the offices will be open as usual, and orders for machine tools, machinists' tools and cutters will receive the same attention as usual.

Virginia Machinery & Well Co., 1319 E. Main St., Richmond, Va., has entered the jobbing field in Richmond with a stock of machinery and supplies, and will cater to hardware dealers, plumbers, machine shops, municipalities, mills, factories, contractors, railroads and consumers.

L. H. Gilmer Co., 52 N. Seventh St., Philadelphia, Pa., has purchased two acres of land on the Philadelphia and New York line of the Pennsylvania Railroad at Tacony Station, on which to erect a modern factory building. The new plant is being built to take care of the increased business in automobile parts and the Gilmer belting line.

Burd High Compression Ring Co., Rockford, Ill., has begun the installation of machinery in an additional new factory building containing 30,000 square feet of floor space. The additional facilities were found necessary to enable the company to make deliveries on large contracts and to start work on business that has been waiting for the increase in capacity.

Cataract Refining & Mfg. Co., Buffalo, N. Y., is pushing its "Acme" cutting lubricant to the attention of manufacturers of shrapnel shells. This compound emulsifies readily with water and has good lubricating qualities. It does not rust the metal, and because of its excellent cooling qualities, higher speeds and increased production are secured at low cost.

Olmsted-Flint Co., Cambridge, Mass., manufacturer of belting, has opened a New York branch at 37 Warren St., under the management of the Benjamin S. Adler Co. Complete facilities have been installed to properly care for the New York trade, and large stocks of all sizes of belting will be carried. The company began operations in its new factory at Cambridge, January 1 this year, and the New York branch is necessary to care for its growing trade.

Union Mfg. Co., New Britain, Conn., is erecting a new building 47 by 160 feet, five stories high. The building is constructed with a steel frame and the first floor will be made of concrete slabs with cement finish. The other floors and roof will be built of wood on steel beams. The outside walls are of brick with artificial stone trimmings. The building is to be equipped with the sprinkler system throughout. A brick tower 114 feet high, 19 feet square will contain the storage tank for the sprinkler system.

Fairbanks, Morse & Co., 30 Church St., New York City, has acquired the business of the Nell Machinery Co., and George E. Nell, its former manager, will act as manager of the machine tool department of Fairbanks, Morse & Co. The following agencies formerly controlled by the Nell Machinery Co. have been taken over: Lees-Bradner Co., Cleveland, Ohio; Kern Machine Tool Co., Hamilton, Ohio; Springfield Machine Tool Co., Springfield, Ohio; Colburn Machine Tool Co., Franklin, Pa., and the Bridgeford Machine Tool Co., Rochester, N. Y.

Classified Advertisements—Situations, Help Wanted, For Sale, etc.

Advertisements in this column, 20 cents a line, seven words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

HELP WANTED

DRAFTSMAN familiar with machine tool designing. State age, experience and salary wanted. ANTHONY S. HILL, Hackettstown, N. J.

SALESMEN on 40 per cent commission basis to handle new $6.00 Boring Tool which sells at sight. Box 761, care MACHINERY, 148 Lafayette St., New York.

MECHANIC WANTED.—Thoroughly familiar with construction and operation of electric tube welding machine. Please state full particulars. Box 743, care MACHINERY, 148 Lafayette St., New York.

EXPERIENCED DRAFTSMEN on rolling and wire mill machinery, also on general mill work; location Connecticut. State age, experience and salary expected. Address M. L., Box 762, care MACHINERY, 148 Lafayette St., New York.

COMPETENT DRAFTSMEN experienced in designing machine tools, for new department in established business. State age, experience, references and salary in first letter. Applications confidential. Box 769, care MACHINERY, 148 Lafayette St., New York.

WANTED AGENTS.—Saunders' Pocket "Hand Book of Practical Mechanics" for tool chest $1.00 only. Why pay more? It fills bill for shop kinks, ready reference, simple arithmetic. Send for circular. E. H. SAUNDERS, 216 Purchase St., Boston, Mass.

HIGH-CLASS FOREMAN for a modern machine shop. Must be an energetic and experienced machinist thoroughly acquainted with modern high-speed machine tools, and capable of producing maximum work from the various machines. Location Buffalo, New York. This is an exceptional opportunity for a first-class man. State experience and remuneration expected. Box 764, care MACHINERY, 148 Lafayette St., New York.

GENERAL FOREMAN for night force by corporation in Hartford, Conn., making interchangeable small parts. Night force will probably last two years and there will be an opportunity for successful applicant to transfer into regular day force if he proves his worth. All applications to receive consideration should state past experience, age and salary expected. No inquiries will be made without consent of applicant. Box 756, care MACHINERY, 148 Lafayette St., New York.

SITUATIONS WANTED

EXPERIENCED HIGH-GRADE MACHINERY SALESMAN with practical shop and office experience, desires position with responsible concern as road salesman or assistant sales manager. Clean past record. Box 753, care MACHINERY, 148 Lafayette St., New York.

EXPERT SPECIAL MACHINERY DESIGNER and experimental engineer, with eighteen years' shop and office experience, desires position. Small town preferred. Might make investment. Box 752, care MACHINERY, 148 Lafayette St., New York.

MANUFACTURERS' AGENT. — Boston headquarters—covering New England, wants to enlarge operations. An exclusive line is desired, selling to manufacturers and mills. We are established and are getting results. Box 712, care MACHINERY, 148 Lafayette St., New York.

MECHANICAL DRAFTSMAN, 21 years of age, desires position in South. Technically educated; experienced in elevating and conveying machinery; neat tracer and letterer. Box 763, care MACHINERY, 148 Lafayette St., New York.

MANUFACTURERS' ADVERTISING MANAGER, several years' experience in compiling and printing illustrated catalogs and price lists, who thoroughly understands his business, has used 21 trade papers, domestic and export, is open for engagement. M. L. B. Box 760, care MACHINERY, 148 Lafayette St., New York.

FOR SALE

GET A "LAST-WORD."—The Test Indicator Par Excellence. H. A. LOWE, 1374 E. 88th St., Cleveland, O.

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PATENTS

PATENTS SECURED.—C. L. PARKER, Ex-member Examining Corps, U. S. Patent Office. Instructions upon request. 900 G St., N. W., Washington, D. C.

PATENTS.—H. W. T. JENNER, patent attorney and mechanical expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact cost. Send for full information.

PATENTS.—A book on patents and patent law for the practical man. Contains the principal provisions of the patent law, describes in detail the procedure in obtaining a patent, and deals with patent infringements. Not a book for patent lawyers, but for practical mechanics. Price, 25 cents. MACHINERY, 148 Lafayette St., New York.

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UNDERSIGNED COUNSEL will confidentially negotiate preliminaries for important executive, technical, administrative, manufacturing, and professional positions, insuring strictest privacy. Though listed as an agency (for want of a more explicit heading) there is no commission nor contract involved in my service, but a counsel fee for actual service only. $2,500 to $15,000 men exclusively. Send only your name and address for prefatory details. R. W. BIXBY, C-1 Niagara Square, Buffalo, N. Y.

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